national gas transmission

Hatton Compressor Station Upgrade

Application for variation to Environmental Permit

Permit Reference: EPR/UP3333LL/V006

May 2023

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Document Structure

Non-technical Summary

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Document history and status

Project details

Project number	NGG.036.b
Project name	Hatton IED Compressor Upgrade
Date	May 2023

Client details

Client contact	
Client name	National Gas Transmission plc
Client address	National Gas Transmission plc Warwick Technology Park Warwick CV34 6DA

Document details

Document title	Application for Variation to Environmental Permit: Substantial change
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Non-technical summary

This application for an environmental permit variation (Substantial Change) under the Environmental Permitting (England and Wales) Regulations (EPR) (2016, as amended) is in relation to National Gas Transmission plc's Hatton Compressor Station. An administrative variation is also made in parallel to reflect the change in name of the operator from National Grid Gas plc to National Gas Transmission plc.

Background

National Gas Transmission plc. (National Gas Transmission) is responsible for the safe and efficient delivery of natural gas from the coastal reception terminals and European interconnector pipelines to the point of use. National Gas Transmission operates twenty-four compressor stations as part of the National Transmission System (NTS). This is a network of high pressure, buried pipelines over 7,600 kilometres in length which enables natural gas from the North Sea and other regions across the world to be transported to consumers across the UK. Within this system, compressor stations are used to compress the gas being transported, to maintain safe system operating pressures. Gas turbine driven compressors are used in all but a few of the compressor stations, the others being driven by variable speed electric motors. Where gas turbines are used they are all fuelled by natural gas from the NTS.

Natural gas is received at the station isolation valves from the NTS pipework at a pressure between 40 and 70 barg and passes through separation units (scrubbers) where any entrained liquid and solid particles are removed. Depending on demand, the natural gas leaves the compressor station at up to 75 barg.

Hatton Compressor Station (also referred to as "the Installation") currently has three Rolls Royce RB211-24C gas turbine driven compressor units (A, B and C), installed in three separate 'cab' buildings (also called compressor enclosures) and a fourth compressor unit (D) powered by a Variable Speed Drive (VSD). The gas turbine compressor units A, B and C each comprise an aero derivative[1] hot gas generator, power turbine and centrifugal compressor. All units can be run individually or in pairs only, although three units may be fired up concurrently for short periods when switching from one driver to another (referred to as 'running changeovers').

The VSD unit D acts as lead unit at the installation, with the gas powered units A, B and C providing additional compression when required and also standby capacity in the event the VSD is unavailable through either power outage or maintenance.

1 Aero derivative - based on the type of engines used in aircraft

Although gas is a clean fuel, like any combustion source, there are emissions of the products of combustion, including oxides of nitrogen, carbon monoxide and carbon dioxide, which are dispersed into the atmosphere via the exhaust stacks (chimneys). National Gas Transmission undertakes regular emissions tests and uses specialist independent consultants to periodically undertake computer modelling of how the emissions disperse in the atmosphere. All of these studies have confirmed that no harm is being caused by the Hatton Compressor Station and no legally binding 'Air Quality Standards' are being breached.

Reasons for change

Under the conditions of the site's environmental permit and the Industrial Emissions Directive (IED), National Gas Transmission is required to investigate then implement environmental improvements at strategic parts of the network on sites which are subject to high utilisation and operate older machinery, such as Hatton. The three Rolls Royce RB211 gas turbine driven compressor units A, B and C, although reliable and efficient are not able to meet the emissions standards achieved by modern 'low emission' gas turbine engines.

As a result, two of the RB211 compressor units (B and C) are due to be retired at the end of 2023 and deactivated (fuel supply disconnected). The remaining RB211 unit A will be retained on site for emergency use only, under the 500hr derogation under the Industrial Emissions Directive, in fully serviced, working order to provide back-up to the VSD unit D or the new unit E, should either become unavailable during periods of high flow. The existing VSD unit D remains unchanged.

With the retirement of units B and C at the end of 2023, National Gas Transmission have assessed a number of technical solutions to replace units B and C and to reduce emissions from the site. After conducting a detailed engineering study and assessment of Best Available Techniques (BAT) (as required by the Environmental Permitting Regulations) National Gas Transmission determined that installation of one new 'ultra-low emission' Siemens STG750 gas turbine driven compressor (unit E) offered the best technical and environmental solution. The BAT assessment detailing this is included in Appendix 6 of this application.

Details of the changes

The new unit E, which is similar in operation to the existing RB211 units, albeit of a larger more modern design, will be installed in a purpose built, bespoke noise control enclosure. It will be fitted with a new combustion air intake, exhaust stack (with emission sampling provisions) and fuel gas pre-heating skid (which will use recovered waste engine heat in normal running conditions).

The new unit E and associated ancillary equipment will be built on land outside of the current installation boundary. Therefore, the installation boundary will be extended to the West on National Gas Transmission land between the gas valve compound (known as the AGI (Above Ground Installation)) and existing compressor boundary.

The project will be implemented in stages, with major invasive activities being carried out during the summer months when the compressor network operates less. Construction activities commenced in 2022 and relate to moving pipelines between the AGI and compressor boundary. The existing VSD unit D will continue to provide lead duty, together with the existing RB211s A, B and C providing support and standby duty until the new unit is operational (subject to the Limited Life and emergency use derogations). The new unit E is scheduled to be ready for operational usage on or before 31st December 2023.

National Gas Transmission will carefully manage the transition phase between current and future unit running. The existing unit control systems, routine maintenance and emissions testing regimes will continue unchanged; detailed commissioning plans and training programmes will be drawn up to facilitate the transition to the new unit. The new unit E will have to be proven through extensive test runs during commissioning, during which Original Equipment Manufacturer (OEM) representatives will train the site operatives in classroom and practical sessions (refer to Section III, Part C2, Question 3d, management systems for further information) on operations, control systems and routine maintenance. It will have its own independent dedicated control system, enabling local and remote operation (as per the current units) and supporting ancillaries, thus there will be few points of operational integration between the systems to facilitate an effective transition. A series of comprehensive process safety assessments have considered potential health safety and environmental risks posed by the new plant, and comprehensive risk controls and safety systems are incorporated and all relevant operational procedures will be reviewed and updated.

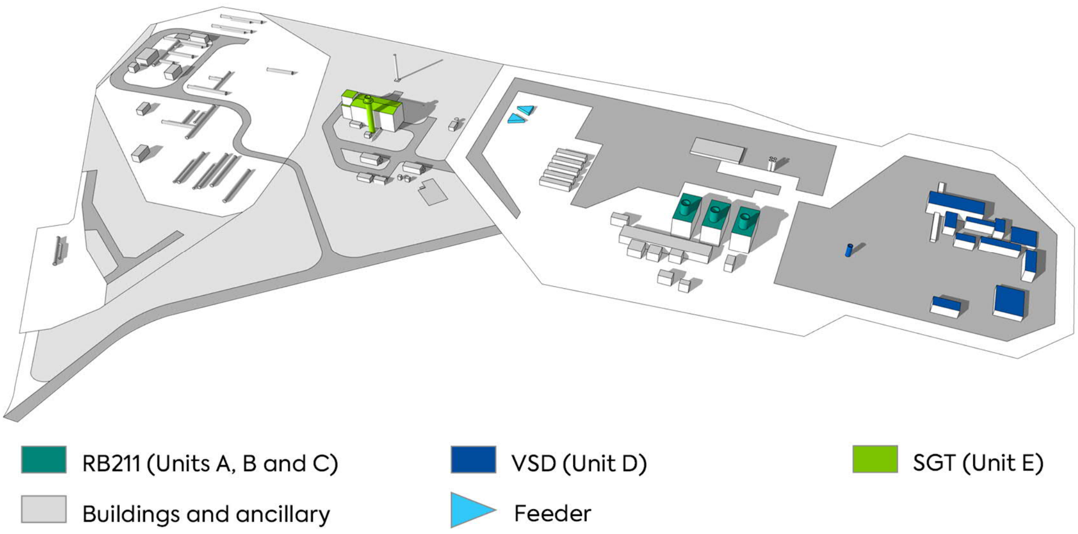
The new unit E ultra-low emission engine will always run in preference to the older retained RB211 unit A to support the VSD, if operationally available. However, retaining certain ancillary plant associated with the operation of unit A will be necessary, for example, the fuel gas pre-heating skids and control systems. Unit A will continue to be served by its existing vent stack. An updated site layout plan is included as Figure 2. This application seeks to demonstrate that either unit D (VSD) or the new unit E represent BAT and can therefore be used interchangeably as the lead unit, in order to maximise efficient and flexible operation.

Summary of changes:

- Retirement of existing units B and C
- Installation of one new ‘ultra-low emission’ Siemens STG750 gas turbine driven compressor (unit E), to include exhaust stack and Continuous Emissions Monitoring System (CEMS) system and new vent stack.
- Installation of new diesel standby generator (replacing an older existing generator)
- Ancillary equipment, such as lube oil cooler, and new control systems

The above summary forms the basis of this application for an environmental permit variation.

Figure NTS-1 Hatton schematic (proposed)



Assessment of environmental impacts

The proposed new compressor unit E, exhaust stack and standby diesel generator represent an alteration to the noise sources on site. A detailed analysis of the potential noise emissions from the installation was carried out during the design stage and this concluded that through appropriate installation of mitigation measures and careful design (including the bespoke noise control enclosures), there will be no significant negative environmental impacts on sensitive receptors with respect to noise (refer to Appendix 3).

Consideration of the potential for pollution to land, water and groundwater was undertaken through production of the original Application Site Report (2006); this was updated and supplemented with the 'Addendum to Application Site Report' in the 2012 environmental permit variation to install unit D. A further addendum has been prepared, in the form of a Site Condition Report (SCR) in respect of the current proposals. The SCR confirms that the installation presents a moderate/low to low risk of future pollution occurring because of storage controls, management practices and planned mitigation measures. Alterations to site drainage and surface water management relate only to the new or modified areas of the installation; these areas will be subject to local infiltration drainage or connected to a new surface water management system, depending on the potential environment risk posed by the areas in question. A new emission point to surface water (W3 on Figure 3) is proposed, which takes uncontaminated surface water from new site areas, via an attenuation tank and interceptor.

As part of the engineering design scheme a geotechnical and geoenvironmental design investigation was undertaken in 2020[2]; this enabled the collection of limited land quality data, which is also submitted as part of the Site Condition Report for the purpose of providing additional baseline information in support of the original 2006 ASR. No significant contamination was noted during this investigation.

An Air Quality Impact Assessment (AQIA) has been undertaken (Appendix 5) which compared emissions from current operations with predicted emissions after installation of the proposed new ultra-low emission gas turbine compressor unit E. This study concluded that both the current and proposed schemes are compliant with all relevant Air Quality Standards and that the installation of the new unit will result in an improvement in local air quality (and mass emissions) for all substances considered in the assessment (oxides of nitrogen and carbon monoxide). There remains, as present, no risk of odour being generated by the process; natural gas in the NTS is unodorised and none of the waste or raw materials in current or future use are odorous.

Overall, it is concluded that the proposed variation will not result in significant negative impacts on environmental receptors and offers the potential for significant improvement with regard to emissions of oxides of nitrogen and carbon monoxide from the installation. The environmental controls and operational practices employed in the facility comply with the requirements of BAT. The proposed scheme will bring about a number of improvements and advantages including:

- Reduced mass emissions of oxides of nitrogen and carbon monoxide to the atmosphere from the installation.
- Reductions in predicted ground level concentrations of oxides of nitrogen and carbon monoxide.
- Installation of a unit with an advanced, modular, low noise design, providing protection from noise impacts at nearby sensitive receptor locations.
- Improvements in thermal and overall compression efficiency.
- Environmental risk reduction through implementation of improved pollution control measures.
- Compliance with current and known future emissions limits as set in the sector BAT Reference (BREF) document in a cost effective manner which represents value for National Gas Transmission's customer base, the nation's energy consumers.
- Provision of greater reliability and reduced maintenance cost.

2 Advisian (2021), Final Geo-Environmental Site Assessment, Hatton Gas Compressor Station, Hatton, Lincolnshire, January 2021.

Section I: Application forms

Part A

Application for an environmental permit
Part A – About you

You will need to fill in this part A if you are applying for a new permit, applying to change an existing permit or surrender your permit, or want to transfer an existing permit to yourself. Please check that this is the latest version of the form available from our website.

You can apply online for Waste standard rules environmental permits, bespoke waste permits and bespoke Medium combustion plant permits

Apply online for an environmental permit.

Please read through this form and the guidance notes that came with it.

The form can be:

1) saved onto a computer and then filled in. Please note that the form follows a logic that means questions will open or stay closed depending on a previous answer. So you may not be able to enter text in some boxes.

2) printed off and filled in by hand. Please write clearly in the answer spaces.

Note: if you believe including information on a public register would not be in the interests of national security you must enclose a letter telling us that you have told the Secretary of State. We will not include the information in the public register unless directed otherwise.

It will take less than one hour to fill in this part of the application form.

Where you see the term ‘document reference’ on the form, give the document references and send the documents with the application form when you’ve completed it.

Contents

1 About you

Are you applying as an individual, an organisation of individuals (for example, a partnership), a company (this includes Limited Liability Partnerships) or a public body?

An individual	☐	Now go to section 2 and if you are applying for a new permit or transferring a permit for an installation or waste activity please also fill in Appendix 1
An organisation of individuals (for example, a partnership)	☐	Now go to section 3 and if you are applying for a new permit or transferring a permit for an installation or waste activity please also fill in Appendix 1
A public body	☐	Now go to section 4
A registered company or other corporate body	☑	Now go to section 5 and if you are applying for a new permit or transferring a permit for an installation or waste activity please also fill in Appendix 1

2 Applications from an individual

2a Please give us the following details

Name

Title (Mr, Mrs, Miss and so on)

First name

Last name

Now go to section 6

3 Applications from an organisation of individuals or charity

3a Type of organisation

For example, a charity, a partnership, a group of individuals or a club

3b Details of the organisation or charity

If you are an organisation of individuals, please give the details of the main representative below. If relevant, provide details of other members (please include their title Mr, Mrs and so on) on a separate sheet and tell us the document reference you have given this sheet

Contact name

Title (Mr, Mrs, Miss and so on)

First name

Last name

Now go to question 3c or section 6

3c Details of charity

Full name of charity

This should be the full name of the legal entity not any trading name.

3d Company registration number

If you are registered with Companies House please tell us your registration number

3e Charity Commission number

If you are registered with the Charity Commission please tell us your registration number

Now go to section 6

4 Applications from public bodies

4a Type of public body

For example, NHS trust, local authority, English county council

4b Name of the public body

4c Please give us the following details of the executive

An officer of the public body authorised to sign on your behalf

Name

Title (Mr, Mrs, Miss and so on)

First name

Last name

Position

Now go to section 6

5 Applications from companies or corporate bodies

5a Name of the company

National Gas Transmission Plc

5b Company registration number

02006000

Date of registration (DD/MM/YYYY) 01/04/1986

If you are applying as a corporate organisation that is not a limited company, please provide evidence of your status and tell us below the reference you have given the document containing this evidence.

Document reference

5 Applications from companies or corporate bodies, continued

5c Please give details of the directors

If relevant, provide details of other directors and company secretary, if there is one, on a separate sheet and tell us the reference you have given this sheet.

Document reference: Details of Company Directors Form A Q5c

Details of company secretary (if relevant) and director/s

Title (Mr, Mrs, Miss and so on):

First name:

Last name:

Title (Mr, Mrs, Miss and so on):

First name:

Last name:

Now go to section 6

6 Your address

6a Your main (registered office) address

For companies this is the address on record at Companies House.

Contact name

Title (Mr, Mrs, Miss and so on): Ms

First name: Sofia

Last name: Bernsand

Address: National Gas Transmission plc, National Grid House
Warwick Technology Park
Gallows Hill
Warwick

Postcode: CV34 6DA

Contact numbers, including the area code

Phone: +44 (0) 1926 65 3000

Fax:

Mobile:

Email:

For an organisation of individuals every partner needs to give us their details, including their title Mr, Mrs and so on. So, if necessary, continue on a separate sheet and tell us below the reference you have given the sheet.

Document reference:

6b Main UK business address (if different from above)

Contact name

Title (Mr, Mrs, Miss and so on):

First name:

Last name:

Address:

Postcode:

6 Your address, continued

Contact numbers, including the area code

Phone	
Fax	
Mobile	
Email	

Now go to section 7

7 Contact details

7a Who can we contact about your application?

It will help us if there is someone we can contact if we have any questions about your application. The person you name should have the authority to act on your behalf.

Please add a second contact on a separate sheet if this person is not always available.

Document reference of this separate sheet	

This can be someone acting as a consultant or an 'agent' for you.

Contact name

Title (Mr, Mrs, Miss and so on)	Mr
First name	Philip
Last name	Smith
Address	Project Environmental Solutions Ltd
	8 Shoplatch
	Shrewsbury
Postcode	SY1 1HF

Contact numbers, including the area code

Phone	
Fax	
Mobile	+44 (0)7747 798898
Email	philip.smith@peslconsulting.com

7b Who can we contact about your operation (if different from question 7a)?

Contact name

Title (Mr, Mrs, Miss and so on)	Mr
First name	Neil
Last name	Billingham
Address	National Gas Transmission plc, National Grid House
	Warwick Technology Park
	Gallows Hill
	Warwick
Postcode	CV34 6DA

Contact numbers, including the area code

Phone	+44 (0)1926 656193
Fax	
Mobile	+44 (0)7748 180447
Email	neil.billingham@nationalgas.com

7 Contact details, continued

7c Who can we contact about your billing or invoice?

Note: Please provide the name and address that all invoices should be sent to for your subsistence fees.

As in question 7a ☐

As in question 7b ☑

Please give details below if different from question 7a or 7b.

Contact name

Title (Mr, Mrs, Miss and so on)

First name

Last name

Address

Postcode

Contact numbers, including the area code

Phone

Fax

Mobile

Email

8 How to contact us

If you need help filling in this form, please contact the person who sent it to you or contact us as shown below.

General enquiries: 03708 506 506 (Monday to Friday, 8am to 6pm)

Textphone: 03702 422 549 (Monday to Friday, 8am to 6pm)

Email: enquiries@environment-agency.gov.uk

Website: www.gov.uk/government/organisations/environment-agency

If you are happy with our service, please tell us. It helps us to identify good practice and encourages our staff. If you're not happy with our service, please tell us how we can improve it. More information on how to do this is available at: www.gov.uk/government/organisations/environment-agency/about/complaints-procedure.

Please tell us if you need information in a different language or format (for example, in large print) so we can keep in touch with you more easily.

9 Where to send your application

For how many copies to send see the guidance note on part A.

For water discharges by email to PSC-WaterQuality@environment-agency.gov.uk

For waste and installations by email to PSC@environment-agency.gov.uk

For flood risk activity permits send 1 copy only to enquiries@environment-agency.gov.uk or to the local Environment Agency office for where the work is proposed to be carried out.

Or

Permitting Support, NPS Sheffield
Quadrant 2
99 Parkway Avenue
Parkway Business Park
Sheffield
S9 4WF

Feedback

(You don't have to answer this part of the form, but it will help us improve our forms if you do.)

We want to make our forms easy to fill in and our guidance notes easy to understand. Please use the space below to give us any comments you may have about this form or the guidance notes that came with it.

How long did it take you to fill in this form?

We will use your feedback to improve our forms and guidance notes, and to tell the Government how regulations could be made simpler.

Would you like a reply to your feedback?

Yes please ☐

No thank you ☐

Crystal Mark 19101
Clarity approved by Plain English Campaign

For Environment Agency use only

Date received (DD/MM/YYYY)

Our reference number

Payment received?

No ☐

Yes ☐ Amount received

£

Appendix 1 – Date of birth information for installation and waste activities (applications for a new permit or transferring a permit) only

Date of birth information in this appendix will not be put onto our Public Register

Are you applying as an individual, an organisation of individuals (for example, a partnership) or a company (this includes Limited Liability Partnerships)?

An individual	☐	Now go to 2
An organisation of individuals (for example, a partnership)	☐	Now go to 3
A registered company or other corporate body	☐	Now go to 4

2 Applications from an individual

Please give us the following details

Name

Date of birth (DD/MM/YY)

3 Applications from an organisation of individuals or charity

Details of the organisation or charity

If you are an organisation of individuals, please give the date of birth details of the main representative below. If relevant, provide details of other members on a separate sheet and tell us the document reference you have given this sheet.

Name

Date of birth (DD/MM/YY)

Document reference

4 Applications from companies or corporate bodies

Name of the company

Please give the date of birth details for all directors and company secretary if there is one. If relevant, provide those details of other directors on a separate sheet and tell us the document reference you have given this sheet.

Details of company secretary (if relevant) and director/s

Name

Date of birth (DD/MM/YY)

Name

Date of birth (DD/MM/YY)

Name

Date of birth (DD/MM/YY)

Document reference

Form A additional information

Question 5c – Details of Company Directors

Title (Ms/Mr)	Position	First Name (s)	Last Name
Ms	Secretary	Sofia	Bernsand
Mr	Secretary	David	Byrne
Ms	Director	Mia	Agoumi
Mr	Director	Jonathan	Butterworth
Ms	Director	Kylee Marie	Dickie
Mr	Director	Jerry James	Divoky
Mr	Director	Howard Charles	Higgins
Mr	Director	Nick	Hooper
Ms	Director	Natalie	Humphries-New
Mr	Director	Timothy	Keeling
Ms	Director	Rhian Catriona	Kelly
Mr	Director	Mark William	Mathieson
Mr	Director	Philip Michael Gerard	Nolan
Ms	Director	Nghi Do Truong	Pham
Mr	Director	William David George	Price
Ms	Director	Cathryn	Ross
Ms	Director	Aikaterini	Tsirimpa
Ms	Director	Lincoln Hillier	Webb
Mr	Director	Benjamin Hollis	Wilson

Correct, as downloaded from Companies House on 06.05.2023

Part C0.5

Application for an environmental permit Part C0.5 – Administrative variation of a standard or bespoke permit

Environment Agency

You should only use this form for administrative changes – read the guidance notes for this form before filling it in. Please check that this is the latest version of the form available from our website.

Fill in this form if you are only applying to make an administrative change to your permit. If you are changing any address or contact details you should also fill in part A with the new details.

You do not need to resend any information from your original permit application if it is not affected by your proposed changes.

Please read through this form and the guidance notes that came with it.

The form can be:

1) saved onto a computer and then filled in. Please note that the form follows a logic that means questions will open or stay closed depending on a previous answer. So you may not be able to enter text in some boxes.
2) printed off and filled in by hand. Please write clearly in the answer spaces.

For more guidance on what we consider to be an administrative change see the 'Environmental Permitting Charging Scheme & Guidance' at www.gov.uk/government/organisations/environment-agency.

It will take less than one hour to fill in this form.

Contents

1 About the permit

1a Discussions before your application

If you have had discussions with us before making your application, give the case reference number or details on a separate sheet and then write the reference number you have given this document below.

Case or document reference

1b Permit number

What is the permit number that this application relates to? EPR/UP3333LL

1c Site details

What is the name, address and postcode of the site?

Site name: Hatton Compressor Station

Address: Horncastle Road
Hatton
Lincolnshire

Postcode: LN8 5QE

1d Contact details

Who can we contact about this application? (This can be someone acting as a consultant or an 'agent' for you.)

Title (Mr, Mrs, Miss and so on): Mr

First name: Philip

Last name: Smith

Position: Project Environmental Coordinator

Address: Project Environmental Solutions Ltd
8 Shoplatch
Shrewsbury

Postcode: SY1 1HF

1 About the permit, continued

Contact numbers, including the area code

Phone	
Mobile	+44 (0) 7747 798 898
Email	philip.smith@peslconsulting.com

Now go to section 2

2 About your proposed administrative changes

2a Details of proposed change

An administrative change can be for example, to correct mistakes in a permit. For more examples, please see the environment permit charging scheme guidance at www.gov.uk/government/organisations/environment-agency.

Please give us brief details in the box below. If you need to provide more information please give details on a separate sheet, give it a document reference and refer to that in the box below.

If your changes include changes to your personal details or company details (for example, a new address or new contacts) please fill in the relevant sections of part A and make a note that you have done this in the box below.

Please note that adding a claim to the application that the information is confidential is not an administrative change, unless you are claiming that the information is confidential for national security reasons.

Details of the administrative change

Change of company name from National Grid Gas Transmission plc to National Gas Transmission plc.

Refer to Section V: Appendices, Appendix 1 for correspondence from the Company Secretary and a copy of the Certificate of Incorporation on Change of Name.

3 Privacy notice

The Environment Agency runs the environmental permit application service.

We are the data controller for this service. A data controller determines how and why personal information is processed.

Our personal information charter explains:

- your rights
- what we do with your personal information

We're allowed to process your personal information because we have official authority as the environmental regulator. We need this information to carry out a task in the public interest that is set out in law.

We need your personal information to process your environmental permit application. If you do not give us this information we cannot issue a permit to you. After we've issued a permit to you, we use your personal information:

- to check that you're complying with your permit
- during any potential enforcement action

What personal information we collect

If you're the individual applicant, director or company secretary of a company applying or a technically competent manager we need your:

- name
- date of birth
- address
- email address

3 Privacy notice, continued

If you're the agent, consultant, employee responsible for the activity or the employee responsible for billing and invoicing we need your:

- name
- address
- email address

If you're the applicant we need details of any:

- convictions
- bankruptcy

We also collect any questions or feedback you leave, including your email address if you contact us.

Your responsibility with other people's personal information

If you've included personal information about other people on your application, you must tell them. You must provide them with a copy of this privacy notice so that they know how their personal information will be used.

What we do with your personal information

We use your personal information to help us decide whether to issue you with a permit.

The information is available online on our consultation website during the consultation period. This website is available to everyone so your information may be seen outside the European Economic Area.

After consultation we put all the information you give us in your application on our public register.

If you can demonstrate that any information you send us is commercially or industrially confidential, we'll consider withholding that information from our public register.

If you think that the information you'll send us may be a threat to national security you must contact the Secretary Of State before you apply. You must still send us that information with your application. We will not include this information on our public register unless the Secretary of State decides it can be included.

See the environmental permitting guidance for guidance on national security.

We may use your email address to contact you for user research to improve our service. You don't have to take part in the research.

Where your personal information is processed and stored

We store and process your personal information on servers in the UK. We will not host your personal information outside the European Economic Area.

We do not use your personal information to make an automated decision or for automated profiling.

How long we keep your personal information

We keep your personal information while your permit is in use and for 7 years after you surrender your permit. If the permit is for a landfill site, we keep the data for 10 years after surrender.

Removing personal information from the public register

We will remove your personal information from the public register if:

- you withdraw your application
- we refuse your application and the time limit for appealing the decision has expired or an appeal is dismissed
- the information is no longer relevant for public participation purposes under the Environmental Permitting Regulations

Contact

Our Data Protection Team gives independent advice. They monitor how the Environment Agency uses your personal information.

If you have questions or concerns about how we process personal information, or to make a complaint or request relating to data protection, please contact:

Address: Data Protection Team
Environment Agency
Horizon House
Deanery Road
Bristol
BS1 5AH

Email: dataprotection@environment-agency.gov.uk

You can also make a complaint to the Information Commissioner's Office (ICO).

3 Privacy notice, continued

The ICO is the supervisory authority for data protection legislation. The ICO website has a full list of your rights under data protection legislation.

Now read section 4 below

4 Confidentiality and national security

Confidentiality

We will normally put all the information in your application on a public register of environmental information. However, we may not include certain information in the public register if this is in the interests of national security, or because the information is confidential.

You can ask for information to be made confidential by enclosing a letter with your application giving your reasons. If we agree with your request, we will tell you and not include the information in the public register. If we do not agree with your request, we will let you know how to appeal against our decision, or you can withdraw your application.

Only tick the box below if you wish to claim confidentiality for your application

Please treat the information in my application as confidential ☐

National security

You can tell the Secretary of State that you believe including information on a public register would not be in the interests of national security. You must enclose a letter with your application telling us that you have told the Secretary of State and you must still include the information in your application. We will not include the information in the public register unless the Secretary of State decides that it should be included.

You can find guidance on national security in 'Environmental permitting guidance: core guidance', published by Defra and available via our website at www.gov.uk/government/organisations/environment-agency.

You cannot apply for national security via this application.

Now go to section 5

5 Declaration

We have provided an additional sheet at the end of this form for extra names.

If you knowingly or carelessly make a statement that is false or misleading in relation to this environmental permit (for yourself or anyone else), you may be committing an offence under the Environmental Permitting (England and Wales) Regulations 2016.

A relevant person should make the declaration (see the guidance notes on part F1).

If you are joint permit holders you should each fill in your own declaration (we have provided an additional sheet at the end for this).

5a Are you a domestic household or an organisation operating for charitable purposes and is the maximum volume of effluent you will discharge five cubic metres (5m3) or less a day? (Please see guidance to B6.5 for definitions.)

This is the figure you have given in question 5b.

No ☑

Yes ☐ A reduced application charge applies

I declare that the information in this application is true to the best of my knowledge and belief.

If you deliberately make a statement that is false or misleading in order to get approval you may be prosecuted.

Tick this box to confirm that you understand and agree with the declaration above, then fill in the details below ☑

Name

Title (Mr, Mrs, Miss and so on)	Mr
First name	Neil
Last name	Billingham
on behalf of (for example, if applying on behalf of a company – see guidance to this form)	National Gas Transmission plc
Today's date (DD/MM/YYYY)	10/05/2023

6 How to contact us

If you need help filling in this form, please contact the person who sent it to you or contact us as shown below.

General enquiries: 03708 506 506 (Monday to Friday, 8am to 6pm)

Textphone: 03702 422 549 (Monday to Friday, 8am to 6pm)

Email: enquiries@environment-agency.gov.uk

Website: www.gov.uk/government/organisations/environment-agency

If you are happy with our service, please tell us. It helps us to identify good practice and encourages our staff. If you're not happy with our service, please tell us how we can improve it.

Please tell us if you need information in a different language or format (for example, in large print) so we can keep in touch with you more easily.

7 Where to send your application

For how many copies to send see the guidance note on part C0.5.

If your application is not complete we will return it to you. If you aren't sure about what you need to send, speak to us before you submit your application.

You must do the following:

Complete legibly all parts of this form that are relevant to you and your activities ☑

or any changes to the site plan, provide a plan that meets the standards given in the guidance note on part C0.5 ☐

Get the declaration completed by a relevant person ☑

Please send your filled in application form to:

For water discharges by email to PSC-WaterQuality@environment-agency.gov.uk

For waste and installations by email to PSC@environment-agency.gov.uk

For flood risk activity permits send 1 copy only to enquiries@environment-agency.gov.uk or to the local Environment Agency office for where the work is proposed to be carried out.

Or by post to:

Permitting Support, NPS Sheffield
Quadrant 2
99 Parkway Avenue
Parkway Business Park
Sheffield
S9 4WF

Do you want all information to be sent to you by email?

Please tick this box if you wish to have all communication about this application sent via email (we will use the details provided in Part A) ☑

Feedback

(You don't have to answer this part of the form, but it will help us improve our forms if you do.)

We want to make our forms easy to fill in and our guidance notes easy to understand. Please use the space below to give us any comments you may have about this form or the guidance notes that came with it.

How long did it take you to fill in this form?

We will use your feedback to improve our forms and guidance notes, and to tell the Government how regulations could be made simpler.

Would you like a reply to your feedback?

Yes please ☐

No thank you ☐

Crystal Mark 19589 Clarity approved by Plain English Campaign

ADDITIONAL SHEET FOR EXTRA NAMES

If you knowingly or carelessly make a statement that is false or misleading in relation to this environmental permit (for yourself or anyone else), you may be committing an offence under the Environmental Permitting (England and Wales) Regulations 2016.

A relevant person should make the declaration (see the guidance notes on part F1).

If you are joint permit holders you should each fill in your own declaration (we have provided an additional sheet at the end for this).

I declare that the information in this application is true to the best of my knowledge and belief.

If you deliberately make a statement that is false or misleading in order to get approval you may be prosecuted.

Tick this box to confirm that you understand and agree with the declaration above ☐

Name

Title (Mr, Mrs, Miss and so on)

First name

Last name

on behalf of
(for example, if applying on behalf of a company – see guidance to this form)

Today's date (DD/MM/YYYY)

Tick this box to confirm that you understand and agree with the declaration above ☐

Name

Title (Mr, Mrs, Miss and so on)

First name

Last name

on behalf of
(for example, if applying on behalf of a company – see guidance to this form)

Today's date (DD/MM/YYYY)

Tick this box to confirm that you understand and agree with the declaration above ☐

Name

Title (Mr, Mrs, Miss and so on)

First name

Last name

on behalf of
(for example, if applying on behalf of a company – see guidance to this form)

Today's date (DD/MM/YYYY)

Part C2

Application for an environmental permit
Part C2 – General – varying a bespoke permit

Fill in this part of the form, together with part A and the relevant parts of C3 to C7 and part F1 or F2, if you are applying to vary (change) the conditions or any other part of the permit. Please check that this is the latest version of the form available from our website.

You only need to give us details in this application for the parts of the permit that will be affected (for example, if you are adding a new facility or changing existing ones).

Waste operation changing to installation or vice versa?

If your changes mean that a waste operation becomes an installation (or vice versa) you also need to fill in either part C3 (waste to installation) or part C4 (installation to waste).

You do not need to resend any information from your original permit application if it is not affected by your proposed changes.

Please read through this form and the guidance notes that came with it.

The form can be:

1) **saved onto a computer and then filled in. Please note that the form follows a logic that means questions will open or stay closed depending on a previous answer. So you may not be able to enter text in some boxes.**
2) **printed off and filled in by hand. Please write clearly in the answer spaces.**

It will take less than two hours to fill in this part of the application form.

Contents

1 About the permit

Note: If you are applying to convert your existing permit to a standard permit or add a standard facility you need to fill out form C1.

1a Discussions before your application

If you have had discussions with us before your application, give us the permit reference or details on a separate sheet. Tell us below the reference you have given this extra sheet.

Permit or document reference ______

1b Permit number

What is the permit number that this application relates to? EPR/UP3333LL

1c Site details

What is the name, address and postcode of the site?

Site name: Hatton Compressor Station

Address: Horncastle Road
Hatton
Lincolnshire
UK

Postcode: LN8 5QE

2 About your proposed changes

2a Type of variation

What type of variation are you applying for?

Minor technical ☐
Normal variation ☐
Substantial ☑

2 About your proposed changes, continued

2b Changes or additions to existing activities

Please give us brief details in the box below. More detailed information can be given in Table 1 below.

A new ultra-low emission gas turbine driven natural gas compressor unit will be installed in a purpose built, bespoke noise control enclosure. It will be fitted with a new combustion air intake, exhaust stack (with continuous emission monitoring provisions) and fuel gas pre-heating skid (which will use recovered waste engine heat in normal running conditions). A new natural gas vent stack will also be installed. The new unit and associated ancillary equipment, including a replacement back-up diesel fired generator will be built on land outside of the current installation boundary. Therefore, the installation boundary will be extended to the West on National Gas Transmission land. Two existing gas turbine driven natural gas compressor units will be retired under the Limited Life Derogation (LLD) provisions for Large Combustion Plant under the Industrial Emissions Directive (IED).

Fill in Table 1 with details of all the proposed changes to current activities. In the final column of the table, give us the document reference for the proposed changes and send them to us with your filled in application form.

Fill in a separate table for each activity you are applying to vary or add. Use a separate sheet if you have a long list and send it to us with your application form. Tell us below the reference you have given this document.

Document reference: Refer to Section II: Proposed changes

You only need to fill in one table for your mining waste operations.

2c Consolidating (combining) or updating existing permits

If your proposed change is to modernise (update) your permit, now answer 2c1; otherwise go to 2d.

If your proposed change is to consolidate (combine) a number of permits, now answer 2c2; otherwise go to 2d.

Note: In both cases we may require additional information from you about, for example, your management system. Therefore we would always advise you to talk to us before you submit any application to modernise or consolidate permits.

2c1 Do you want to have a modern style permit?

No ☐

Yes ☑

2c2 Identify all the permits you want to consolidate (combine) by listing the permit numbers in Table 2 below

Table 2 – Permit numbers

2d Treating batteries

2d Are you proposing to treat batteries?

No ☑

Yes ☐ Tell us how you will do this and send us a copy of your explanation and tell us below the reference you have given this explanation

Document reference for the explanation

2e Ship recycling

2e1 Is your activity covered by the Ship Recycling Regulations 2015? (See the guidance notes on part C2.)

No ☑

Yes ☐ Tell us how you will do this. Please send us a copy of your explanation and your facility recycling plan, and tell us below the reference numbers you have given these documents

Document reference for the explanation

Document reference for the facility recycling plan

2e2 Is this a renewal of an existing authorisation covered by the Ship Recycling Regulations 2015?

No ☑

Yes ☐ Tell us the expiry date of your existing authorisation (DD/MM/YYYY)

2 About your proposed changes, continued

Table 1 – Changes to existing activities

Fill in Table 1 with details of all the proposed changes to current activities. In the final column of the table, give us the document reference for the proposed changes and send them to us with your filled in application form.

Name	Installation schedule 1 references	Description of the installation activity	Description of waste operation	Description of the mining waste operations	Description of water discharge activity	Description of groundwater activity	Proposed changes document reference
i.e. name of installation, waste operation, mining waste operation, water discharge activity or groundwater activity							
Example – effluent unique name					Example – treated sewage effluent		
If you do not have enough room, go to the line below or send a separate document and give us the document reference here							
Refer to Section III: Su	Section 1.1, Part A(1) (	Burning any fuel in an					Refer to Section II: Pro

2 About your proposed changes, continued

2f Low impact installations (installations only)

2f1 Will any changes mean that any of the regulated facilities will become low impact installations?

No ☑ Now go to section 3

Yes ☐ If yes, tell us how you meet the conditions for a low impact installation (see the guidance notes on part C2 – Appendix 1)

Document reference ____

Tick the box to confirm you have filled in the low impact installation checklist in appendix 1 for each regulated facility ☐

3 Your ability as an operator

If you are applying to add waste installations or waste operations to a permit that has not previously had them, you need to fill in all of section 3.

If you are applying to consolidate (combine) two or more permits or have an updated permit you must fill in question 3d.

This section does not apply for applications to surrender a permit.

3a Relevant offences

Installations and waste operations only (see the guidance notes on part C2).

3a1 Have you, or any other relevant person, been convicted of any relevant offence?

No ☑ Now go to question 3b

Yes ☐ Please give details below

Name of the relevant person

Title (Mr, Mrs, Miss and so on) ____

First name ____

Last name ____

Position held at the time of the offence ____

Name of the court where the case was dealt with ____

Date of the conviction (DD/MM/YY) ____

Offence and penalty set ____

Date any appeal against the conviction will be heard (DD/MM/YYYY) ____

If necessary, use a separate sheet to give us details of other relevant offences and tell us below the reference number you have given the extra sheet.

Document reference ____

Now go to question 3b

Please also complete the details in Appendix 2.

3b Technical ability

Specified waste management activities and waste operations only (see the guidance notes on part C1).

Please indicate which of the two schemes you are using to demonstrate you are technically competent to operate your facility and the evidence you have enclosed to demonstrate this.

ESA/EU skills

I have enclosed a copy of the current Competence Management System certificate ☐

CIWM/WAMITAB scheme

Please select **one** of the following:

- I have enclosed a copy of:
  - the relevant qualification certificate/s ☐

  or
  - evidence of deemed competence ☐

  or

3 Your ability as an operator, continued

- Environment Agency assessment ☐

or

- evidence of nominated manager status under the transitional provisions for previously exempt activities ☐

and, if deemed competent or Agency-assessed, or if there is evidence of a nominated manager, or if the original qualification is over two years old:

I have enclosed a copy of the relevant current continuing competence certificate/s ☐

For each technically competent manager please give the following information. If necessary, use a separate sheet to give us these details and tell us below the document reference you have given the extra sheet.

Title (Mr, Mrs, Miss and so on)

First name

Last name

Phone

Mobile

Email

Please provide the environmental permit number/s and site address for **all** other waste activities that the proposed technically competent manager provides technical competence for, including permits held by other operators. Continue on a separate sheet as required.

Permit number	Site address	Postcode

Document reference

Now go to question 3c

Please also complete the details in Appendix 2.

3c Finances

Installations, waste operations and mining waste operations only (see the guidance notes on part C2).

Please note that if you knowingly or carelessly make a statement that is false or misleading to help you get an environmental permit (for yourself or anyone else), you may be committing an offence under the Environmental Permitting (England and Wales) Regulations 2016.

Do you or any relevant person or a company in which you were a relevant person have current or past bankruptcy or insolvency proceedings against you?

No ☑

Yes ☐ Please give details below, including the required set-up costs (including infrastructure), maintenance and clean up costs for the proposed facility against which a credit check may be assessed

We may want to contact a credit reference agency for a report about your business's finances.

3 Your ability as an operator, continued

Landfill, Category A mining waste facilities and mining waste facilities for hazardous waste only

How do you plan to make financial provision (to operate a landfill or a mining waste facility you need to show us that you are financially capable of meeting the obligations of closure and aftercare)?

Renewable bonds ☐

Cash deposits with the Environment Agency ☐

Other – provide comprehensive details ☐

Document reference

Provide a cost profile and expenditure plan of your estimated costs throughout the aftercare period of your site.

Document plan reference

Now go to question 3d

3d Management systems

You must have an effective, written management system in place that identifies and reduces the risk of pollution. You may show this by using a certified scheme or your own system.

Your permit requires you (as the operator) to ensure that you manage and operate your activities in accordance with a written management system.

You need to be able to explain what happens at each site and which parts of the overall management system apply. For example, at some sites you may need to show you are carrying out additional measures to prevent pollution because they are nearer to sensitive locations than others.

You can find guidance on management systems on our website at www.gov.uk/government/organisations/environment-agency.

Tick this box to confirm that you have read the guidance and that your management system will meet our requirements ☑

What management system will you provide for your regulated facility?

ISO 14001 ☑

BS 8555 (Phases 1–5) ☐

Acorn ☐

Green dragon ☐

Own management system ☐

Please make sure you send us a summary of your management system with your application.

Document reference/s: Refer to Section III: Supporting information

4 Consultation

Fill in 4a to 4c for installations and waste operations and 4d for installations only.

Could the waste operation or installation involve releasing any substance into any of the following?

4a A sewer managed by a sewerage undertaker?

No ☑

Yes ☐ Please name the sewerage undertaker

4b A harbour managed by a harbour authority?

No ☑

Yes ☐ Please name the harbour authority

4c Directly into relevant territorial waters or coastal waters within the sea fisheries district of a local fisheries committee?

No ☑

Yes ☐ Please name the fisheries committee

4 Consultation, continued

4d Is the installation on a site for which:

4d1 a nuclear site licence is needed under section 1 of the Nuclear Installations Act 1965?

No ☑

Yes ☐

4d2 a policy document for preventing major accidents is needed under regulation 5 of the Control of Major Accident Hazards Regulations 2015, or a safety report is needed under regulation 7 of those Regulations?

No ☑

Yes ☐

5 Supporting information

5a Provide a plan or plans for the site

See the guidance notes on part C2 for what needs to be marked on the plan.

Clearly mark the site boundary or discharge point, or both. Also include site drainage plans, site layout plans, and plant design drawings/process flow diagrams (as required). (See the guidance notes on part C2.)

Document reference/s of the plans: Refer to Section IV: Figures

5b Do any of the variations you plan to make need extra land to be included in the permit?

No ☐

Yes ☑ Please provide a site report for the extra land

Document report reference/s: Refer to Section V: Appendix 2, Site condition report

5c Provide a non-technical summary of your application

Document reference of the summary: Refer to Non-technical summary

5d Risk of fire from sites storing combustible waste

Are you applying for an activity that includes the storage of combustible wastes?

(This applies to all activities excluding standalone water and groundwater discharges.)

No ☑ Go to question 5f

Yes ☐ Go to question 5e

5e Will your variation increase the risk of a fire occurring or increase the environmental risk if a fire occurs?

See the guidance notes on part C2.

No ☐

Yes ☐ Provide a fire prevention plan. You need to highlight any changes you have made since your pre-application discussions

Document reference of the plan:

5f Adding an installation

If you are applying to add an installation, tick the box to confirm that you have sent in a baseline report and provide a reference ☑

Document reference of the report: Refer to Section V: Appendix 2, Site condition report

6 Environmental risk assessment

If you need one, see the guidance notes on part C2.

Provide an assessment of any additional risks the proposed changes or additions to your regulated facilities poses to the environment as part of your application to vary this permit. The risk assessment must follow the methodology set out in 'Risk assessments for your environmental permit' at https://www.gov.uk/guidance/risk-assessments-for-your-environmental-permit or an equivalent method.

Document reference for the assessment: Refer to Section III: Supporting information

7 How to contact us

If you need help filling in this form, please contact the person who sent it to you or contact us as shown below.

General enquiries: 03708 506 506 (Monday to Friday, 8am to 6pm)

Textphone: 03702 422 549 (Monday to Friday, 8am to 6pm)

Email: enquiries@environment-agency.gov.uk

Website: www.gov.uk/government/organisations/environment-agency

If you are happy with our service, please tell us. It helps us to identify good practice and encourages our staff. If you're not happy with our service, please tell us how we can improve it.

Please tell us if you need information in a different language or format (for example, in large print) so we can keep in touch with you more easily.

Feedback

(You don't have to answer this part of the form, but it will help us improve our forms if you do.)

We want to make our forms easy to fill in and our guidance notes easy to understand. Please use the space below to give us any comments you may have about this form or the guidance notes that came with it.

How long did it take you to fill in this form?

We will use your feedback to improve our forms and guidance notes, and to tell the Government how regulations could be made simpler.

Would you like a reply to your feedback?

Yes please ☐

No thank you ☐

Crystal Mark 19110 Clarity approved by Plain English Campaign

For Environment Agency use only

Date received (DD/MM/YYYY)

Our reference number

Payment received?

No ☐

Yes ☐ Amount received

£

Plain English Campaign's Crystal Mark does not apply to appendix 1.

Appendix 1 – Low impact installation checklist

Installation reference				
Condition	Response			Do you meet this?
A – Management techniques	Provide references to show how your application meets A			Yes ☐ No ☐
	References			
B – Aqueous waste	Effluent created		m^3/day	Yes ☐ No ☐
C – Abatement systems	Provide references to show how your application meets C			Yes ☐ No ☐
	References			
D – Groundwater	Do you plan to release any hazardous substances or non-hazardous pollutants into the ground?		Yes ☐ No ☐	Yes ☐ No ☐
E – Producing waste	Hazardous waste		Tonnes per year	Yes ☐ No ☐
	Non-hazardous waste		Tonnes per year	
F – Using energy	Peak energy consumption		MW	Yes ☐ No ☐
G – Preventing accidents	Do you have appropriate measures to prevent spills and major releases of liquids? (See 'How to comply'.)		Yes ☐ No ☐	Yes ☐ No ☐
	Provide references to show how your application meets G			
	References			
H – Noise	Provide references to show how your application meets H			Yes ☐ No ☐
	References			
I – Emissions of polluting substances	Provide references to show how your application meets I			Yes ☐ No ☐
	References			
J – Odours	Provide references to show how your application meets J			Yes ☐ No ☐
	References			
K – History of keeping to the regulations	Say here whether you have been involved in any enforcement action as described in Compliance History Appendix 1 explanatory notes		Yes ☐ No ☐	

Appendix 2 – Date of birth information for Relevant offences and/or Technical ability questions only

Date of birth information in this appendix will not be put onto our Public Register

Have you filled in the Relevant Offences question?

Yes ☐

No ☐

Have you filled in the Technical ability question?

Yes ☐

No ☐

2 Relevant Offences - date of birth information

Please give us the following details

Name	
Date of birth (DD/MM/YY)	

3 Technical ability - date of birth information

Name	
Date of birth (DD/MM/YY)	

Part C3

Application for an environmental permit
Part C3 – Variation to a bespoke installation permit

Environment Agency

Fill in this part of the form, together with part A, part C2 and part F1, if you are applying to vary (change) the conditions or any other part of the permit.

Please check that this is the latest version of the form available from our website.

You only need to give us details in this application for the parts of the permit that will be affected (for example, if you are adding a new facility or making changes to existing ones).

You do not need to resend any information from your original permit application if it is not affected by your proposed changes.

Please read through this form and the guidance notes that go with it.

The form can be:

1) saved onto a computer and then filled in. Please note that the form follows a logic that means questions will open or stay closed depending on a previous answer. So you may not be able to enter text in some boxes.
2) printed off and filled in by hand. Please write clearly in the answer spaces.

It will take less than three hours to fill in this part of the application form.

Contents

1 What activities are you applying to vary?

Fill in Table 1a below with details of all the activities listed in schedule 1 or other references (see note 1) of the Environmental Permitting Regulations (EPR) and all directly associated activities (DAAs) (in separate rows), that you propose to vary.

Note: if you want to add a Medium Combustion Plant or Specified Generator (MCP/SG) to your installation please use part C2.5 instead. If you want to vary an intensive farm permit please use part C3.5 instead.

Fill in a separate table for each installation you are applying to vary. Use a separate sheet if you have a long list and send it to us with your application form. Tell us below the reference you have given the document.

Document reference: Refer to Section III: Supporting information

1 What activities are you applying to vary?, continued

Table 1a – Types of activities

Schedule 1 listed activities						
Installation name	Schedule 1 or other references (See note 1)	Description of the activity (See note 2)	Activity capacity (See note 3)	Annex I (D codes) and Annex II (R codes) and descriptions	Hazardous waste treatment capacity (if this applies) (See note 3)	Non-hazardous waste treatment capacity (if this applies) (See note 3)
If there are not enough rows, send a separate document and give the document reference number here	Put your main activity first			For installations that take waste only	For installations that take waste only	For installations that take waste only
Hatton Compressor Station	Section 1.1, Part	Burning any fuel in an	174 MWth			
information Table C3 – 1a						

Directly associated activities (See note 4)		
Name of DAA If there are not enough rows, send a separate document and give the document reference number here	Description of the DAA (please identify the schedule 1 activity it serves)	
	Refer to Section III: Supporting information Table C3 – 1a	
For installations that take waste (See note 5 below)	Total storage capacity	
	Annual throughput (tonnes each year)	

1 What activities are you applying to vary?, continued

Notes

1. Quote the section number, part A1 or A2 or B, then paragraph and sub paragraph number as shown in EPR part 2 of schedule 1.
2. Use the description from schedule 1 of EPR. Include any extra detail that you think would help to accurately describe what you want to do.
3. By 'capacity', we mean:

- the total incineration capacity (tonnes every hour) for waste incinerators
- the total landfill capacity (cubic metres) for landfills
- the total capacity (cubic metres) for the recovery of hazardous waste on land
- the total treatment capacity (tonnes each day) for waste treatment operations
- the total storage capacity (tonnes) for waste storage operations
- the processing and production capacity for manufacturing operations, or
- the thermal input capacity for combustion activities

4. Fill this in as a separate line and give an accurate description of any other activities associated with your schedule 1 activities. You cannot have Directly Associated Activities (DAAs) as part of a mobile plant application.
5. By 'total storage capacity', we mean the maximum amount of waste, in tonnes, you store on the site at any one time.

Types of waste accepted

For those installations that take waste, for each line in Table 1a (including DAAs), fill in a separate document to list those wastes you will accept on to the site for that activity. Give the List of Wastes catalogue code and description (see https://www.gov.uk/government/publications/waste-classification-technical-guidance).

If you need to exclude waste from your activity or facility by restricting the description, quantity, physical nature, hazardous properties, composition or characteristic of the waste, include these in the document. Send it to us with your application form.

Please provide the reference for each document.

You can use Table 1b as a template.

If you want to accept any waste with a code ending in 99, you must provide more information and a full description of the waste in the document, (for example, detailing the source, nature and composition of the waste). Where you only want to receive specific wastes within a waste code you can provide further details of the waste you want to receive. Where a waste is dual coded you should use both codes for the waste.

Document reference of this extra information

1 What activities are you applying to vary?, continued

Table 1b – Template example – types of waste accepted and restrictions

Waste code	Description of the waste
Example	Example
02 01 08*	Agrochemical waste containing hazardous substances
18 01 03*	Infectious clinical waste, not contaminated with chemicals or medicines – human healthcare (may contain sharps) for alternative treatment
17 05 03*/17 06 05*	Non-hazardous soil from construction or demolition contaminated with fragments of asbestos cement sheet

1c Recovery of hazardous waste on land

Are you applying for a waste recovery activity involving the permanent deposit of inorganic hazardous waste on land for construction or land reclamation?

No ☑ Now go to question 2

Yes ☐

Have you written a waste recovery plan (WRP) that shows that you will use waste to perform the same function as non waste materials you would have used?

No You must write a WRP to support your application.

Yes

Have we advised you during pre-application discussions that we believe the activity is waste recovery?

No

Yes

Have there been any changes to your proposal since the discussions?

No

Yes

Please send us a copy of your current waste recovery plan that complies with our guidance at https://www.gov.uk/government/publications/deposit-for-recovery-operators-environmental-permits/waste-recovery-plans-and-deposit-for-recovery-permits. You need to highlight any changes you may have made since your pre-application discussions.

Document reference

Please note that there is an additional charge for the assessment or re assessment of a waste recovery plan that must be submitted as part of this application. For the charge see https://www.gov.uk/government/publications/environmental-permitting-charges-guidance/environmental-permitting-charges-guidance

2 Point source emissions to air, water and land

Fill in Table 2 below with details of the point source emissions that result from the operating techniques at each of your installations.

Fill in one table for each installation, continuing on a separate sheet if necessary.

Table 2 – Emissions (releases)

Installation name	Hatton Compressor Station			
Point source emissions to air				
Emission point reference and location	Source	Parameter	Quantity	Unit
Refer to Section III: Supporting information				
and Tables C3: 2 – 1 to C3: 2 – 8				
Point source emissions to water (other than sewers)				
Emission point reference and location	Source	Parameter	Quantity	Unit
Refer to Section III: Supporting information				
and Table C3: 2 – 9				
Point source emissions to sewers, effluent treatment plants or other transfers off site				
Emission point reference and location	Source	Parameter	Quantity	Unit
None				
Point source emissions to land				
Emission point reference and location	Source	Parameter	Quantity	Unit
None				

You will also need to complete application form part C6 if your variation includes changing or adding a point source emission(s) to:

- water
- groundwater or
- sewer

Supporting information

3 Operating techniques

3a Technical standards

Fill in Table 3a for each activity at the installation you refer to in Table 1a above and list the 'Best Available Techniques' you are planning to use. If you use the standards set out in the relevant BAT conclusion(s), BAT reference document(s) (BREF) and/or technical guidance(s) (TGN) there is no need to justify using them within your documents in Table 3a.

For Part A(2) activities refer to https://www.gov.uk/government/collections/integrated-pollution-prevention-and-control-sector-guidance-notes and for Part B and Schedule 14 activities see https://www.gov.uk/government/collections/local-air-pollution-prevention-and-control-lappc-process-guidance-notes

You must justify your decisions in a separate document if:

- there is no technical standard
- the technical guidance provides a choice of standards, or
- you plan to use another standard

This justification could include a reference to the Environmental Risk Assessment provided in part C2 (general bespoke permit) of the application form.

For each of the activities listed in Table 1a, the documents in Table 3a should summarise:

- the operations undertaken
- the measures you will use to control the emissions from your process, as identified in your risk assessment or the relevant BAT conclusions, BREF or technical guidance
- how you will meet other standards set out in the relevant BAT conclusions document, BREF or technical guidance

Table 3 – Technical standards

Fill in a separate table for each activity at the installation.

Installation name	Hatton Compressor Station	
Description of the schedule 1 activity or directly associated activity	Best available technique (BATC, BREF or TGN reference) (see footnote below)	Document reference (if appropriate)
Refer to Section III: Supporting information Table 3		

* Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control)

In all cases, describe the type of facility or operation you are applying for and provide site infrastructure plans, location plans and process flow diagrams or block diagrams to help describe the operations and processes undertaken. Give the document references you use for each plan, diagram and description.

Document reference: Refer to Section II: Technical description and Section IV Figu

3a1 Does your permit (in Table 1.2 Operating Techniques or similar table in the permit) have references to any of your own documents or parts of documents submitted as part of a previous application for this site?

No ☐ Now go to 3b

Yes ☑ Please tell us in a separate document what document references are no longer valid or have been superseded and why

Please also tell us below the reference number you have given the document and send it in with your application

Document reference: Refer to Section III: Supporting information

3b General requirements

Fill in a separate Table 4 for each installation.

Table 4 – General requirements

Name of the installation	Hatton Compressor Station
If the technical guidance or your risk assessment shows that emissions of substances not controlled by emission limits are an important issue, send us your plan for managing them	Document reference or references Refer to Section III: Supporting informatio
Where the technical guidance or your risk assessment shows that odours are an important issue, send us your odour management plan	Document reference or references N/A
If the technical guidance or your risk assessment shows that noise or vibration are important issues, send us your noise or vibration management plan (or both)	Document reference or references Section III Table 4b and Appendix 4

For guidance on risk assessments for your environmental permit see https://www.gov.uk/guidance/risk-assessments-for-your-environmental-permit

3c Types and amounts of raw materials

Fill in Table 5 for all schedule 1 activities. Fill in a separate table for each installation.

Table 5 – Types and amounts of raw materials

Name of the installation		Hatton Compressor Station		
Capacity (See note 1 below)		N/A		
Schedule 1 activity	Description of raw material and composition	Maximum amount (tonnes) (See note 2 below)	Annual throughput (tonnes each year)	Description of the use of the raw material including any main hazards (include safety data sheets)
Refer to Section III: Supporting information and				

Notes

1 By 'capacity', we mean the total storage capacity (tonnes) or total treatment capacity (tonnes each day).

2 By 'maximum amount', we mean the maximum amount of raw materials on the site at any one time.

Use a separate sheet if you have a long list of raw materials, and send it to us with your application form. Please also provide the reference of this extra sheet.

Document reference: Refer to Section III: Supporting information and Table 5

3d Information for specific sectors

For some of the sectors, we need more information to be able to set appropriate conditions in the permit. This is as well as the information you may provide in sections 5, 6 and 7. For those activities listed below, you must answer the questions in the related document.

Table 6 – Questions for specific sectors

Sector	Appendix
Combustion	See the questions in appendix 1
Chemicals	See the questions in appendix 2
Incinerating waste	See the questions in appendix 3
Landfill and recovery of hazardous waste on land	See the questions in appendix 4

General information

Complete section 4 if you are proposing to change or add an emission point(s).

4 Monitoring

4a Describe the measures you use for monitoring emissions by referring to each emission point in Table 2 above

You should also describe any environmental monitoring. Tell us:

- how often you use these measures
- the methods you use
- the procedures you follow to assess the measures

Document reference: Refer to Section III: Tables C3: 4a – 1 and 4a – 2

4b Point source emissions to air only

4b1 Has the sampling location been designed to meet BS EN 15259 clause 6.2 and 6.3?

No ☐

Yes ☑

4b2 Are the sample ports large enough for monitoring equipment and positioned in accordance with section 6 and appendix A of BS EN 15259?

No ☐

Yes ☑

4b3 Is access adjacent to the ports large enough to provide sufficient working area, support and clearance for a sample team to work safely with their equipment throughout the duration of the test?

No ☐

Yes ☑

4b4 Are the sample location(s) at least 5 HD from the stack exit

No ☑

Yes ☐

4b5 Are the sample location(s) at least 2 HD upstream from any bend or obstruction?

No ☐

Yes ☑

4b6 Are the sample location(s) at least 5 HD downstream from any bend or obstruction?

No ☑

Yes ☐

4b7 Does the sample plane have a constant cross sectional area?

No ☐

Yes ☑

4b8 If horizontal, is the duct square or rectangular (unless it is less than or equal to 0.35 m in diameter)

No ☐

Yes ☐

4b9 If you have answered 'No' to any of the questions 4b1 to 4b8 above, provide an assessment to how the standards in BS EN 15259 will be met.

Document reference of the assessment: Section III: Supporting information C3: 4b

5 Environmental impact assessment

5a Have your proposals been the subject of an environmental impact assessment under Council Directive 85/337/EEC of 27 June 1985 [Environmental Impact Assessment] (EIA)?

No ☑ Now go to question 6

Yes ☐ Please provide a copy of the environmental statement and, if the procedure has been completed:

- a copy of the planning permission
- the committee report and decision on the EIA

Document reference of the copy

6 Resource efficiency and climate change

If the site is a landfill or a recovery of hazardous waste on land activity, you only need to fill in this section if the application includes gas engines.

6a Describe the basic measures for improving how energy efficient your activities are

Document reference of the description: Refer to Section III: Supporting information

6b Provide a breakdown of any changes to the energy your activities use up and create

Document reference of the description: Refer to Section III: Supporting information

6c Have you entered into, or will you enter into, a climate change levy agreement?

No ☑ Describe the specific measures you use for improving your energy efficiency

Document reference of the description: Refer to Section III: Supporting information

Yes ☐ Please give the date you entered (or the date you expect to enter) into the agreement (DD/MM/YYYY)

Please also provide documents that prove you are taking part in the agreement.

Document reference of the proof

6d Explain and justify the raw and other materials, other substances and water that you will use

Document reference of the justification: Refer to Section III: Supporting information

6e Describe how you avoid producing waste in line with Council Directive 2008/98/EC on waste

If you produce waste, describe how you recover it. If it is technically and financially impossible to recover the waste, describe how you dispose of it while avoiding or reducing any effect it has on the environment.

Document reference of the description: Refer to Section III: Supporting information

7 How to contact us

If you need help filling in this form, please contact the person who sent it to you or contact us as shown below.

General enquiries: 03708 506 506 (Monday to Friday, 8am to 6pm)

Textphone: 03702 422 549 (Monday to Friday, 8am to 6pm)

Email: enquiries@environment-agency.gov.uk

Website: https://www.gov.uk/government/organisations/environment-agency

If you are happy with our service, please tell us. It helps us to identify good practice and encourages our staff. If you're not happy with our service, please tell us how we can improve it.

Please tell us if you need information in a different language or format (for example, in large print) so we can keep in touch with you more easily.

Feedback

(You don't have to answer this part of the form, but it will help us improve our forms if you do.)

We want to make our forms easy to fill in and our guidance notes easy to understand. Please use the space below to give us any comments you may have about this form or the guidance notes that came with it.

How long did it take you to fill in this form?

We will use your feedback to improve our forms and guidance notes, and to tell the Government how regulations could be made simpler.

Would you like a reply to your feedback?

Yes please ☐

No thank you ☐

Crystal Mark 19107
Clarity approved by Plain English Campaign

For Environment Agency use only

Date received (DD/MM/YYYY)

Payment received?

No ☐

Our reference number

Yes ☐ Amount received

£

Plain English Campaign's Crystal Mark does not apply to appendices 1 to 4.

Appendix 1 – Specific questions for the combustion sector

1 Identify the type of fuel burned in your combustion units (including when your units are started up, shut down and run as normal). If your units are dual fuelled (that is, use two types of fuel), list both the fuels you use

Fill in a separate table for each installation.

Installation reference			
Type of fuel	When run as normal	When started up	When shut down
Coal	☐	☐	☐
Gas oil	☑	☑	☑
Heavy fuel oil	☐	☐	☐
Natural gas	☑	☑	☑
WID waste	☐	☐	☐
Biomass (see notes 1 and 2 below)	☐	☐	☐
Biomass (see notes 1 and 2 below)	☐	☐	☐
Biomass (see notes 1 and 2 below)	☐	☐	☐
Biomass (see notes 1 and 2 below)	☐	☐	☐
Biomass (see notes 1 and 2 below)	☐	☐	☐
Landfill gas	☐	☐	☐
Other	☐	☐	☐

Notes

1. Not covered by Industrial Emissions Directive 2010/75/EU.
2. ‘Biomass’ is referred to The Renewables Obligation Order 2002 (https://www.legislation.gov.uk/uksi/2002/914/contents/made)

Give extra information if it helps to explain the fuel you use.

Document reference: Refer to Section III: Supporting information

Appendix 1 – Specific questions for the combustion sector, continued

2 Give the composition range of any fuels you are currently allowed to burn in your combustion plant

Fill in a separate table for each installation, continuing on a separate sheet if necessary

Fuel use and analysis					
Installation reference	Refer to Section III: Supporting information				
Parameter	Unit	Fuel 1	Fuel 2	Fuel 3	Fuel 4
Maximum percentage of gross thermal input	%	Natural gas	Diesel		
Moisture	%				
Ash	% wt/wt dry				
Sulphur	% wt/wt dry				
Chlorine	% wt/wt dry				
Arsenic	% wt/wt dry				
Cadmium	% wt/wt dry				
Carbon	% wt/wt dry				
Chromium	% wt/wt dry				
Copper	% wt/wt dry				
Hydrogen	% wt/wt dry				
Lead	% wt/wt dry				
Mercury	% wt/wt dry				
Nickel	% wt/wt dry				
Nitrogen	% wt/wt dry				
Oxygen	% wt/wt dry				
Vanadium	mg/kg dry				
Zinc	mg/kg dry				
Net calorific value	MJ/kg				

Appendix 1 – Specific questions for the combustion sector, continued

3 If NOx factors are necessary for reporting purposes (that is, if you do not need to monitor emissions), please provide the factors associated with burning the relevant fuels

Fill in a separate table for each installation.

Installation reference	N/A
Fuel	NOx factor (kgt^{-1})
Fuel 1	
Fuel 2	
Fuel 3	
Fuel 4	

Note: kgt^{-1} means kilograms of nitrogen oxides released for each tonne of fuel burned.

4 Will your combustion plant be subject to Chapter III of the Industrial Emissions Directive 2010/75/EU?

No ☐ Now fill in application form part F

Yes ☑

5 What is your plant?

an existing one ☐ A plant licensed before 1 July 1987

a new one ☐ A plant licensed on or after 1 July 1987 but before 27 November 2002, or a plant for which an application was made before 27 November 2002 and which was put into operation before 27 November 2003

a new-new one ☑ A plant for which an application was made on or after 27 November 2002 If you run more than one type of plant or a number of the same type of plant on your installation, please list them in the table below

6 If you run more than one type of plant or a number of the same type of plant on your installation, please list them in the table below

Fill in a separate table for each installation.

Installation reference	Refer to Section III: Supporting information
Type of plant	Number within installation
Existing	3 (1 no. retained 500hrs; 2 no. to be retired under LLD)
New	
New-new	1
Gas turbine (group A)	
Gas turbine (group B)	

Appendix 1 – Specific questions for the combustion sector, continued

7 If you run an existing plant, have you submitted a declaration for the 'limited life derogation' set out in Article 33 of Chapter III of the Industrial Emissions Directive?

No ☐ Now go to question 9

Yes ☑

8 Have you subsequently withdrawn your declaration?

No ☑

Yes ☐

9 List the existing large combustion plants (LCPs) which have annual mass allowances under the National Emission Reduction Plan (NERP), and those with emission limit values (ELVs) under the LCPD

Installation reference	Hatton Gas Compressor Station
LCPs under NERP	LCPs with ELVs
	LCP 239 (RB211 unit B) (LLD)
	LCP 240 (RB211 unit C) (LLD)
	ELVs to be set for new unit E (LCP ref. TBC)

10 Do you meet the monitoring requirements of Chapter III of the Industrial Emissions Directive?

No ☐

Yes ☑ Document reference: Refer to Section III: Table C3: 4a-1

11 Are you substantially refurbishing an existing installation according to the meaning given in Article 14 of the Energy Efficiency Directive?

No ☑

Yes ☐ Now go to question 12

12 Have you carried out a cost–benefit assessment (CBA) of opportunities for cogeneration (combined heat and power) or district heating under Article 14 of the Energy Efficiency Directive?

No ☑ Please provide supporting evidence of why a CBA is not required (for example, an agreement from us)

Document reference of this evidence: Refer to Section III: Part C3: Appendix 1, Q 12

Yes ☐ Please submit a copy of your CBA

Document reference of the CBA:

Appendix 2 – Specific questions for the chemical sector

1 Please provide a technical description of your activities

- The description should be enough to allow us to understand:
- the process
- the main plant and equipment used for each process
- all reactions, including significant side reactions (that is, the chemistry of the process)
- the material mass flows (including by products and side streams) and the temperatures and pressures in major vessels
- the all emission control systems (both hardware and management systems), for situations which could involve releasing a significant amount of emissions – particularly the main reactions and how they are controlled
- a comparison of the indicative BATs and benchmark emission levels standards: technical guidance notes (TGNs) (see https://www.gov.uk/government/collections/technical-guidance-for-regulated-industry-sectors-environmental-permitting); additional guidance 'The production of large volume organic chemicals' (EPR 4.01); 'Speciality organic chemicals sector' (EPR 4.02); 'Inorganic chemicals sector' (EPR 4.03); and best available techniques reference documents (BREFs) for the chemical sector

Document reference

2 If you are applying for a multi-purpose plant, do you have a multi-product protocol in place to control the changes?

No ☐

Yes ☐ Provide a copy of your protocol to accompany this application

Document reference

3 Does Chapter V of the Industrial Emissions Directive (IED) apply to your activities?

No ☐

Yes ☐ Fill in the following

3a List the activities which are controlled under the IED

Installation reference	
Activities	

3b Describe how the list of activities in question 3a above meets the requirements of the IED

Document reference

Appendix 3 – Specific questions for the waste incineration sector

If you are proposing to accept clinical waste, please complete your answer to question 3a 'Technical standards' with reference to relevant parts of our healthcare waste appropriate measures guidance (see https://www.gov.uk/guidance/healthcare-waste-appropriate-measures-for-permitted-facilities)

1a Do you run incineration plants as defined by Chapter IV of the Industrial Emissions Directive (IED)?

No ☐ You do not need to answer any other questions in this appendix

Yes ☐ IED applies

1b Are you subject to IED as

An incinerator? ☐

A co-incinerator? ☐

2 Do any of the installations contain more than one incineration line?

No ☐ Now go to question 4

Yes ☐

3 How many incineration lines are there within each installation?

Fill in a separate table for each installation.

Installation reference		
Number of incineration lines within the installation		
Reference identifiers for each line		

You must provide the information we ask for in questions 4, 5 and 6 below in separate documents. The information must at least include all the details set out in section 2 ('Key Issues') of S5.01 'Incineration of waste: additional guidance' (under the sub heading 'European legislation and your application for an EP Permit'). See https://www.gov.uk/government/collections/technical-guidance-for-regulated-industry-sectors-environmental-permitting.

You must answer questions 7 to 13 on the form below.

4 Describe how the plant is designed, equipped and will be run to make sure it meets the requirements of IED, taking into account the categories of waste which will be incinerated

Document reference ____________________

5 Describe how the heat created during the incineration and co-incineration process is recovered as far as possible (for example, through combined heat and power, creating process steam or district heating)

Document reference ____________________

Appendix 3 – Specific questions for the waste incineration sector, continued

6 Describe how you will limit the amount and harmful effects of residues and describe how they will be recycled where this is appropriate

Document reference

For each line identified in question 3, answer questions 7 to 13 below

Question 3 identifier, if necessary

7 Do you want to take advantage of the Article 45 (1)(f) allowance (see below) if the particulates, CO or TOC continuous emission monitors (CEM) fail?

No ☐

Yes ☐ This allows 'abnormal operation' of the incineration plant under certain circumstances when the CEM for releases to air have failed. Annex VI, Part 3(2) sets maximum half hourly average release levels for particulates (150 mg/m3), CO (normal ELV) and TOC (normal ELV) during abnormal operation.

Describe the other system you use to show you keep to the requirements of Article 13(4) (for example, using another CEM, providing a portable CEM to insert if the main CEM fails, and so on).

8 Do you want to replace continuous HF emission monitoring with periodic hydrogen fluoride (HF) emission monitoring by relying on continuous hydrogen chloride (HCl) monitoring as allowed by IED Annex VI, Part 6 (2.3)?

Under this you do not have to continuously monitor emissions for hydrogen fluoride if you control hydrogen chloride and keep it to a level below the HCl ELVs.

No ☐

Yes ☐ Please give your reasons for doing this

Appendix 3 – Specific questions for the waste incineration sector, continued

9 Do you want to replace continuous water vapour monitoring with pre-analysis drying of exhaust gas samples, as allowed by IED Annex VI, Part 6 (2.4)?

Under this you do not have to continuously monitor the amount of water vapour in the air released if the sampled exhaust gas is dried before the emissions are analysed.

No ☐

Yes ☐ Please give your reasons for doing this

10 Do you want to replace continuous hydrogen chloride (HCl) emission monitoring with periodic HCl emission monitoring, as allowed by IED Annex VI, Part 6 (2.5), first paragraph?

Under this you do not have to continuously monitor emissions for hydrogen chloride if you can prove that the emissions from this pollutant will never be higher than the ELVs allowed.

No ☐

Yes ☐ Please give your reasons for doing this

Appendix 3 – Specific questions for the waste incineration sector, continued

11 Do you want to replace continuous HF emission monitoring with periodic HF emission monitoring, as allowed by IED Annex VI, Part 6 (2.5), first paragraph?

Under this you do not have to continuously monitor emissions for hydrogen fluoride if you can prove that the emissions from this pollutant will never be higher than the ELVs allowed.

No ☐

Yes ☐ Please give your reasons for doing this

12 Do you want to replace continuous SO_2 emission monitoring with periodic sulphur dioxide (SO_2) emission monitoring, as allowed by IED Annex VI, Part 6 (2.5), first paragraph?

Under this you do not have to continuously monitor emissions for sulphur dioxide if you can prove that the emissions from this pollutant will never be higher than the ELVs allowed.

No ☐

Yes ☐ Please give your reasons for doing this

Appendix 3 – Specific questions for the waste incineration sector, continued

13 If your plant uses fluidised bed technology, do you want to apply for a derogation of the CO WID ELV to a maximum of 100 mg/m^3 as an hourly average, as allowed by IED Annex VI, Part 3?

No ☐

Does not apply ☐

Yes ☐ Please give your reasons for doing this

14 Are you substantially refurbishing an existing installation according to the meaning given in Article 14 of the Energy Efficiency Directive?

No ☐

Yes ☐ Please go to question 15

Document reference of the CHP-ready assessment

15 Have you carried out a cost–benefit assessment (CBA) of opportunities for cogeneration (combined heat and power) or district heating under Article 14 of the Energy Efficiency Directive?

No ☐ Please provide supporting evidence of why a CBA is not required (for example, an agreement from us)

Document reference of this evidence

Yes ☐ Please submit a copy of your CBA

Document reference of the CBA

Appendix 4 – Specific questions for the landfill sector and recovery of hazardous waste on land activities

1. For the landfill sector, provide your Environmental Setting and Installation Design (ESID) report and any other risk assessments to control emissions.

For recovery of hazardous waste on land activities, provide your Environmental Setting and Site Design (ESSD) report and any other risk assessments to control emissions

Document reference

2. For recovery of hazardous waste on land activities, provide your Waste Acceptance Procedures (including Waste Acceptance Criteria)

Document reference

Refer to our guidance at
https://www.gov.uk/government/publications/deposit-for-recovery-operators-environmental-permits/waste-acceptance-procedures-for-deposit-for-recovery

3. Provide your hydrogeological risk assessment (HRA) for the site

Document reference

4. Provide your outline engineering plan for the site

Document reference

5. Provide your stability risk assessment (SRA) for the site

Document reference

6. Provide your landfill gas risk assessment (LFGRA) for the site

Document reference

We have developed guidance on these assessments and their reports which can be found at
https://www.gov.uk/government/collections/environmental-permitting-landfill-sector-technical-guidance

7. For recovery of hazardous waste on land activities, have you completed a monitoring plan for the site?

No ☐ Please refer to the section of your ESSD that explains why this is unnecessary for your site

Document reference of this evidence

Yes ☐ Document reference

8. Have you completed a proposed plan for closing the site and your procedures for looking after the site once it has closed?

No ☐ If you have answered ‘no’ for recovery of hazardous waste on land activities, refer to the section of your ESSD that explains why this is unnecessary for your site

Document reference of this evidence

Yes ☐ For landfill you must provide a closure and aftercare plan

Document reference

Part F1

Application for an environmental permit Part F1 – Charges and declarations

Environment Agency

You will need to use an Adobe Acrobat reader product to complete this form. The form may not work properly if you use a different pdf reader, such as the one built-in to your internet browser.

Fill in this part for all applications for:

- installations (excluding intensive farming)
- waste operations
- mining waste operations
- medium combustion plant
- specified generators
- water discharges (excluding small discharges of $23m^3$ per day if using Part B6.5)
- groundwater activities (excluding small discharges of $15m^3$ per day or less if using Part B6.5 OR existing small discharges to Source Protection Zone1 if using Part B6.6)

Please check that this is the latest version of the form available from our website.

Please read through this form and the guidance notes that came with it.

The form can be:

1) saved onto a computer and then filled in.
2) printed off and filled in by hand. Please write clearly in the answer spaces.

It will take less than two hours to fill in this part of the application form.

Contents

1 Working out charges

You must fill in this section.

You have to submit an application fee with your application. For guidance on the fee and how to pay your charges, please see our charging guidance (**https://www.gov.uk/government/publications/environmental-permitting-charges-guidance**) and associated links to the current charging scheme. You can also contact us for pre-application to help work out charges

Please that there is an annual subsistence charge to cover the costs we incur in the ongoing regulation of the permit.

1 Working out charges, continued

Table 1 – Type of application (fill number of activity being applied for in each column)

Installation	Waste	Mining waste	Medium Combustion Plant (MCP)/ Specified Generator (SG)	Water discharge	Groundwater activity
1					

Table 2 – Charge type (A)

Charge activity reference	Charge activity description	What are you applying to do? For example, a new permit, minor variation, normal variation, substantial variation, surrender, low risk surrender, transfer	Amount
e.g. 1.17.3	e.g. Section 5.2 – landfill for hazardous waste	e.g. transfer application	e.g. £5,561
1.10.1	Section 1.1, Part A(1) (a) Burning any fue	Substantial Variation	£17,193
Total A			£17,193

1 Working out charges, continued

Table 3 – Additional assessment charges (B)

Part 1.19 Charges for plans and assessments			Tick appropriate
Reference	Plan or assessment	Charge	
1.19.1	Waste recovery plan	£1,231	☐
1.19.2	Habitats assessment (except where the application activity is a flood risk activity)	£779	✔
1.19.3	Fire prevention plan (except where the application activity is a farming installation)	£1,241	☐
1.19.4	Pests management plan (except where the application activity is a farming installation)	£1,241	☐
1.19.5	Emissions management plan (except where the application activity is a farming installation)	£1,241	☐
1.19.6	Odour management plan (except where the application activity is a farming installation)	£1,246	☐
1.19.7	Noise and vibration management plan (except where the application activity is a farming installation)	£1,246	✔
1.19.8	Ammonia emissions risk assessment (intensive farming applications only)	£620	☐
1.19.9	Dust and bio-aerosol management plan (intensive farming applications only)	£620	☐
	Advertising	£500	☐
Total B			£2,025

Total charges

Total A plus total B

£19,218.00

2 Payment

Tick below to show how you have paid.

Cheque

Credit or debit card

✔ Electronic transfer (for example, BACS)

Cheques

You should make cheques payable to ‘Environment Agency’ and make sure they have ‘A/c Payee’ written across them if it is not already printed on.

Please write the name of your company and application reference number on the back of your cheque. We will not accept cheques with a future date on them.

2 Payment, continued

Credit/debit cards

If you are paying by credit or with debit card we will call you. We can accept payments by Visa, MasterCard or Maestro card only.

☐ Call me to arrange payment by debit or credit card

Electronic transfer BACS

If you choose to pay by electronic transfer, you will need to use the following information to make your payment:

Company name	Environment Agency
Company address	SSCL (Environment Agency), PO Box 797, Newport Gwent, NP10 8FZ
Bank	RBS/NatWest
Address	London Corporate Service Centre, CPB Services, 2nd Floor, 280 Bishopsgate, London EC2M 4RB
Sort code	60-70-80
Account number	10014411
Account name	EA RECEIPTS
Payment reference number	PSCAPPXXXXXYYY

You need to create your own reference number. It should begin with PSCAPP (to reflect that the application is for a permitted activity) and it should include the first five letters of the company name (replacing the X's in the above reference number) and a unique numerical identifier (replacing the Y's in the above reference number). The reference number that you supply will appear on our bank statements.

You should also email your payment details and reference number to **ea_fsc_ar@gov.sscl.com**.

If you are making your payment from outside the United Kingdom, it must be in sterling. Our IBAN number is GB23NWBK60708010014411 and our SWIFTBIC number is NWBKGB2L.

If you do not quote your reference number, there may be a delay in processing your payment and application.

Provide a unique reference number for the application, i.e. do not only use the company name only

PSCAPPNATIO276

State who is paying (full name and whether this is the agent/applicant/other)

National Gas Transmission plc

Fee paid

£ 19218.00

Date payment sent (DD/MM/YYYY)

26/05/2023

3 Privacy notice

The Environment Agency runs the environmental permit application service.

See **https://www.gov.uk/guidance/environmental-permits-privacy-notice** for how we use your personal information in services to services to support environmental permitting.

4 Confidentiality and national security

Confidentiality

We will normally put all the information in your application on a public register of environmental information. However, we may not include certain information in the public register if this is in the interests of national security, or because the information is confidential.

You can ask for information to be made confidential by enclosing a letter with your application giving your reasons. If we agree with your request, we will tell you and not include the information in the public register. If we do not agree with your request, we will let you know how to appeal against our decision, or you can withdraw your application. You can find guidance on confidentiality in 'Environmental permitting guidance: core guidance', published by Defra and available at **https://www.gov.uk/government/publications/environmental-permitting-guidance-core-guidance--2**.

Only tick the box below if you wish to claim confidentiality for parts of your application

Please treat the specified information in my application as confidential

National security

You can tell the Secretary of State that you believe including information on a public register would not be in the interests of national security. You must enclose a letter with your application telling us that you have told the Secretary of State and you must still include the information in your application. We will not include the information in the public register unless the Secretary of State decides that it should be included.

You can find guidance on national security in 'Environmental permitting guidance: core guidance', published by Defra and available at **https://www.gov.uk/government/publications/environmental-permitting-guidance-core-guidance--2**

You cannot apply for national security via this application.

Now fill in section 5

5 Declaration

If you knowingly or carelessly make a statement that is false or misleading to help you get an environmental permit (for yourself or anyone else), you may be committing an offence under the Environmental Permitting (England and Wales) Regulations 2016.

A relevant person should make the declaration (see the guidance notes on part F1). An agent acting on behalf of an applicant is NOT a relevant person.

Each individual (or individual trustee) who is applying for their name to appear on the permit must complete this declaration. You will have to print a separate copy of this page for each additional individual to complete.

If you are transferring all or part of your permit, both you and the person receiving the permit must make the declaration. You must fill in the declaration directly below; the person receiving the permit must fill in the declaration under the heading 'For transfers only'.

Note: we will issue a letter to both current and new holders to confirm the transfer. If you are changing address we will need to send this letter to your new address; therefore please tell us your new address in a separate letter.

If you are unable to trace one or more of the current permit holders please see below under the transfers declaration.

5 Declaration, continued

I declare that the information in this application is true to the best of my knowledge and belief.
I understand that this application may be refused or approval withdrawn if I give false or incomplete information.

If you deliberately make a statement that is false or misleading in order to get approval you may be prosecuted.

- [x] Tick this box to confirm that you understand and agree with the declaration above, then fill in the details below (you do not have to provide a signature as well)
- [ ] I confirm that my standard facility will fully meet the rules that I have applied for (this only applies if the application includes standard facilities)
- [ ] Tick this box if you do not want us to use information from any ecological survey that you have supplied with your application (for further information please see the guidance notes on part F1)

Name

Title

Mr

First name

Neil

Last name

Billingham

on behalf of (if relevant; for example, a company or organisation and so on)

National Gas Transmission plc

Position (if relevant; for example, a company or organisation and so on)

Senior Environmental Engineer

Today's date (DD/MM/YYYY)

10/05/2023

For transfers only – declaration for person receiving the permit

A relevant person should make the declaration (see the guidance notes on part F1). An agent acting on behalf of an applicant is NOT a relevant person.

I declare that the information in this application to transfer an environmental permit to me is true to the best of my knowledge and belief. I understand that this application may be refused or approval withdrawn if I give false or incomplete information.

Note: If you cannot trace a person or persons holding the permit you may be able to transfer the permit without their declaration as above. Please contact us to discuss this and supply evidence in your application to confirm you are unable to trace one or all of the permit holders.

If you deliberately make a statement that is false or misleading in order to get approval you may be prosecuted.

- [ ] Tick this box to confirm that you understand and agree with the declaration above, then fill in the details below (you do not have to provide a signature as well)

5 Declaration, continued

Name

Title

First name

Last name

on behalf of (if relevant; for example, a company or organisation and so on)

Position (if relevant; for example, a company or organisation and so on)

Today's date (DD/MM/YYYY)

Now go to section 6

6 Application checklist

You must fill in this section.

If your application is not complete, we will return it to you. If you aren't sure about what you need to send, contact us before you submit your application. For further information on pre-application advice, see **https://www.gov.uk/guidance/get-advice-before-you-apply-for-an-environmental-permit.**

You must do the following:

- ✔ Complete legibly all parts of the application form that are relevant to you and your activities
- ✔ Identify relevant supporting information in the form and send it with the application
- ✔ List all the documents you are sending in the table below. If necessary, continue on a separate sheet. This separate sheet also needs to have a reference number and you should include it in the table below
- ✔ For new permit applications or any changes to the site plan, provide a plan that meets the standards given in the guidance note on part F1
- ✔ Provide a supporting letter for any claim that information is confidential
- ✔ Get the declaration completed by a relevant person (not an agent)
- ✔ Send the correct fee

6 Application checklist, continued

Question reference	Document title	Document reference
Form F, Q2	Payment reference	Form F
All	Hatton CS Upgrade variation application	Supporting Information document
Form A,C0.5,C2, C3, F1	Hatton CS Upgrade variation application	Section I Forms (A, C0.5, C2, C3, F1)
Form C2, C3	Hatton CS Upgrade variation application	Section II Technical Description
Form C2, C3	Hatton CS Upgrade variation application	Section III Supporting Information
Form C2, C3	Hatton CS Upgrade variation application	Section IV Figures (nos. 1 to 4)
Form C2, C3	Hatton CS Upgrade variation application	Section V Appendices

7 How to contact us

If you have difficulty filling in this form, please contact the person who sent it to you or contact us as shown below.

General enquiries: 03708 506 506 (Monday to Friday, 8am to 6pm)

Textphone: 03702 422549 (Monday to Friday, 8am to 6pm)

Email: **enquiries@environment-agency.gov.uk**

Website: **www.gov.uk/government/organisations/environment-agency**

If you are happy with our service, please tell us. It helps us to identify good practice and encourages our staff. If you're not happy with our service, or you would like us to review a decision we have made, please let us know. More information on how to do this is available at: **https://www.gov.uk/government/organisations/environment-agency/about/complaints-procedure.**

Please tell us if you need information in a different language or format (for example, in large print) so we can keep in touch with you more easily.

8 Where to send your application

For how many copies to send see the guidance note on part F1.

Please send your filled in application form and supporting documents to:

For water discharges and groundwater activities by email to
PSC-WaterQuality@environment-agency.gov.uk

For waste, installations, medium combustion plant and specified generators by email to
PSC@environment-agency.gov.uk

For large electronic documents (too large for email attachment) you can upload your applications to file sharing sites and send us a link to download the documents. Alternatively, you can send more than one email with documents attached.

Or by post to:

Permitting Support, NPS Sheffield
Quadrant 2
99 Parkway Avenue
Parkway Business Park
Sheffield
S9 4WF

Do you want all information to be sent to you by email?

☐ Please tick this box if you wish to have all communication about this application sent via email (we will use the details provided in part A)

Feedback

(You don't have to answer this part of the form, but it will help us improve our forms if you do.)

We want to make our forms easy to fill in and our guidance notes easy to understand. Please use the space below to give us any comments you may have about this form or the guidance notes that came with it.

How long did it take you to fill in this form?

We will use your feedback to improve our forms and guidance notes, and to tell the Government how regulations could be made simpler.

Would you like a reply to your feedback?

☐ Yes please

☐ No thank you

For Environment Agency use only

Date received (DD/MM/YYYY)

Our reference number

Payment received?

☐ No

☐ Yes

Amount received (£)

National Grid House
Warwick technology Park
Gallows Hill, Warwick
CV34 6DA

+44 (0) 1926 65 3000
nationalgas.com

To Whom It May Concern

25 April 2023

I confirm that Neil Billingham, Senior Environmental Engineer is authorised to sign applications for, variations to, or surrender of Environmental Permitting Regulations, Pollution, Prevention and Control and UK Emission Trading Scheme permits on behalf of National Gas Transmission plc.

Yours sincerely

Sofia Bernsand
Company Secretary
National Gas Transmission plc

Section II: Proposed changes

This section of the application provides a Technical Description of the proposed changes to activities carried out at the installation.

The Information provided in this section should be viewed in parallel with:

- Section I: Application forms
- Section III: Supporting information

Introduction

This application for an environmental permit variation (Substantial Change) under the Environmental Permitting (England and Wales) Regulations (EPR) (2016, as amended) is in relation to National Gas Transmission's Hatton Compressor Station. An administrative variation is also made in parallel to reflect the change in name of the operator from National Grid Gas plc to National Gas Transmission plc.

Overview of existing operation and drivers for change

National Gas Transmission's Hatton site is a key compressor installation that has historically seen high levels of duty; its purpose is to compress gas, increasing flows and pressures in the network for onward transmission to the wider network and ultimately customers.

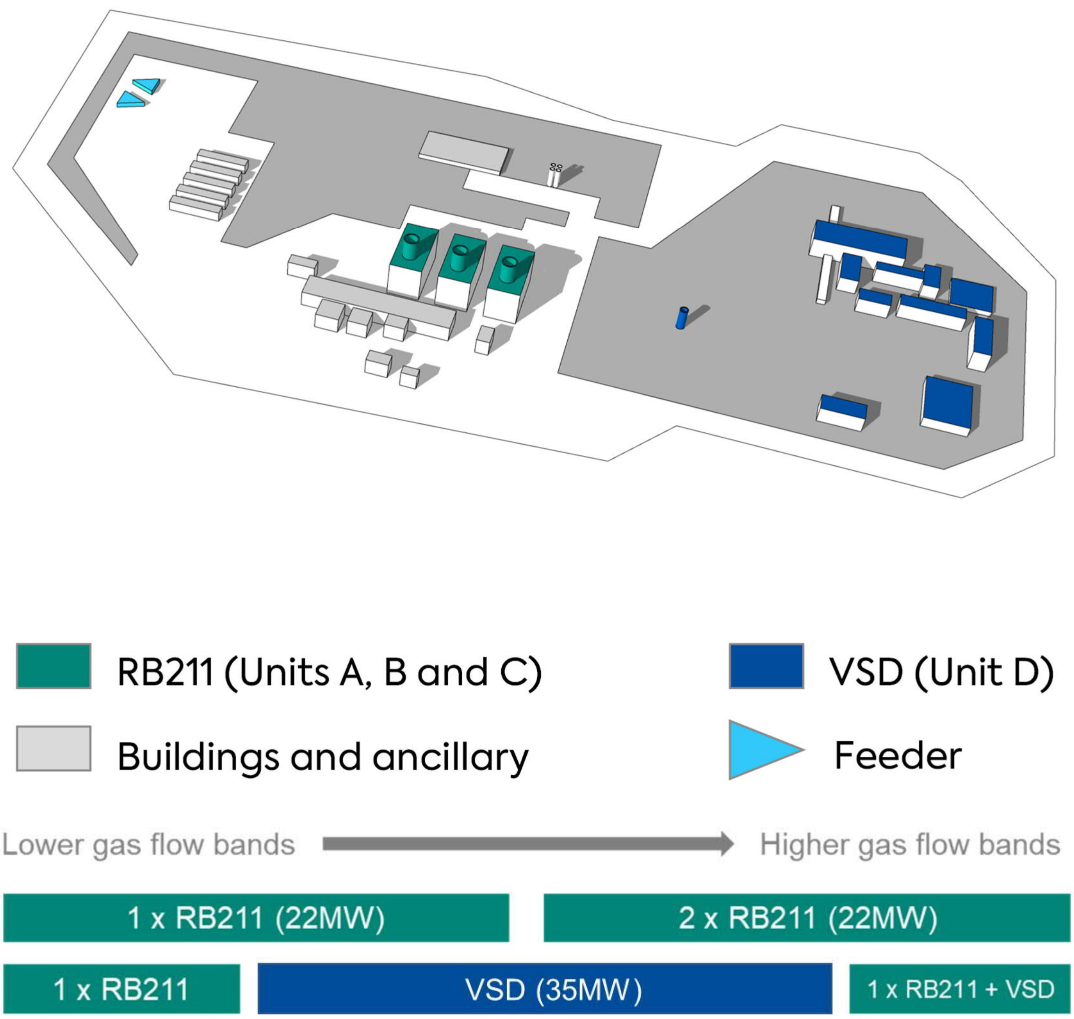
Existing equipment comprises three legacy compressors (units A, B and C) installed in the 1980s, in three separate 'cab' buildings (also called compressor enclosures) each with an aero derivative[3] hot gas generator, power turbine and centrifugal compressor, and a single modern electric Variable Speed Drive (VSD) compressor (unit D) installed in the mid-2000s.

The site Environmental Permit (EP) at present dictates that the Best Available Techniques (BAT) unit D (the VSD unit) is used, when operationally available, in preference to the legacy gas turbine driven compressors (units A, B and C). These older units provide additional compression when required, meet low flows and also provide standby capacity in the event the VSD is unavailable through either power outage or maintenance. All units can be run individually or in pairs with a maximum of two units providing duty, although three units may be fired up concurrently for short periods when switching from one driver to another (referred to as 'running changeovers').

Current key plant is illustrated on the site schematic below (Figure A), the table underneath shows the modular way in which existing units can be combined to accommodate the full range of site power requirements (as megawatts (MW)).

3 Aero derivative - based on the type of engines used in aircraft

Figure A Hatton schematic



Gas turbine back-up to the electric VSD must be maintained into the future to provide security of supply, the site is already at its maximum acceptable reliance on third party energy supplies in using the VSD for bulk compression. As such, no further investment in electric drives can be made at the site; instead compression upgrades must utilise low emission gas turbine driven units.

The two primary drivers for the proposed gas turbine compressor upgrade project are:

- **Tightening environmental regulatory requirements associated with legacy gas turbines**. The existing Large Combustion Plant[4] (LCP) at the site comprising three Rolls-Royce RB211-24C gas turbine driven compressor sets (hereafter RB211s) are not capable of meeting existing plant emissions limits as set out in the Industrial Emissions Directive[5] (IED). As such, National Gas Transmission elected to place unit A onto the 500 hours 'emergency use' derogation, this being the maximum hours the unit can run per year for the remainder of its operational life. Units B and C were placed under Limited Life Derogation (LLD) whereby they must be retired on the sooner of 17,500 run hours from derogation or 31/12/2023. Associated Emissions Levels (AELs) contained in the Large Combustion Plant BAT Reference (BREF) documents[6] also drive future compliance standards for the site.
- **Mass emissions reduction**. National Gas Transmission is required to regularly review network wide environmental emissions performance with the Environment Agency (EA), Scottish Environment Protection Agency (SEPA) and Natural Resources Wales (NRW); this is called the Network Review, annual updates of which are set by a condition in all the sites' permits. This process, carried out in discussion with the environmental regulators, involves the review of options to make material improvements to site mass emissions of oxides of nitrogen (NOx) (as well as improvements in carbon monoxide (CO) emission concentrations). The improvements focus on those sites with higher running hours and older gas turbine compressor machinery; although Hatton was subject to an earlier phase of the Emissions Reduction Programme (ERP), when the unit D was installed, the remaining usage of the RB211 units makes the site a Network Review priority despite lead duty being preferentially met by the BAT compliant electric VSD compressor at present.

The location of the Hatton installation is shown in Figure 1 in Section IV: Figures.

This application for a 'substantial change' variation to environmental permit UP3333LL is for the installation and operation of one new Siemens SGT-750 industrial gas turbine driven natural gas compressor machinery package, with associated air intake, exhaust stack (with emissions sampling provisions), fuel gas pre-heating skid, lube oil cooler and control system. It also includes description of additional associated capital investment works at the installation relating to a new additional vent stack, local process gas valves, and a replacement standby generator.

4 Plant with an individual thermal input in excess of 50MW
5 Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control)
6 Best Available Techniques (BAT) Reference Document for the Large Combustion Plants Industrial Emissions Directive 2010/75/EU (Integrated Pollution Prevention and Control) JOINT RESEARCH CENTRE. European IPPC Bureau. (December 2017) and Commission Implementing Decision (EU) 2017/1442 of 31 July 2017 establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for large combustion plants (August 2017).

Technology selection and BAT process overview

National Gas Transmission assessed a number of technical solutions to reduce emissions from the site, which focused on replacing two of the three RB211 engines with either two new medium sized or a single new large gas turbine driven compressor. After conducting a detailed engineering study, tendering exercise and assessment of Best Available Techniques (BAT) (as required by the Environmental Permitting Regulations) National Gas Transmission determined that the chosen package, comprising one new Dry Low Emission (DLE) Siemens SGT-750 unit, offered the best technical and environmental solution. This outcome has previously been present to the Environment Agency via the periodic 'Network Review' liaison between National Gas Transmission and the environmental regulators. This scheme, together with new ancillary equipment forms the basis for this application for a permit variation. The BAT assessment is included in Appendix 6 of this application.

Outline scope of changes

The scheme will require a number of changes to be made at the Hatton installation. These changes include:

- Installation of one new Siemens SGT-750 compressor unit (E) in a low-noise enclosure. In normal circumstances, the new unit will operate alone or under higher station flow conditions in parallel with the variable speed electric motor driven compressor unit D. The VSD unit D and new unit E will both take on the duties of 'lead machine' depending on the circumstances. If the VSD becomes unavailable at any time, for e.g. through either power outage or maintenance purposes, the new unit E will function as lead unit and, when required, will operate in parallel with the remaining RB211 (500hrs) unit A (under station high flow conditions).
- The new unit (and associated ancillaries) will be situated outside of the current installation boundary, on land owned by National Gas Transmission to the west of the existing site boundary, between the current compressor station boundary and adjacent National Gas Transmission Above Ground Installation (AGI) (or gas valve compound).
- Installation of an exhaust stack, incorporating silencer, with sampling ports, Continuous Emissions Monitoring System (CEMS) probes, high level platform and stairway to facilitate periodic extractive emissions testing in line with the requirements of Environment Agency Guidance 'Monitoring stack emissions: measurement locations'[7] (formerly TGN M1).
- Installation of a new engine air intake, including anti-icing filters using pulse jet technology.
- Installation of Predictive Emission Monitoring Systems (PEMS) and CEMS for monitoring NOx and CO emissions and to support process monitoring.
- Installation of a new fuel gas pre-treatment skid (incorporating lube oil heat recovery), to preheat the fuel gas prior to pressure let down into the fuel gas system.

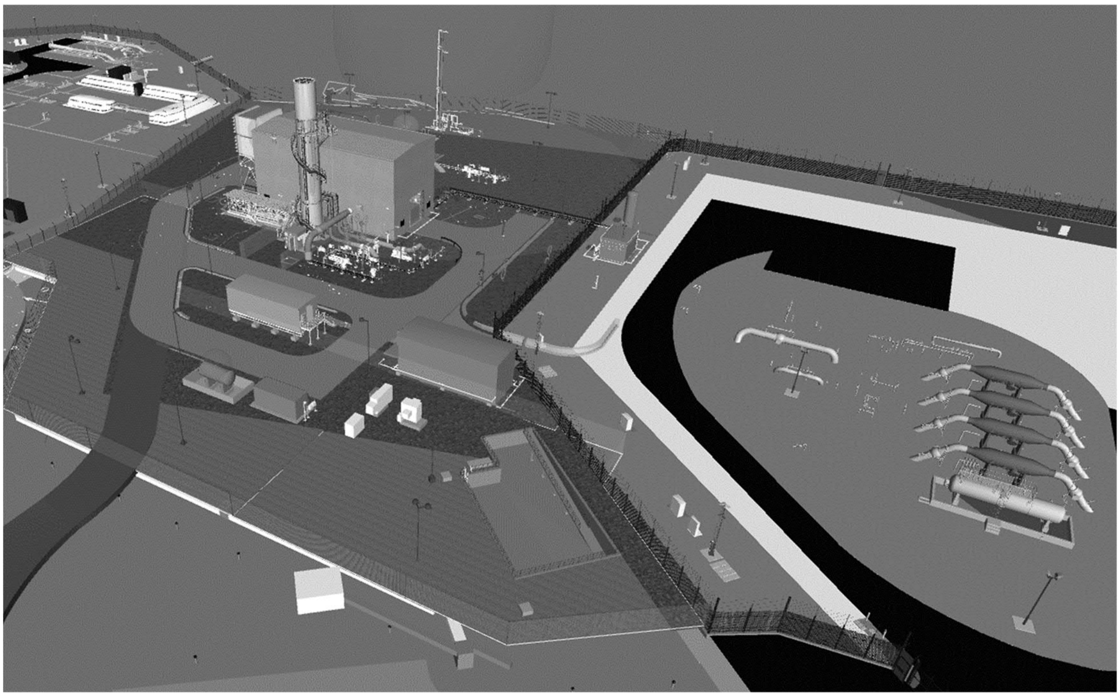
7 https://www.gov.uk/government/publications/monitoring-stack-emissions-measurement-locations/monitoring-stack-emissions-measurement-locations

- Installation of an elevated risk drainage zone to provide secondary and tertiary containment in the event of a loss of liquid containment. This system is aligned to remote containment principles described in CIRIA 736[8].
- Provision of a new vent stack for unit venting of the new compressor and associated local pipework. The vent stack will include a nitrogen fire suppression ('snuffing') system.
- Package diesel reciprocating standby generator and bunded fuel oil tank to provide continued control and instrumentation power in the event of a mains supply failure or in a 'black start' scenario. This replaces the older of the two existing standby generators on site, due to increased electrical capacity requirements associated with the proposed new unit E.
- Extensions and alterations to the security fence, to accommodate the boundary extension.

The remaining RB211 unit A will be unchanged; it will take on the operational function of a standby unit, only to be used in the event of higher station flows and in parallel with the new SGT750 unit E, when the VSD is unavailable. Unit A will be limited to operate for 500 per year. Annual projected and actual running hours will continue, as present, to be reported to the Environment Agency via the annual Network Review.

Illustrative visualisation of the proposed new compressor enclosure and access provisions are shown in Figure B below.

Figure B Illustrative visualisation of the new development area



8 CIRIA C736 Containment systems for the prevention of pollution, Secondary, tertiary and other measures for industrial and commercial premises (2014)

The proposed changes are considered to bring about a number of environmental improvements and advantages including:

- Significantly reduced mass emissions of NOx to the atmosphere from the installation.
- Reductions in predicted ground level concentrations of NOx and CO, as a result of reduction at source and improved dispersion resulting from the installation of a taller exhaust stack.
- 'FutureGrid' compliance built in, allowing methane / hydrogen fuel blends.
- Installation of a unit with an advanced, modular, low noise design, providing protection from noise impacts at nearby sensitive receptor locations.
- Improvements in thermal efficiency and overall compressor train efficiency brought about by:
    - modern combustion plant.
    - compressor mapping to predicted site duty requirements.
    - compressor matching to power turbine speeds.
- These measures will reduce the potential for requiring the unit to run in reduced efficiency 'recycle' conditions for key process duty points.
- Increased 'balance of plant' (ancillary equipment) energy efficiency including variable speed air compressors, and localised waste heat recovery accommodated via lube oil heat recovery for fuel gas pre-treatment.
- State-of-the-art low emission engine combustion control systems, which offer a market leading turndown performance from 100% Maximum Continuous Rating (MCR) to 30% MCR.
- Adoption of electro-hydraulic or electric valve actuators for new process valves, which avoids the release of natural gas (methane) associated with operating more traditional process gas actuated valves, which use the pressure in the gas as the motive force for valve operation.
- Increased versatility and unit flexibility, offering a wide compressor operating envelope over which emissions compliant engine performance is achieved, increasing the likelihood of the site being able to accommodate future gas process supply and demand scenarios without adversely impacting on environmental performance.
- Compliance with emissions limits as set in the BREF conclusions[9] and LCP requirements of the IED in a cost-effective manner which represents value for National Gas Transmission's customer base, the nation's energy consumers.
- Provision of greater reliability and reduced maintenance cost through replacement of ageing assets.
- Improvements in environmental risk controls through bunding and containment provision of key potential risk areas, such as the fuel gas skid and compressor machinery skid and enclosure.
- Enhanced process control interface on site and with the wider network control systems.

9 Commission Implementing Decision (EU) 2021/2326 of 30 November 2021 establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for large combustion plants.

In summary, this application for variation demonstrates that the proposed changes in operation at the site will not result in significant negative impacts upon environmental receptors and offers the potential for significant improvements with regard to emissions of NOx and CO from the installation. The environmental controls and operational practices employed in the installation are considered to comply with the requirements of BAT, this is considered to be enhanced through the ancillary upgrades described.

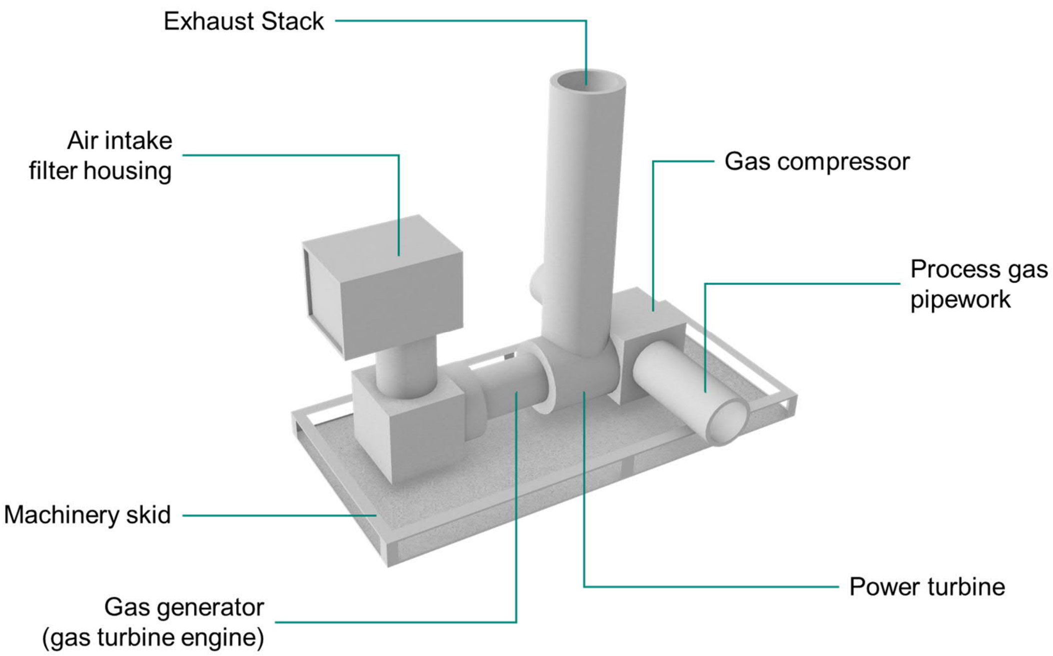
The remainder of Section II describes the proposed changes in more detail, focusing on the environmental aspects of the scheme and in demonstrating the application of BAT.

New compressor machinery train

Overview

The basic principle of operation for the proposed new compressor machinery is the same as for the existing gas turbine (RB211) units. Ambient air is drawn into the gas turbine engine (or gas generator), where its temperature and pressure are raised in the engine intake compressor. The high-pressure air proceeds into the combustion chamber, where the natural gas fuel is mixed and burnt. The resulting high-temperature gases then enter the power turbine, where they expand to atmospheric pressure through a row of nozzle vanes. This expansion causes the turbine blades and shaft to spin, the shaft is directly connected to the centrifugal gas compressor. The unit operates in an open cycle configuration and exhaust gases leave the turbine without recycling or heat recovery. The general arrangement of the compressor machinery train is presented in Figure C.

Figure C Indicative general arrangement of principal compressor machinery components

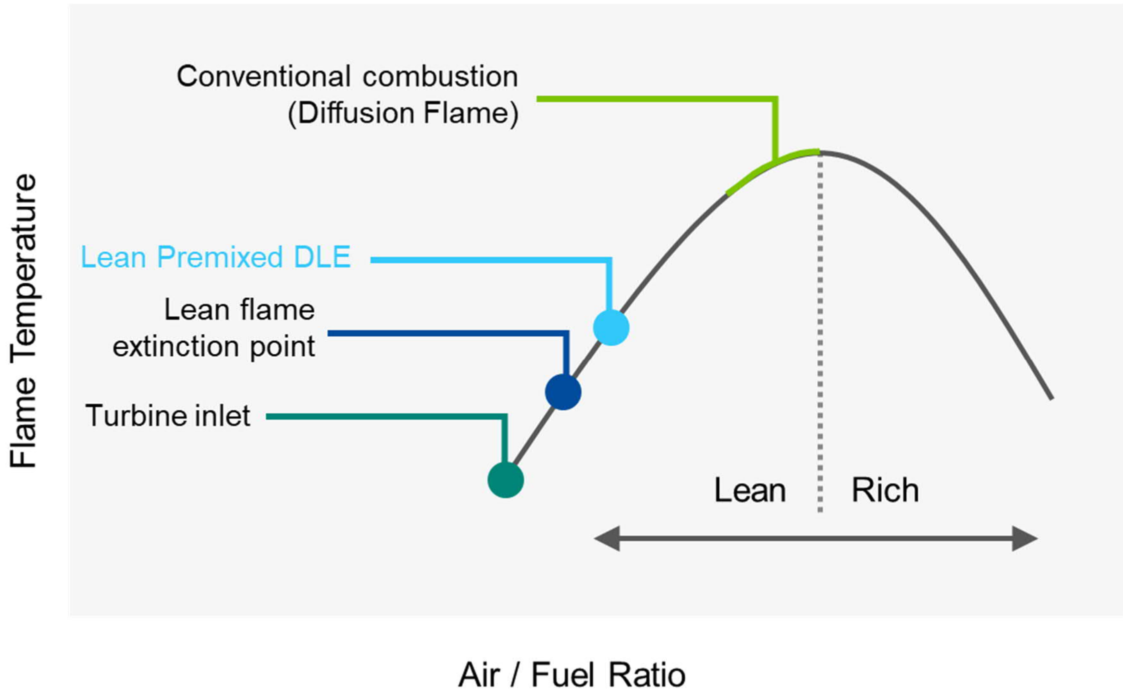


Emissions control system

The new gas turbine engine is fitted with the latest advanced DLE combustion system. The existing RB211 engines are Single Annular Combustor (SAC) type and do not have any equivalent emission control systems.

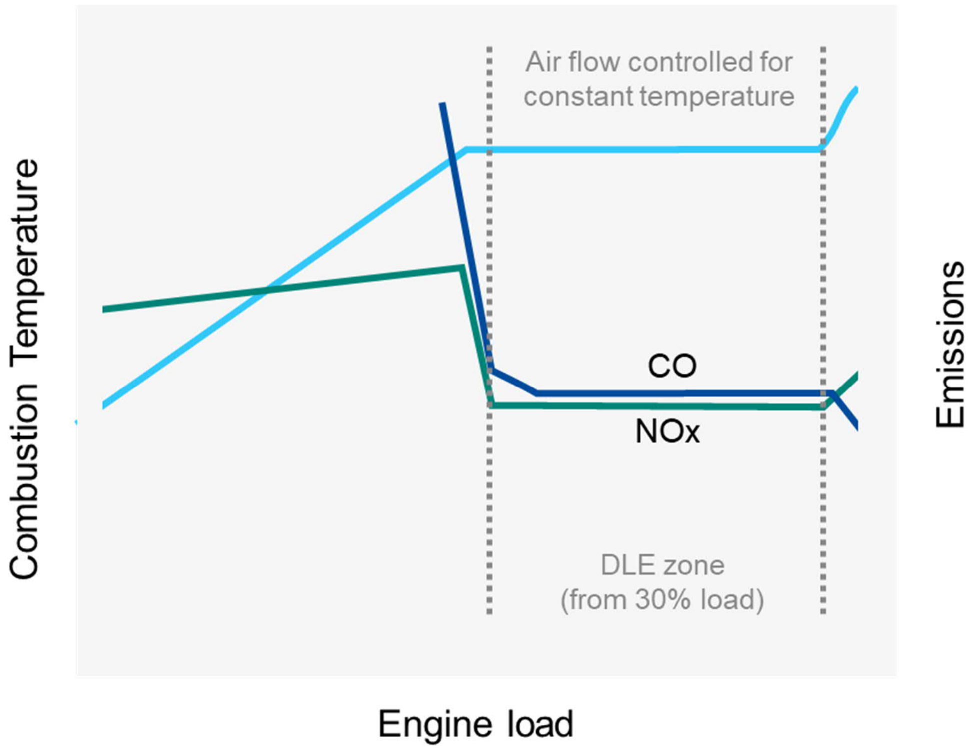
The DLE system controls a number of key engine parameters and utilises lean premixed combustion techniques, plus a fuel system with main and pilot fuel streams to create a uniform air/fuel mixture and lower the maximum flame temperature, reducing the formation of NOx, CO and unburnt hydrocarbons.

Figure D Effect of stoichiometry on flame temperature as used in modern DLE systems



For the Hatton applications the OEM has offered an enhanced engine map, which allows the DLE combustion control system to operate over a wider power turndown range, from 100% to 30% MCR; this is accompanied by an emissions performance guarantee. The general principles of DLE operation are illustrated in Figure E.

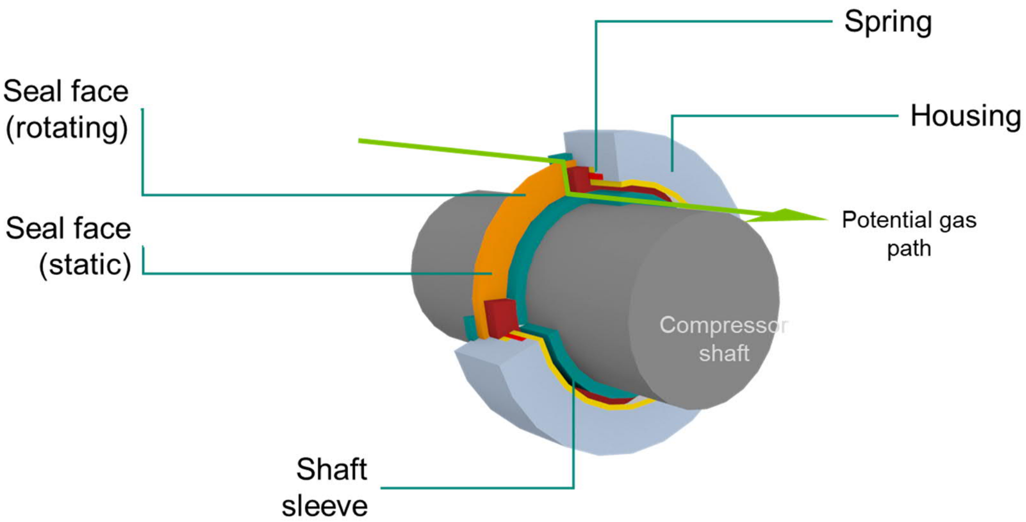
Figure E General indication of combustion temperature, airflow and emissions in a DLE combustion system



Shaft dry gas seal

The compressor shaft seal prevents pressurised process (natural) gas from escaping from within the compressor at the point that the drive shaft (from the power turbine) enters the compressor casing.

Figure F Simplified illustration of dry gas seal arrangement, showing potential gas path



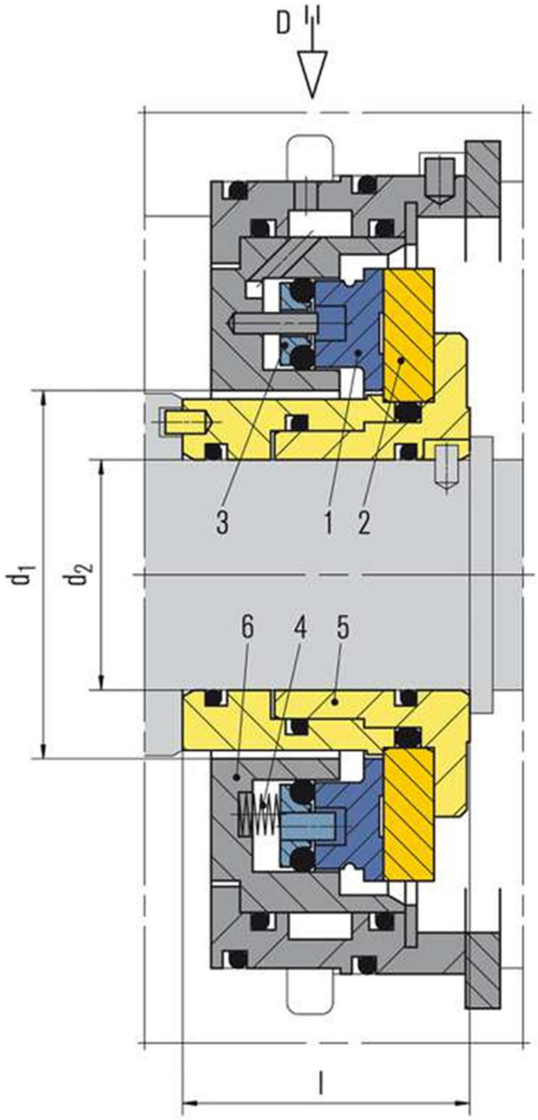
Currently units A, B and C have dry gas seals, although these are unlikely to perform as well as equivalent modern systems. Unit D (VSD) has a modern dry gas seal system, being a more modern unit. Process gas venting losses are lower for dry gas seals than wet gas seals and are considered to represent BAT (Refer to Information Box 1).

An advanced Eagle Burgmann tandem PDGS low emission dry gas with Cobaseal coaxial separation seal (refer to Figure G) has been selected for the new unit E application. A future connection point has been included for possible connection to a seal gas recovery system (a new technology which is yet to be proven on the UK gas transmission network); this would allow the ready retrofit of system to capture and recompress the residual process gas losses associated with dry gas seal operation for reinjection into the network[10].

Figure G Section diagram of coaxial separation seal (source: Eagle Burgmann UK)

1. Seal face, stationary
2. Seat, rotating
3. Thrust ring
4. Spring
5. Shaft sleeve and seat retainer
6. Housing

D. Separation gas (compressed air)



10 A field trial of a seal and process gas capture solution is scheduled to start in 2024 under the National Gas Transmission CH4RGE emission reduction programme.

The primary seal gas uses filtered process (natural) gas and fulfils the function of maintaining the mechanical sealing function. The secondary seal uses compressed air, and performs three functions:

- Prevents the migration of lube oil down the compressor shaft from the power turbine.
- Preventing the primary seal gas from reaching the shaft bearings.
- Ensures that gas vented from the secondary seal is primarily air, minimising process gas (methane) losses.

Information Box 1: BAT Review for the gas seal technology selection

There are several compressor shaft seal technologies in use on National Gas Transmission compressor stations. The technology in use reflects the differing design practices on assets of different ages and supplied by different compressor OEMs. National Gas Transmission has developed a Compressor Balance of Plant BAT case study looking at dry Gas Compressor Seals on Gas Transmission Assets (Issue 01, 15/08/2014) in order to provide guidance to designers working on gas NTS capital projects on the application of BAT.

The BAT assessment process employed in these case studies is defined in a National Gas Transmission procedure and follows the principles of a regulatory BAT assessment. A series of environmental and operational criteria are defined which are relevant to the technology area. Technology options are identified and shortlisted, and then assessed using cost benefit analysis techniques comparing whole life cost to a combined environmental and technical score. This is then plotted graphically and used to support decision making to identify the candidate option or options that represent BAT.

The choice of compressor seals has a number of consequences for the environmental and operational performance of the compressor station, including:

- Direct emission of gas during running and pressurised standby periods, due to: (a) leakage via the main seal faces; or (b) oil degassing releases (for wet seal systems).
- Increased rolling friction and fuel or power consumption of the compressor-drive unit.
- Indirect emissions from ancillary services (e.g. oil systems or nitrogen or compressed air systems for barrier (secondary) seal gases).
- Contamination of the process gas stream (e.g. by wet seal oil), which may cause problems for downstream equipment (at other compressor stations).
- Direct emission of gas due to venting, when depressurising the compressor.
- Contamination of the lubricating oil system by process gas (safety risk).
- Contamination of the main dry gas seal from the process gas (e.g. from wet hydrocarbons) leading to seal damage.

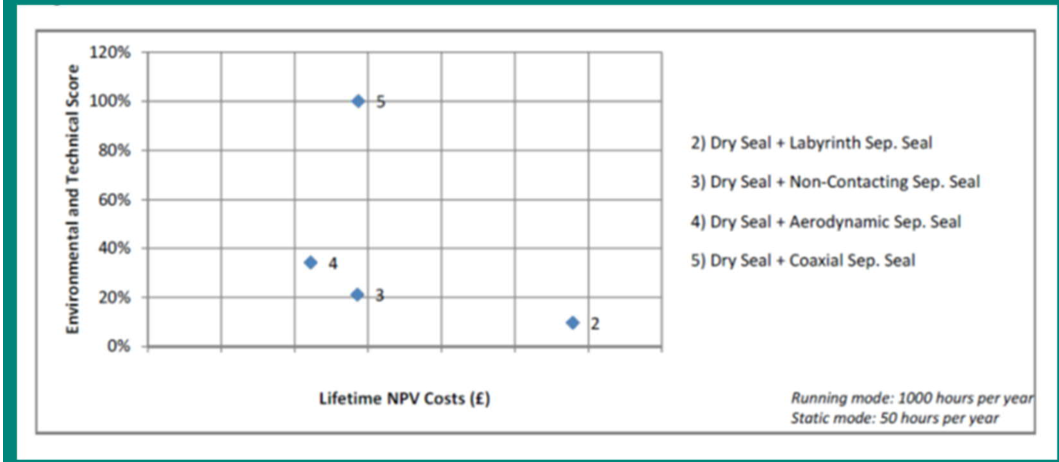
It is generally considered that wet seals no longer represent BAT when specifying new equipment, but some older compressors still use them (albeit not at the Hatton site). The primary objective of this study was therefore to determine different technical applications of dry gas seal technology, having rejected wet seals as not representing BAT for new plant. This study focused on a comparison of separation seal options for dry gas seals and four technology types were taken forward to detailed cost-benefit analysis:

- Tandem dry gas main seal + labyrinth separation seal (Option 2)
- Tandem dry gas main seal + contact-type separation seal (Option 3)
- Tandem dry gas main seal + aerodynamic-type separation seal (Option 4)
- Tandem dry gas main seal + coaxial separation seal (Option 5)

The environmental BAT criteria for this study was greenhouse gas emissions, measured as tonnes of carbon dioxide equivalent (tCO2e). These emissions are associated with energy consumption for seal support systems (i.e. energy used in nitrogen / compressed air generation). Process gas losses were not considered a differentiator between different dry gas seal options, as seal losses from all types of dry gas seals are very low. A single operational BAT parameter, reliability, was determined for the study.

The complete technical and financial comparison is presented in the BAT assessment chart below:

Gas seal BAT study environmental-technical score vs cost



The BAT evaluation uses the consumption of energy required to support seal systems as a metric for the retention capability of the alternative separation seal options. This environmental measure is combined with an assessment of relative reliability for the overall evaluation.

The results show that, for high-use compressors (running for 2,000 hours per year or more), the co-axial type separation seals (Option 5) offer the low total costs (capital + operating costs) and the best environmental and technical score. This running hour range is consistent with the Hatton site and therefore the conclusions were considered appropriate and representative in this application. The selected co-axial separation seal is consistent with the conclusions of the Balance of Plant BAT assessment.

Large Combustion Plant (LCP) requirements

With a thermal input of 103 MW, unit E will fall under the LPC requirements of the IED, including the mandatory provision of a CEMS. National Gas Transmission has yet to determine the LCP minimum start up load and minimum shutdown load for unit E, refer to Proposed Improvement programme. The unit LPC reference is to be determined by the Environment Agency in due course.

Fuel gas skid

The fuel gas skid is required to supply clean, dry, metered gas at the required pressure and temperature for use in the engine fuel system. The fuel gas supply is taken from the process gas pipework at NTS pressures; when this high pressure gas is allowed to expand during pressure reduction, it is subject to rapid cooling (due to the Joule-Thompson effect). This can cause liquid condensates to form in the fuel gas line, and therefore the gas has to be preheated prior to pressure reduction. A new fuel gas skid is proposed for unit E, this will operate on a cold start using electric gas pre-heating elements, when the engine oil has reach the correct operating temperature fuel gas preheating continues by lube oil heat recovery, to make use of waste engine heat. This significantly reduces energy consumption compared to traditional gas fired water bath heater or boiler systems or relying solely on electric heating. The selected unit will be located in an area served by a remote containment provision to contain any leakage from the lube oil heat exchanger and connections. The lube oil lines feeding the heat recovery unit will all be above ground which will allow periodic full-length inspection. Welded joints will be used in preference to flanged joints, where practical, on the connecting pipework between the fuel gas skid bund and the compressor enclosure (which is itself a bund).

Information Box 2: Fuel gas skid BAT assessment

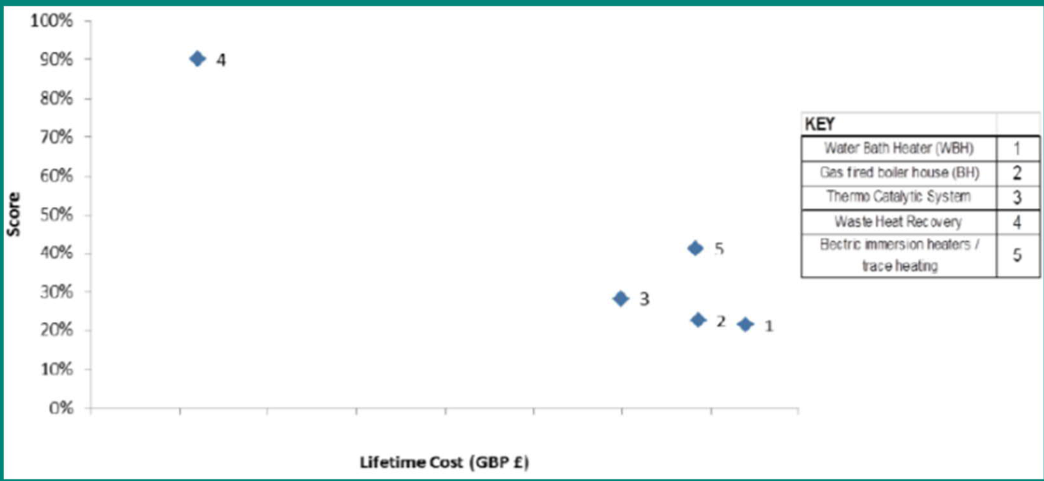
National Gas Transmission undertook a cost-benefit analysis BAT assessment to look fuel gas skid technologies. There are a number of fuel gas preheating / gas conditioning technologies in use on National Gas Transmission compressor stations. The technologies in use reflect the differing design practices on assets of different ages and different compressor OEMs. National Gas Transmission has developed a Compressor Balance of Plant BAT case study looking at Fuel Gas Pre-Heating on Gas Transmission Assets (Issue 01, 18/08/2014) in order to provide guidance to designers working on gas NTS capital projects on the application of BAT.

Water bath heaters have traditionally provided the preheating function, however, as they have aged they have been found to be increasingly unreliable whilst their energy efficiency is considered very low. Electric heating and heat recovery from oil cooling systems are alternative pre-heating solutions that have been implemented more recently however the energy and environmental performance of these different technologies is not understood and there is little available information to help quantify this. New technologies investigated in this study and considered 'available' due to their being proven in use in similar applications included: gas fired boilers (used widely for process gas preheating on gas AGIs), thermos-catalytic solutions (trialled in the UK on AGIs), and electric immersion / trace heating.

The environmental BAT criteria for this study were air emissions, greenhouse gas emissions (tCO_2e associated with energy consumption or on-site direct combustion), pollution risk (i.e. potential glycol leaks, waste disposal (e.g. boiler condensate), raw materials (e.g. glycol), noise (e.g. burners or gas flows) and water use. Operational BAT parameters for the study were reliability, maintainability and constructability.

A summary of the technical and financial comparison is presented in the BAT assessment chart below:

Fuel gas pre-heating technology BAT study environmental-technical score vs cost



The results show that using waste heat recovery from the compressor oil cooling system is the best performing solution, and offers a very favourable cost benefit balance; the study concluded that this technology was likely to be the primary solution for new installations or major re-designs.

National Gas Transmission is therefore procuring a fuel gas conditioning skid utilising lube oil heat recovery. The chosen BAT design has the potential to offer a financial payback compared to an all-electric heating solution, due to the reduced electricity consumption, and a significant saving in carbon dioxide (CO_2) emissions over a nominal 20-year design life.

Anti-icing filter

The gas turbine air intake filter could ice up during certain metrological conditions (including freezing fog). This would reduce the air flow rates into the engine, and if pre-set differential pressure levels were reached the unit would automatically shut down (or 'trip out') to protect the unit. To prevent this, an anti-icing system is proposed which utilises compressed air pulse jets to shed any built up ice or snow off the filters; this is a proven technique in-use on other modern gas turbine driven compressors on the NTS. Anti-icing is only required during running conditions, as historical operations have shown that the intakes will not freeze up without intake draft, and louvres and other design features prevent, for example, snow build-up. The system operates on a differential pressure basis (or via a predetermined timed interval) and thus does not run unless necessary.

Silencer and stack

A new exhaust stack with integrated high-performance silencer will be installed; the stack will be approximately 25m above slab height. The silencer utilises baffle structures to modify exhaust gas flow and attenuate noise (Refer to Section III, Part C3, Question 3b noise). A detailed Air Quality Impact Assessment has been undertaken, which includes a stack height assessment; this concludes that the selected stack height assessment represents BAT.

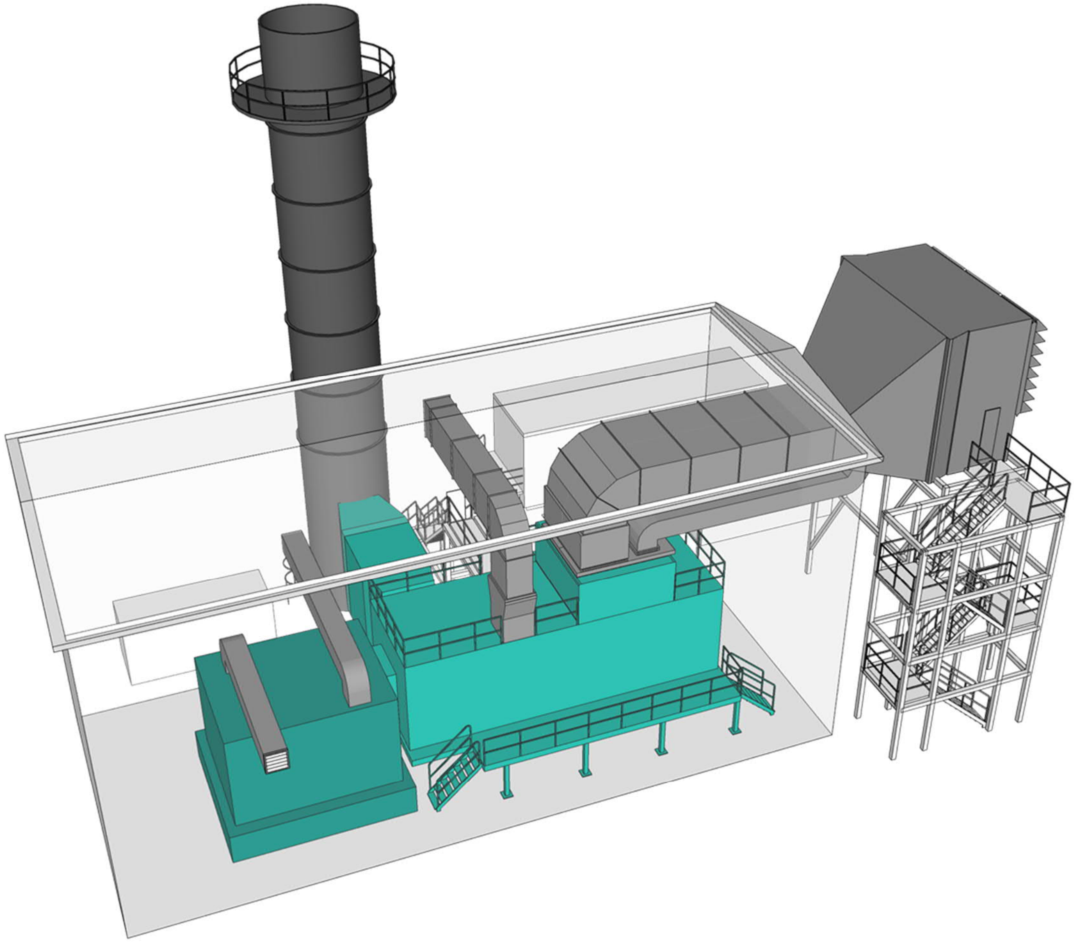
Enclosure

The machinery package is mounted on a frame (or 'skid') with a primary noise enclosure. In its standard design, this would be the primary noise control mechanism and no further enclosure would be necessary. However, this approach would not meet the stringent noise levels that National Gas Transmission has agreed with the Local Planning Authority or enable the demonstration of BAT for noise mitigation.

As such, an off-skid noise attenuation enclosure housing (or 'cab') has been selected which wraps around the standard skid-mounted package. The skid within the enclosure is designed to act as a bund to retain the inventory of engine and power turbine lube oil in the event of a loss of containment. The enclosure then provides a tertiary containment function for fluid losses and is sealed to floor level without internal drains. A threshold drainage channel is provided in the cab maintenance access doorway routing to the remote underground containment tank. The routing of services through the enclosure will be sealed to avoid breaching containment or creating noise propagation pathways.

The enclosure structure is illustrated in Figure H overleaf.

Figure H Illustration of package showing principal components and layer noise controls



Gas turbine engine inner noise enclosure

Gas compressor inner noise enclosure

Engine exhaust stack (with acoustic controls)

Intakes, inlets and outlets (with acoustic controls)

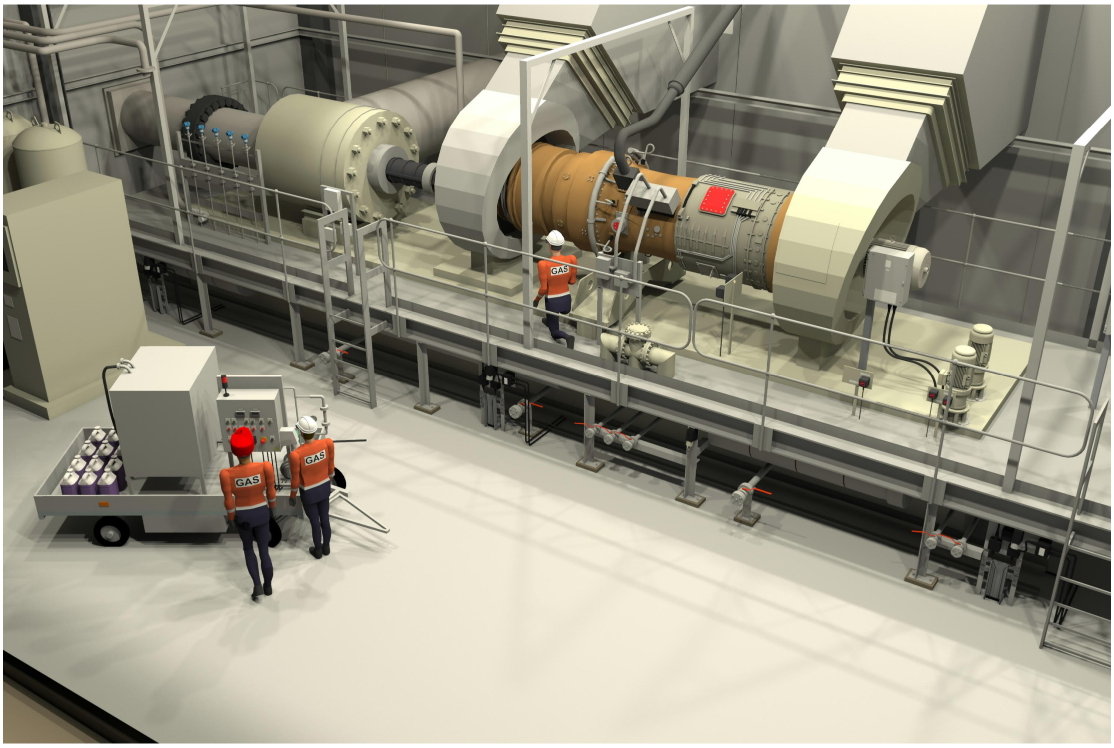
Outer noise enclosure (cab building)

Drawing is indicative.
Stair access to exhaust sampling platform not shown.
Planning drawings should be referred to for detailed information.
Colours used for illustrative purposes and these do not represent final scheme colours.

Turbine washing

The new compressor unit will be subject to periodic turbine washing as per the existing units. This is undertaken using a water detergent mix using a proprietary portable cleaning unit. The washing process removes impurities from the blades and intakes and ensures the unit runs at optimal efficiency levels. Washwater arising from this activity, which takes place withing the controlled area provided by the outer cab, is transferred to a 1,000 litre bunded container inside the cab, from where it will be collected and disposed of off-site by specialist contractor as hazardous waste. An inner shallow kerb is provided inside the noise enclosure to serve to contain any localised spills of detergent / washwater within the building, preventing it from entering the doorway drain channel (to the underground hydrocarbon spill remote containment sump) to reduce the risk of any detergents being transferred to the separator where they might disrupt its operation.

Figure I Conceptual illustration of turbine washing skid in a National Gas Transmission compressor enclosure



New diesel standby generator

A new diesel standby generator will be installed, replacing the older and smaller of the existing diesel generators (0.56MW thermal input) on the grounds of capacity and asset health. The design output of the new standby generator engine is 1675kVA electrical, and with a gross mechanical engine output of 1,429 kW. This equates to a thermal input of approximately 3.5MW.

As with the current site configuration, in the event of an electrical supply failure, the diesel fuelled standby generator will automatically start and restore power supplies. This enables the station to remain fully functional as required by legal gas supply obligations. While the use of the standby generator is non-routine, it is functionally tested monthly to ensure its availability.

The unit will be supplied in an acoustic enclosure which will also act as a containment sump and containment provision for the engine lube oil inventory. A bunded fuel tank with a capacity of 27,000 litres has been sized to provide sufficient fuel to allow for 72 hours running; this will be fully compliant with the requirements of oil storage legislation.

Information Box 3: Standby power generation BAT assessment

National Gas Transmission undertook a BAT assessment (using the methodology set out in the Compressor Balance of Plant BAT toolkit described in Information Box 1) to review standby power generation options for the Hatton compressor station. National Gas Transmission has developed a Compressor Balance of Plant BAT case study looking standby power generation on gas transmission assets (Issue 01, 15/08/2014), which informed the assessment, although it was wholly reviewed and updated by the project FEED contractor in 2022. Following technology screening the following main options were identified as being ‘available’, on the grounds of suitability for the application and their being proven in use.

1) Diesel reciprocating engine
2) Gas reciprocating engine
3) Gas fuelled turbine
4) Gas fuelled micro turbine

Whilst no major technology additions were identified by the authors over those in the 2014 study, the option of a gas reciprocating engine was revisited to update to current market offerings. Solar photovoltaic and fuel cells were also reviewed, but screened out on availability grounds. Following screening and assessment, which is presented in detail in Appendix 7 (Balance of Plant Studies), the final BAT selection was between diesel and gas reciprocating engines. Whilst gas reciprocating engines are a proven technology and were identified as a candidate BAT in many respects, as backup power supply, the higher CAPEX and lower availability (compared to diesel alternatives) mean that they are seldomly adopted. Indeed, benchmarking against other recent oil and gas projects revealed that diesel power generation is the preferred method of back-up power for reasons of availability, reliability, maintainability and CAPEX. It was for these reasons diesel generators were selected for the backup power generation solution for Hatton.

New unit E vent stack

A new vent stack will be installed to allow compressor casing venting for the new and existing compressor units and associated station suction and discharge pipework.

The vent stack is required to safely disperse process gas (natural gas) in the local environment in the event that a compressor or other station pipework needs to be emptied of gas for maintenance, shutdown, or very rarely, in a potential emergency situation. National Gas Transmission is required under law and external guidance[11] to ensure that:

- The released gas can disperse effectively and safely in the environment.
- At no point can released gas get sucked into a running engine via its air intake.
- If a major gas vent ignites the vent stack can burn safely without sustaining damage to people or property and a 'sterile area' is created around the stack free of equipment, trees and under secure access to prevent a wider fire being set off. The sterile area is designed to allow an intense, albeit short-lived fire to burn out safely without heat from the fire causing risk to humans (site operatives or members of public outside the site fence line), damage to plant or setting off a wider fire on the site.

It must be noted that this would be an extremely rare event, where an automatic vent release combines with an electrical storm and a direct lightning strike; this has never occurred on any National Gas Transmission site in nearly 50 years of operations, but the design must still accommodate this possibility. For this reason, planned venting would only take place during meteorological conditions of low ignition risk.

There have however been instances on the NTS where passing or stuck gas valves have allowed a small continuous leak to exit a vent stack; these have on rare occasions been ignited during electrical storms, allowing a small, controlled flame on the vent stack. The stack is designed to safely accommodate this scenario, and a manually initiated nitrogen snuffing (fire suppression) system will be installed to rapidly and safely extinguish a vent flame.

Venting velocity must also be carefully balanced and a minimum speed must be achieved to ensure effective dispersion. In-line vent stack silencer will be installed to mitigate noise from gas flows (Refer to Section III, Part C3, Question 3b Noise for further information on venting noise).

The vent stack is uncapped, and is configured with a 'u-bend' to prevent rainwater from entering the site pipework. Uncontaminated rainwater that may collect in the vent stack is drained to ground at the base of the stack.

11 Institute of Gas Engineers and Managers' IGEM/SR/23 – Venting of Natural Gas

Information Box 4: Gas venting BAT assessment

National Gas Transmission undertook a BAT assessment to review venting options for the compressor casing and associated compressor and pipework for the Hatton compressor upgrade. This study took account of the findings of the 2014 Compressor Balance of Plant BAT case study, the ongoing CH4RGE[12] methane emissions reduction programme and was updated by the project FEED contractor in 2022. Potential technology options for depressurisation and safe disposal of natural gas are as follows.

1. **Venting** - Venting is the controlled release of unburned gases directly into the atmosphere. This is the current practice at Hatton Compressor Station, and all other NTS stations. A new vent stack will comprise a vent pipe which can safely discharge process gas from pipework and compressor casing.
2. **Recompression** - Using a compressor to compress and re-inject the venting gas back into live pipework. National Gas Transmission is currently investigating gas recompression technology as part of the CH4RGE project. So far desk and site-based engineering feasibility studies have been undertaken with a view to site trials in 2024 (not at Hatton). CH4RGE has confirmed so far that recompression will not be suitable for use in emergency situations as a recompression cycle can take 8 hours or more to complete; it is however viable for planned recompression event.
3. **ANG (Absorbed Natural Gas) Storage and Recovery** - Use of activated carbon to store the vent gas in a storage vessel. The stored gas can be either used on site if there are low pressure gas consumers or recompressed and re injected into the NTS. National Gas Transmission's generic Balance of Plant BAT assessment in 2014 identified several limitations of using ANG for recovering vent gas with the most significant issue being the reduced storage capacity over repeated cycles and the composition change of the discharged gas. The technology option was reviewed again as part of the CH4RGE options appraisal but not shortlisted as a viable candidate for the pilot.
4. **Flaring** - Flaring is the controlled burning of vent gas. The option was reviewed and screened out as not representing BAT by the CH4RGE project.
5. **Retain Gas within Compressor** - Minimise the frequency of venting by holding the compressor under pressure (and maintaining all associated ventilation, safety and control systems in an active state). This option is only relevant to compressors and largely relies on the effectiveness of compressor seals. Reducing venting is already a priority within National Gas Transmission due to Gas Transporter Licence conditions which place financial penalties on gas venting, and thus operational practices seek to reduce this activity to a minimum. Considerable work has focused on determining break even points when the financial, environmental and technical challenges of maintaining gas at NTS pressure within the casing exceed the financial and carbon value of venting the gas.

12 CH4RGE – Methane (CH4) Reduction from Gas Equipment

The 2022 Hatton study (refer to Appendix 7) concluded that for emergency release, only venting or flaring offer the speed of depressurisation required to maintain an acceptable level of safety. Due to the nearby sensitive receptors to the site, venting is considered to be the preferred method of emergency release. Recompression was considered for non-emergency releases, however, the added cost of an additional small compressor and complexity of tying an as yet unproven solution into a live part of the system was not considered practical in the design, given the 'hard stop' set by the IED limited life derogation (31st December 2023) driving the delivery programme. As discussed above, National Gas Transmission is reviewing options for depressurisation through the CH4RGE gas recovery project. The Hatton site was screened out of the CH4RGE trial, largely due to the complexity of trying to integrate a pilot into the a hectic site outage schedule at the same time as a major compressor installation project. Hatton has been identified a candidate site for a future CH4RGE roll out programme, assuming the trials conclude successfully.

Therefore, the recommended method for depressurisation on the Site is to vent unburnt hydrocarbons to atmosphere. To reduce the inventory lost, the pipe length design was reduced by installing the new vent stack close to the new compressor. Additionally, to further reduce inventory, compressor isolation valves are being placed as close to the entry and exit points of the compressor enclosure as possible. Future CH4RGE developments will be closely monitored, and lessons learnt considered for future investment at Hatton.

Predictive Emissions Monitoring System (PEMS) and Continuous Emissions Monitoring System (CEMS)

Hatton unit E, by virtue of its installed thermal input exceeding 100 MWth, will have a CEMS system installed to provide continuous monitoring of NOx and CO. As with the existing units across the wider network, emissions of NOx and CO will also be tracked monitored via a continuous Predictive Emission Monitoring Systems (PEMS) approved by the Environment Agency, which monitors key engine operational parameters to determine compliance with Emission Limit Values (ELVs). The continued application of PEMS system together with use of a new application of CEMS system was considered BAT.

The CEMS system is designed and manufactured, and will be operated in accordance with:

- EN 14181 Stationary source emissions – quality assurance of automated measuring systems
- EN 15267-1 Air quality - Certification of automated measuring systems - Part 1: General aspects
- EN 15267-2 Air quality - Certification of automated measuring systems - Part 2: Minimum requirements for product quality assurance, initial assessment and on-going surveillance
- EN 15267-3 Air quality — Certification of automated measuring systems — Part 3: Performance criteria and test procedures for automated measuring systems for monitoring emissions from stationary sources.
- Technical Guidance Note (TGN) M20 - Quality assurance of continuous emissions monitoring systems - application of EN 14181.

The CEMS comprises stack mounted sampling equipment, heated lines, analysers and data handling and acquisition in a dedicated enclosure which will be located in close proximity to the stack at ground level. The system will have alarms at preset points on emissions performance and other operating parameters, data points will be taken every five seconds, with local logging (and backup) as well as transfer to the central ALERT compressor data management system. Post analysis sample and bypass are vented to atmosphere via two enclosure mounted vents (at a rate of 200 litres/hr). Condensate, which will only be mildly acidic due to the low levels of pollutants present in the exhaust stream, will be collected in a small dedicated container (with level detection), mounted internally in the analysis cabinet. Condensate will be periodically manually transferred to the waste wash water tank in the cab, from where it will be disposed of off-site.

Calibration and span gases are maintained as part of the system to ensure analysis accuracy; these are small bottled cylinders stored externally in a small cage and piped into the analyser cabinet; these comprise nitrogen, carbon monoxide in a nitrogen carrier, nitrogen dioxide in a nitrogen carrier and oxygen.

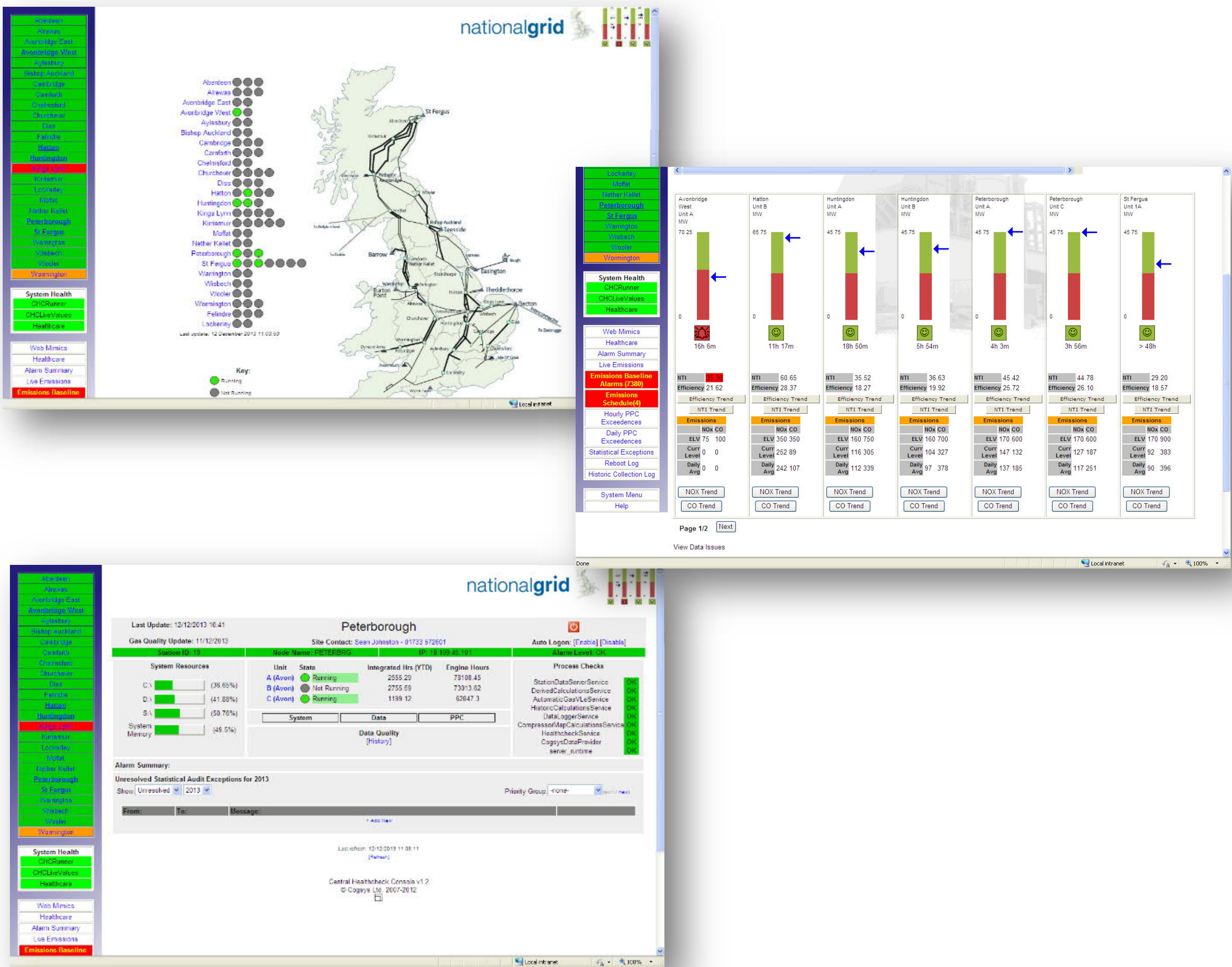
Figure J CEMS condensate collection in the Hatton enclosure

Process monitoring and controls

The new unit will continue to be subject to comprehensive remote monitoring and data logging via National Gas Transmission's 'ALERT' system and Central Healthcare Console (CHC) graphical user interface. This system provides a live dashboard to the Gas National Control Centre (GNCC) and is fully integrated with the PEMS system. CHC provides:

- Remote management of site systems
- Central notification of alarms and ELV excursions
- Central notification of predicted ELV excursion based on current running
- Management of central databases for reporting
- Monitoring of running units and operating level
- Monitoring of system alarms and utilisation
- Management of central databases for reporting
- Monitoring of unit operating hours
- Monitoring and notification of unit operating level

Figure II.13 Example screenshots from central healthcare console



Permanent access provision

The proposed scheme provides permanent access provision (with associated stairs and rails) for air emissions sampling, with other access provisions made to allow periodic access the gas turbine air intake and enclosure air intake filters and fan motors.

The extent and outline design of the sampling platform has been determined having regard to Environment Agency Guidance 'Monitoring stack emissions: measurement locations'[13] (formerly TGN M1), in particular in the requirement to provide sufficient working area to manipulate probes and operate the measuring instruments, without emissions testing equipment overhanging the guardrails.

Of particular note the emissions testing platform has been designed to allow, should it be deemed necessary, grid sampling techniques compliant with the requirements of BS EN 15259[14], making use of two perpendicular sampling planes accessed via two emissions sampling ports. This will be utilised for the initial homogeneity assessment, as per BS EN 15259.

Surface water and foul drainage

The project results in extension of the site boundary to the west, including new hardstanding areas and roadways. There are no sources of foul effluent requiring arising within the development area. There are no process effluent discharges made from the site, any liquid wastes arising are disposed off off-site only.

The drainage strategy for the site extension has been developed based on the existing site philosophy, incorporating current legislative requirements, good practice (including SUDS principles where appropriate) and BAT in respect of pollution control measures. The latter has focused on:

- The protection of adjacent watercourses from contamination from activities on the new development.
- The control of potential oil leaks from plant or activities on the new development.
- Maintenance and operability of the new system.

The following drainage system elements are proposed:

- **Clean (uncontaminated) rainwater** from low risk roadway areas and roofs, will be routed through a SUDs compliant field drain system to maximise infiltration to the ground at source, in line with best practice design principles. Excess run-off will be routed through an oil / silt interceptor to an attenuation basin to manage flows at greenfield rates prior to discharge to surface water via a new discharge point (reference W3).

13 https://www.gov.uk/government/publications/monitoring-stack-emissions-measurement-locations/monitoring-stack-emissions-measurement-locations
14 BS EN 15259:2007 Air quality. Measurement of stationary source emissions. Requirements for measurement sections and sites and for the measurement objective, plan and report

- **Potentially contaminated rainwater system**, from areas of roads where standing vehicles may be regularly present will be collected via drainage channels and routed through an oil / silt interceptor to the attenuation basin prior to discharge to surface water.
- Below ground oil containment chamber; this is discussed further below in Information Box 5.

Information Box 5: Drainage BAT review

Following a detailed environmental challenge and review, involving internal and external environmental specialists and engineers, the following measures were identified and incorporated into the containment and site drainage system for the development area:

- The compressor machinery train sits on an internal bunded skid providing secondary containment for the engine / power turbine / compressor lube oil system. The machinery train sits within an internal, tight fitting on-skid enclosure. This is primarily an acoustic measure but would serve to direct any jetting fluids to the bunded skid.
- The entire outer compressor cab (noise enclosure) is designed to act as a bund providing tertiary containment. The compressor cab design includes a sealed junction between external cladding and floor slab, and channel drains across the door threshold to a containment sump.
- The outer compressor cab also has to have as small upstand (25mm) to the inner face of the channel drain to contain wash water (1000 litres), preventing it for entering the oil containment chamber (where the presence of detergents may interfere with later oil separation).
- The external lube oil cooler, fuel gas skid and compressor cab threshold channel are fully bunded via a remote connection to a below ground oil containment chamber designed to accommodate 110% of the total oil inventory within the compressor system (12,500 litres). This system is aligned to remote containment principles described in CIRIA 736. The chamber to be designed to allow inspection from surface level and control of rainwater ingress, via an automatic dewatering system, comprising a float switch and oil detector, to pump rainwater into the potentially contaminated rain water system. Oil 'jet leaks' from external oil containing equipment will be localised and contained within bunds by flange guards.
- Rainwater which will collect in the below ground chamber will be subject to positive release via an Aquasentry type oil / water interface detector.
- A new dedicated full retention oil interceptor / silt trap to be located upstream of attenuation tank.
- The diesel storage tank (27,000 litres) is fully compliant with the Oil Storage Regulations (2001). In addition to this, the diesel off-loading area drained to a valved gully, connected to the potentially contaminated drainage system. Valve normally open and closed during loading operations, which will normally be very infrequent.

Valves

The project requires the introduction of new valves for isolation, control and emergency shutdown. These valves have two use cases, emergency shutdown (ESD) actuators required to operated effectively and quickly as a safety control and non-ESD valves, which must operate effectively and reliably over regular operations.

Direct electric motors were selected for non-ESD valve actuation due to environmental performance, cost and operability from a central control room. For ESD, electro-hydraulic (scotch yoke) is selected for speed of operation, environmental performance, cost and central control. Hydraulic oil will be specified as low toxicity and biodegradable.

Candidate BAT options subject to review in 2022 are summarised in Information Box 6 below.

Information Box 6: BAT Review for valve actuation
National Gas Transmission undertook a BAT review of options for new valve actuators for the extended area at the Hatton compressor station. The Compressor Balance of Plant BAT case study looking valve actuation on gas transmission assets (Issue 01, 15/08/2014) informed the review, although it was wholly updated by the project FEED contractor in 2022. The following BAT candidate options were considered, leading to the selection of direct electric and electro-hydraulic (scotch yoke) actuation:

- **Direct Gas (with Spring Return)** – environmental disadvantages of this design include the release of gas during operation, likely fugitive emission leaks and noise. The technology is proven and is readily available. Suitable for ESD and non-ESD. It may be possible to include Emissions Control Actuator Technology (ECAT) to capture escaping gas, however this would add significant cost and complexity to the design.
- **Gas-over-Oil (Double Acting)** – environmental disadvantages of this design include the release of gas during operation, possible fugitive emission leaks and noise. The technology is proven and is readily available. Suitable for ESD and non-ESD. It may be possible to include Emissions Control Actuator Technology (ECAT) to capture escaping gas, however this would add significant cost and complexity to the design.
- **Pneumatic** – direct release of gas is avoided, the technology is proven and available. However, ancillary equipment is required (air compressor / increased air compressor capacity) with associated cost, emissions (noise) and waste (oil, filters). Suitable for ESD and non-ESD.
- **Direct Electric Motor** – this offers low noise operation, no direct loss of inventory and relatively low CAPEX and OPEX. Suitable for non-ESD only due to low speed of actuation.
- **Electro-hydraulic (Scotch Yoke)** – this offers good speed of operation for ESD, no direct loss of inventory, low noise operation and relatively low CAPEX and OPEX. A small volume of hydraulic oil is contained in each valve (app. one litre per valve). Suitable for ESD and non-ESD.

- **Electro-hydraulic (Vane)** – this offers good speed of operation. However, the technology is relatively expensive and not readily available from all vendors.
- **Manually operated** – good environmental performance, reliability, CAPEX and OPEX. However, only local control is possible and closing speed is slow. Therefore, not suitable for ESD or non-ESD where central control may be required.

Proposed improvement programme

National Gas Transmission proposes the following items should form permit Improvement Conditions:

Ref.	Section	Description	Proposed Date
1	Section II Technical Description	National Gas Transmission to determine LCP minimum start up load and minimum shutdown load for unit E (LPC reference to be determined by Environment Agency).	3 months after operational acceptance of unit.
2	Part C2: Question 3d - Management Systems	Update of National Gas Transmission emissions monitoring procedures to include site specific requirements.	To be submitted to the EA for comment 1 month prior to first schedule round of periodic extractive exhaust emissions testing (anticipated to be due winter 2024/2025).
3	Part C2: Question 3d - Management Systems	National Gas Transmission operations staff to undergo training on usage and routine maintenance of the updated systems at the installation.	To be completed at least 1 month prior to Asset Acceptance of new plant (the point of effective handover from the Project Delivery Team to the Asset Owner (the gas transmission asset management team).
4	Section II: Proposed changes Part C3: Question 4a	National Gas Transmission to submit results of BS EN 15259 homogeneity test, together with proposals for ongoing monitoring strategy and practices.	3 months prior to first scheduled emissions test.
5	Part C3: Question 6d	National Gas Transmission to undertake an updated resource efficiency review following commencement of normal operations at the site in the new configuration.	12 months after asset acceptance of all new assets.

Section III: Supporting information

This part of the application provides detailed responses to questions in Section I: Application Forms, where further space is required to provide the necessary information.

Responses are provided only where further information is required, and the questions numbers are as stated in the application forms.

The information provided in this section should be viewed in parallel with:

- Section I: Application forms
- Section II: Technical description

EP Form: Part C2: Question 3d - Management Systems

Table C2: 3d-1 Summary of Management System

Management System Features	How National Gas Transmission applies this to Environmental Permitting
1. Clear management structure, management commitment and allocated responsibilities	Commitment, responsiveness and active support is provided by top management to ensure the success of the EMS. The President of GT&M, as the most Senior Manager alongside the Senior Leadership Team, is accountable for the effectiveness, commitment to and leadership of the EMS. The EMS includes written procedures that define the organisation and reporting lines of all personnel including those with environmental responsibilities. The same set of procedures also defines the resources that are available for environmental management activities. The EMS includes procedures for control of activities undertaken by contractors.
2. Identification, assessment and management of significant environmental impacts	The EMS has procedures in place for the identification, assessment and management of the environmental aspects of site activities.
3. Compliance with legal and other requirements applicable to activities having an impact on the environment	The EMS has established processes to identify, and manage compliance with, legal and other requirements applicable to activities having an impact on the environment. Legislative requirements relating to environmental issues are reviewed at regular intervals and are communicated to the appropriate management and operational personnel using the internal communication channels defined within the EMS.
4. Establishing an environmental policy and setting objectives and targets	The Environmental Sustainability Policy provides a framework for management of the environmental aspects of our past, ongoing and planned activities, products or services. The policy defines the strategic direction of the business, including a commitment to continuous improvement, and the Environmental Action Plan provides business specific targets.
5. Environmental improvement programme to implement policy objectives and targets	The risks and opportunities register, compliance obligations, legal register and interested parties information is used to inform objectives and targets and ensure environmental aspects are addressed in business procedures. Environmental objectives and targets are established by the Environmental Strategy Team. These consist of specific performance targets to be achieved in an established timeframe, or strategic organisational goals to be delivered over a longer period of time. For example, environmental objectives and targets are established in relation to greenhouse gas emissions reduction.

Management System Features	How National Gas Transmission applies this to Environmental Permitting
6. Establish operational controls to prevent and minimise significant environmental impacts	The EMS has established operational controls to prevent and minimise significant environmental impacts. This includes: • Operational environmental management series of documents establish environmental requirements in relation to operational activities. • Formal Environmental Assessment (FEA) processes for design and delivery stage of gas transmission projects as well as modifications and site or asset decommissioning. • Formal Consenting Activities (FCA) for liaising with and preparing submissions to local planning authorities. • Emissions trading documentation provides guidance on the application of the emissions trading system. Operational environmental management procedures cover topics including air emissions, carbon management, hazardous substances, land management and biodiversity, statutory nuisance and waste management.
7. Preventive maintenance programme for relevant plant and equipment	A planned preventative maintenance system is operated (under the 'MAINT' series of management and specification procedures) to ensure that wherever possible, appropriate equipment is prevented from unplanned stoppages, especially where this may have environmentally significant consequences. Any breakdown that could result in a significant environmental effect would be prioritised. A suitable service level agreement and warranties will be established with the compressor and equipment OEMs to ensure appropriate maintenance activities and spares provisions are in place for all new plant and equipment. Existing provisions will remain in place for all retained equipment on site.
8. Emergency planning and accident prevention	Emergency planning and accident prevention are addressed by procedures in the EMS. This includes the establishment of site specific emergency preparedness plans. Emergency plans are tested in accordance with documented procedures.
9. Monitoring and measuring performance	Procedures within the EMS address the environmental performance of all key plant and equipment to ensure the installation functions as intended, allowing the detection of faults. This includes procedures relating to the CEMS, PEMS monitoring systems, periodic extractive emissions testing and other monitoring undertaken in accordance with permit conditions. Unintended operations, poor performance including breaches of emissions limits and other changes in plant performance will trigger investigation and any necessary preventative maintenance. Performance monitoring is also undertaken in order to track performance against established objectives and targets. Procedures ensure that monitoring equipment used to verify compliance with environmental legislative requirements is appropriately maintained and calibrated. These procedures will be updated to include any site specific requirements associated with the new gas turbine unit.

Management System Features	How National Gas Transmission applies this to Environmental Permitting
10. Training.	The management system defines a range of specific and generic training for personnel whose work may have a significant impact on the environment in accordance with the requirements of job specifications and competencies. The EMS includes procedures to cover training requirements and planning. National Gas recognises that the installation of the new compressor units and 'balance of plant' at the site will introduce equipment which the current operations team will not initially be familiar with. As such an operator training programme is planned which will support the usage and routine maintenance of the systems (noting that certain activities such as specialist annual systems maintenance will be undertaken by specialist contractors).
11. Communications and reporting incidents of potential or actual non-compliance and complaints	The EMS contains procedures for internal and external communication with respect to the environmental aspects and environmental management system. These procedures include systems for responding to and recording communications and complaints from external parties. Internal communication mechanisms are in place to share key environmental information and to raise awareness of the EMS and the environmental values of the business. Where incidents and complaints arise, processes are in place to ensure that the immediate symptoms are remediated and that the root causes are identified and addressed. Internal communication between the various organisational levels and functions is important to enable effective implementation of the EMS and monitoring of performance, goals and objectives. The Senior Leadership Team has a key responsibility for building awareness in relation to the EMS and environmental performance.
12. Auditing	The EMS includes an internal audit system, which ensures that all aspects of the site activities, which may have an environmental relevance, are audited on a regular basis. Environmental audits take place at several different business functions and include: • Corporate level audits; • SHE & assurance interventions; • Environment and Sustainability site engagement visits; • Asset engineering verification audits; and • Senior management site visits. The EMS is audited by an independent certification body to ensure compliance with ISO 14001.
13. Corrective action to analyse faults and prevent recurrence	The EMS contains procedures for identification and reporting of any environmental incidents and non-conformities. Corrective actions are identified to remedy the immediate symptoms and root causes are identified and addressed. General EMS and safety management ensures non-conformities are analysed by appropriate management. Similarly audit non-conformities are recorded in the audit reports and the internal audit system, and managed with other corrective actions.

Management System Features	How National Gas Transmission applies this to Environmental Permitting
14. Planning	Proposed or planned activities are reviewed to ensure that potential environmental impacts are identified and addressed at the earliest stage. The EMS also includes procedures to ensure that proposed activities meet all legal and other requirements deemed applicable to the environmental aspects. In particular, the Formal Environmental Assessment (FEA) process establishes environmental requirements during the design and delivery stage of compressor projects as well as modifications and site or asset decommissioning. With regard to developing new projects and replacement of plant and equipment, National Gas maintains active involvement in technology development through its Ofgem funded innovation schemes, participation in industry bodies (such as Marcogaz) and through carrying out contractor led BAT assessments for major new plant items.
15. Reviewing and reporting environmental performance	Senior management conduct reviews on the EMS to ensure its continuing suitability, adequacy and effectiveness. The management review requirements include: • All requirements detailed in ISO14001 must be covered at least annually. • The outputs from the management review must be documented. • Key issues and outcomes are communicated upstream and downstream through the business as appropriate. Environmental issues are incorporated into all other relevant aspects of the business. Based on the results from the management reviews, an annual report on environmental performance is produced.
16. Managing documentation and records	Environmental records are managed through a set of procedures operated by the EMS, which identifies, maintains and disposes of documents. The EMS controlled documentation includes environmental manuals, registers, procedures and other primary documentation as part of the system. Individual copies of these documents are identified and issued to company personnel as appropriate. All documentation is subject to review to ensure its continued relevance. All controlled documentation under the EMS is identified by date and revision number.

Summary of training proposals and transition management

National Gas Transmission will carefully manage the transition phase between the current and future unit operations, the existing unit control systems, routine maintenance and emissions testing regimes will continue unchanged; detailed commissioning plans and training programmes will be drawn up to facilitate the transition to the new unit. The new unit will have to be proven through extensive test runs during commissioning, during which OEM representatives will train the site operatives in classroom and practical sessions on operations, control systems and routine maintenance. Key elements of the transition / training syllabus will include:

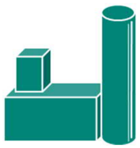
- Operations training, to include:
  - Overview of the new Siemens unit, covering gas turbine and drive
  - Control system and controls
  - Materials and spares
  - Interfaces with existing equipment (including control and instrumentation and protection systems)
  - Maintenance requirements (including warranty provisions)
- Maintenance training, to include:
  - Maintenance of Siemens instrumentation control and automation (ICA) plant:
    - Unit control panel / unit protection panel
    - Field instrumentation interface
  - Maintenance of Siemens mechanical plant:
    - Compressors, motors and protection
    - Cooling systems
    - Seal gas systems
    - Compressor vent and drainage systems
    - Lube oil systems
    - Purge air systems
  - Maintenance of Siemens low voltage (LV) plant:
    - Motor control centres (MCCs)
    - Enclosure and air-conditioning system

EP Form: Part C2: Question 6 - Environmental Risk Assessment

Part I – Identify Risks from Your Activity, Screening Assessment

The table below sets out the screening assessment for the environmental risks that are included in the Environment Agency guidance "Environmental management – guidance: Risk assessments for your environmental permit"[15]. Issues not screened out in this assessment will require a more detailed environmental risk assessment.

Table C2: 6-1: Risk Assessment – Identifying risks which require a specific risk assessment

Identified risk area		Pathway	Receptors	Discussion	Identified risk
	Point source emissions to air - gas combustion	Airborne	Human health receptors: Single houses or groups of houses (estates, villages etc). Schools and hospitals. Footpaths, recreation areas such as playing fields and playgrounds. Industrial estates. Ecological receptors including: European and national designated habitat sites within 10km	Natural gas is the sole fuel source for the proposed new unit E gas turbine driven compressor unit. Although gas is a clean fuel, like any combustion source, there are emissions of the products of combustion, including NOx, CO and CO_2, which are dispersed into the atmosphere via the exhaust stack. An Air Quality Impact Assessment (AQIA) has been undertaken (Appendix 5) which compares emissions from current operations with predicted emissions after installation of the proposed new ultra-low emission gas turbine compressor unit E.	✓ Further review

15 Risk assessments for your environmental permit - GOV.UK (www.gov.uk)

Identified risk area		Pathway	Receptors	Discussion	Identified risk
	Noise and vibration	Airborne	Human receptors (nuisance) including houses, schools and hospitals. Footpaths, recreation areas such as playing fields and playgrounds. Industrial estates or places of work. Certain sensitive habitat sites	The proposed new compressor unit E, exhaust stack and standby diesel generator will introduce new noise sources, although this will be offset by the reduction in noise as a result of retiring units B and C, and one of the existing generators. The design of the new unit E incorporates noise mitigation measures, including: primary turbine and compressor noise enclosures, outer noise enclosure (cab building) and integrated high-performance silencer for the exhaust stack. A review of noise impacts, and mitigation measures, is included as Appendix 3.	✓ Further review
	Accidental Releases	Airborne Overland runoff / infiltration / percolation	Human receptors including houses, schools and hospitals. Footpaths, recreation areas such as playing fields and playgrounds. Industrial estates or places of work. Rivers, streams, ponds etc., drainage systems/sewers, groundwater	Potential accident hazards associated with operation of the new compressor unit E have been reviewed as part of National Gas Transmission's comprehensive project risk assessment process. The procedure for the assessment of environmental risks forms a key part of the EMS that is in use at the site. New potential risk scenarios associated with the new compressor unit E have are shown in Table 4a.	✓ Further review

Identified risk area		Pathway	Receptors	Discussion	Identified risk
	Point source emissions to surface, groundwater and land	Discharge to surface water channel via oil and silt separator and attenuation tank	Rivers, streams ponds etc.	The new equipment will be located in a new area of site (outside of the current installation boundary) with a new drainage system. There is no mains sewer connection available; clean surface water runoff will discharge to the nearby stream (part of the Tile House Beck catchment) via a new surface water discharge point (W3). An oil and silt separator, attenuation tank and penstock valve are located upstream of the discharge point. Secondary and tertiary containment controls are incorporated into the site design in order to prevent contamination of the surface water drainage with potentially polluting materials. This system is aligned to remote containment principles described in CIRIA 736[16]. A Site Condition Report, which details the new site area and protective measures that will be in place, is provided in Appendix 2. A specific risk assessment of emissions to W3 is not considered necessary. The risk of fugitive emissions to surface water and / or groundwater arising from Accidents is considered in response to Form C3 Question 3b.	Not considered further

16 CIRIA C736 Containment systems for the prevention of pollution, Secondary, tertiary and other measures for industrial and commercial premises (2014)

Identified risk area		Pathway	Receptors	Discussion	Identified risk
	Fugitive emissions to air (gas leaks)	Airborne	Human receptors (nuisance) including houses, schools and hospitals. Footpaths, recreation areas such as playing fields and playgrounds. Industrial estates or places of work.	The proposed changes incorporate new pipework and valves whilst removing pipework and valves associated with two existing RB211 units. There will be no new types of fugitive emissions to air on site and overall no increase in the amount of pipework and valves. New valves will be electro-hydraulic or electric valve actuators on new large process valves, which avoids the release of natural gas (methane) associated with operating more traditional process gas actuated valves, which use the pressure in the gas as the motive force for valve operation. The proposed new compressor installation will not significantly affect fugitive emissions from the site compared to existing and therefore no further assessment is deemed necessary.	✘ Not considered further
	Odour	Airborne	Human receptors (nuisance) including houses, schools and hospitals. Footpaths, recreation areas such as playing fields and playgrounds. Industrial estates or places of work.	The site transports unodorised gas and there are no odour sources on site. The proposed changes do not alter this situation. Therefore, no further assessment or controls are considered necessary.	✘ Not considered further
	Visible plumes	Airborne	Human receptors (nuisance) including houses, schools and hospitals. Footpaths, recreation areas such as playing fields and playgrounds.	The nature of the combustion sources is such that plume moisture levels will be low and thus in normal operations, and for the majority of weather conditions, plume visibility is expected to be very low.	✘ Not considered further

Identified risk area		Pathway	Receptors	Discussion	Identified risk
	Global warming potential	Airborne	Global atmosphere	The new gas compressor unit will replace two existing compressors. The new unit will be of a modern energy efficient design. No overall increase in fossil fuel combustion is predicated as a result of this change; utilisation of the site (which is determined by gas NTS demand and supply considerations) determine the overall operational duty requirements. These will not alter as a result of the new unit E installation. However, replacement of two open cycle gas turbines with a single, modern, more efficient unit will result in an overall energy efficiency gain for the given work done. The new plant will also reduce emissions of process gas (natural gas, largely methane) through valve actuation and high-performance gas seals. Further energy information is provided in a detailed response to Q 6 of Form C3.	✘ Not considered further

EP Form: Part C3: Question 1 - What activities are you applying to vary?

Table 1a below sets out the details of all the activities listed in schedule 1 of the EPR and all directly associated activities (DAAs) that are carried out at the installation. Sections which have changed are highlighted in italics.

Table C3-1a Type of activities

Installation name	Schedule 1 references	Description of the activity
Hatton Compressor Station	Section 1.1, Part A(1) (a)	Burning any fuel in an appliance with a rated thermal input of 50 or more megawatts: Unit A: LCP 238: 66.5 MWth* open cycle gas turbine (OCGT) for the purpose of compressing natural gas. Unit B: LCP 239: 64.7 MWth* OCGT for the purpose of compressing natural gas. Unit C: LCP 240: 64.9 MWth* OCGT for the purpose of compressing natural gas. *Installation of a single new LCP compressor unit, with a rated thermal input of 103 MW, with new exhaust stack (with integral silencer) and air intake.* *Retirement, under the LLD, or two existing gas turbine compressor units B and C (LCP 239 and LCP 240 respectively), each with a nominal rated thermal input of 70 MW (~ 140 MWth in total).* *New replacement diesel fired reciprocating engine standby generator (with bunded fuel tank) with an approximate rated thermal input of 3.5 MW. Replaces the older and smaller of the current diesel standby generators (0.56 MW thermal input), the other (1 MW thermal input) remaining unchanged.* *Installation of machinery enclosure, access platforms, stairways and supporting steelwork.* *No changes to the configuration of the retained unit A (LCP 238).* * ratings as measured in February 2015 to ISO standards, nominal rating of 70 MWth, power lost to non-recoverable engine degradation due to age.
Directly Associated Activities (DAA)		
Name of DAA		**Description of the DAA – all serve the activity listed under Section 1.1, Part A(1) (a)**
One VSD compressor unit running on electricity from national grid for the purpose of compressing natural gas		No change.
Operation of water bath heater using natural gas (fuel gas preheating)		No change to existing units (only unit A will be retained, units B and C to be retired under LLD). *Installation of new fuel gas heating skid with lube oil heat recovery associated with the new compressor unit.*
Oil storage		*New 27,000 litre bunded diesel storage tank associated with the new standby generator*
Surface water drainage		No change to existing site area or emission points. *New site extension served by new BAT compliant surface water drainage systems and new discharge point to drainage channel (W3).*

EP Form: Part C3: Question 2 - Emissions to Air, Water and Land

Emissions to Air

Following the installation of the proposed new plant there will be a number of additional emissions points (relating to new compressor unit E) some which replace existing emissions points (for example the new standby generator). Emission points associated with units B and C will be retired under the LLD which requires that they cease operation on 31st December 2023. Many of the existing emission points will however be unchanged, as existing compressor unit A will remain available for use (albeit in a standby capacity). None of the new or replacement emissions points materially alter the character or compositions of any of the emissions to air from the installation.

The changes by reference number are presented below in summary.

Table C3: 2-1 Summary of changes

Status	Emission point references (current nomenclature)
Retained unchanged	A1, A4, A7, A8, A9, A14, A17, A20, A23, A26, A29, A33, A34, A35, A36, A37, A39, A41, A42, A43, A44, A45
Proposed for immediate removal from permit	A32, A38, A40 [17]
Proposed for retirement under LLD	A2, A3, A5, A6, A10, A11, A12, A13, A15, A16, A18, A19, A21, A22, A24, A25, A27, A28, A30, A31
Proposed new	A46, A47, A48, A49, A50, A51, A52, A53, A54, A55

17 A40 was included in error in V003, it has never operated under the permitted installation and is now being removed for completeness

Table C3: 2-2 Updated full emissions inventory (Table 2)

Emission Point Ref.	Status	Location	Emission	Expected Emission Concentration mg/Nm^3	Proposed Emission Limit Values mg/Nm^3	Techniques to minimise emissions
A1	Existing, unchanged (Refer to UP3333LL/V004)	Unit A gas turbine exhaust (LCP No. 238)	NOx	350 mg/Nm^3 [1]	None – emergency use derogation	Maintenance; natural gas fuel source
			Sulphur dioxide (SO_2)	-	-	
			CO	-	-	
A2	Existing, unchanged but due to be retired under LLD on or by 31st December 2023 (Refer to UP3333LL/V004)	Unit B gas turbine exhaust (LCP No. 239)	NOx	<318 mg/Nm^3	318 mg/Nm^3 [2]	Maintenance; natural gas fuel source
				<350 mg/Nm^3	350 mg/Nm^3 [3]	
			SO_2	-		
			CO	<318 mg/Nm^3	318 mg/Nm^3 [2]	
				<350 mg/Nm^3	350 mg/Nm^3 [3]	
A3	Existing, unchanged but due to be retired under LLD on or by 31st December 2023 (Refer to UP3333LL/V004)	Unit C gas turbine exhaust (LCP No. 240)	NOx	<318 mg/Nm^3	318 mg/Nm^3 [2]	Maintenance; natural gas fuel source
				<350 mg/Nm^3	350 mg/Nm^3 [3]	
			SO_2	-		
			CO	<318 mg/Nm^3	318 mg/Nm^3 [2]	
				<350 mg/Nm^3	350 mg/Nm^3 [3]	
A4	Existing, unchanged	Unit vent cab A	Process gas	N/A unit vent line, normally ungassed No limit under existing permit		Venting minimised through operational controls and Ofgem gas transporter licence incentives

Emission Point Ref.	Status	Location	Emission	Expected Emission Concentration mg/Nm³	Proposed Emission Limit Values mg/Nm³	Techniques to minimise emissions
A5	Existing, unchanged but due to be retired under LLD on or by 31st December 2023 (Refer to UP3333LL/V004)	Unit vent cab B	Process gas	N/A unit vent line, normally ungassed No limit under existing permit		Venting minimised through operational controls and Ofgem gas transporter licence incentives
A6	Existing, unchanged but due to be retired under LLD on or by 31st December 2023 (Refer to UP3333LL/V004)	Unit vent cab C	Process gas	N/A unit vent line, normally ungassed No limit under existing permit		Venting minimised through operational controls and Ofgem gas transporter licence incentives
A7	Existing, unchanged	Station vent	Process gas	N/A unit vent line, normally ungassed No limit under existing permit		Venting minimised through operational controls and Ofgem gas transporter licence incentives
A8	Existing, unchanged	Primary seal vent cab A	Process gas	N/A	No limit under existing permit	Low emission dry gas seal system
A9		Secondary seal vent cab A				
A10	Existing, unchanged but due to be retired under LLD on or by 31st December 2023 (Refer to UP3333LL/V004)	Primary seal vent cab B	Process gas	N/A	No limit under existing permit	Low emission dry gas seal system
A11		Secondary seal vent cab B				
A12	Existing, unchanged but due to be retired under LLD on or	Primary seal vent cab C	Process gas	N/A	No limit under existing permit	Low emission dry gas seal system

Emission Point Ref.	Status	Location	Emission	Expected Emission Concentration mg/Nm^3	Proposed Emission Limit Values mg/Nm^3	Techniques to minimise emissions
A13	by 31st December 2023 (Refer to UP3333LL/V004)	Secondary seal vent cab C				
A14	Existing, unchanged	Fuel gas vent cab A	Process gas	N/A fuel gas skid vent line, normally ungassed. No limit under existing permit		None, fuel gas skid only vented to meet process requirements
A15	Existing, unchanged but due to be retired under LLD on or by 31st December 2023 (Refer to UP3333LL/V004)	Fuel gas vent cab B	Process gas	N/A fuel gas skid vent line, normally ungassed. No limit under existing permit		None, fuel gas skid only vented to meet process requirements
A16	Existing, unchanged but due to be retired under LLD on or by 31st December 2023 (Refer to UP3333LL/V004)	Fuel gas vent cab C	Process gas	N/A fuel gas skid vent line, normally ungassed. No limit under existing permit		None, fuel gas skid only vented to meet process requirements
A17	Existing, unchanged	Starter vent cab A	Process gas	N/A	No limit under existing permit	Unit will provide back up rather than main duty, unit E has electric starter (no gas release)
A18	Existing, unchanged but due to be retired under LLD on or by 31st December 2023 (Refer to UP3333LL/V004)	Starter vent cab B	Process gas	N/A	No limit under existing permit	Venting minimised through operational controls
A19	Existing, unchanged but due to be retired under LLD on or by 31st December 2023 (Refer to UP3333LL/V004)	Starter vent cab C	Process gas	N/A	No limit under existing permit	Venting minimised through operational controls
A20	Existing, unchanged	Lube oil breather vent cab A	Oil fume	Negligible	No limit under existing permit	-

Emission Point Ref.	Status	Location	Emission	Expected Emission Concentration mg/Nm^3	Proposed Emission Limit Values mg/Nm^3	Techniques to minimise emissions
A21	Existing, unchanged but due to be retired under LLD on or by 31st December 2023 (Refer to UP3333LL/V004)	Lube oil breather vent cab B	Oil fume	Negligible	No limit under existing permit	-
A22	Existing, unchanged but due to be retired under LLD on or by 31st December 2023 (Refer to UP3333LL/V004)	Lube oil breather vent cab C	Oil fume	Negligible	No limit under existing permit	-
A23	Existing, unchanged	Lube oil compressor tank breather vent cab A	Oil fume	Negligible	No limit under existing permit	-
A24	Existing, unchanged but due to be retired under LLD on or by 31st December 2023 (Refer to UP3333LL/V004)	Lube oil compressor tank breather vent cab B	Oil fume	Negligible	No limit under existing permit	-
A25	Existing, unchanged but due to be retired under LLD on or by 31st December 2023 (Refer to UP3333LL/V004)	Lube oil compressor tank breather vent cab C	Oil fume	Negligible	No limit under existing permit	-
A26	Existing, unchanged	Lube oil generator tank breather vent cab A	Oil fume	Negligible	No limit under existing permit	-
A27	Existing, unchanged but due to be retired under LLD on or by 31st December 2023 (Refer to UP3333LL/V004)	Lube oil generator tank breather vent cab B	Oil fume	Negligible	No limit under existing permit	-

Emission Point Ref.	Status	Location	Emission	Expected Emission Concentration mg/Nm^3	Proposed Emission Limit Values mg/Nm^3	Techniques to minimise emissions
A28	Existing, unchanged but due to be retired under LLD on or by 31st December 2023 (Refer to UP3333LL/V004)	Lube oil generator tank breather vent cab C	Oil fume	Negligible	No limit under existing permit	-
A29	Existing, unchanged	Surge recycle control valve vent cab A	Process gas	N/A	No limit under existing permit	Unit will provide back up rather than main duty, unit E has electric / electrohydraulic valve actuation (no gas release)
A30	Existing, unchanged but due to be retired under LLD on or by 31st December 2023 (Refer to UP3333LL/V004)	Surge recycle control valve vent cab B	Process gas	N/A	No limit under existing permit	-
A31	Existing, unchanged but due to be retired under LLD on or by 31st December 2023 (Refer to UP3333LL/V004)	Surge recycle control valve vent cab C	Process gas	N/A	No limit under existing permit	-
A32	Removed from service	Standby generator exhaust stack	NOx	Not quantified	No limit under existing permit	Maintenance, engine controls
			PM			
			CO			
			SO_2			
A33	Existing, unchanged	Water bath heater vent	NOx	Not quantified	No limit under existing permit	Maintenance, reduced duty as only cab A will be served.
			CO			

Emission Point Ref.	Status	Location	Emission	Expected Emission Concentration mg/Nm^3	Proposed Emission Limit Values mg/Nm^3	Techniques to minimise emissions
A34	Existing, unchanged	Condensate tank vent	Process gas	N/A – pressure relief valve No limit under existing permit		-
A35	Existing, unchanged	Condensate tank vent	Process gas	N/A – pressure relief valve No limit under existing permit		-
A36	Existing, unchanged	Condensate tank vent	Process gas	N/A – pressure relief valve No limit under existing permit		-
A37	Existing, unchanged	Lube oil storage tank breather vent	Oil fume	Negligible	No limit under existing permit	Reduced duty as only cab A will be served.
A38	Removed from service	Diesel tank breather vent	Oil fume	Negligible	No limit under existing permit	-
A39	Existing, unchanged	Cab D (VSD) compressor unit vent stack	Process gas	N/A	No limit under existing permit	Venting minimised through operational controls and Ofgem gas transporter licence incentives
A40	In current permit, but does not exist on site, included in error in V003	Cab D (VSD) compressor anti surge recycle valve	Process gas	N/A	No limit under existing permit	
A41	Existing, unchanged	Standby generator exhaust stack	NOx	Not quantified	No limit under existing permit	Maintenance, engine controls
			PM			
			CO			
			SO_2			

Emission Point Ref.	Status	Location	Emission	Expected Emission Concentration mg/Nm^3	Proposed Emission Limit Values mg/Nm^3	Techniques to minimise emissions
A42	Existing, unchanged	Standby generator diesel tank breather vent	Oil fume	Negligible	No limit under existing permit	-
A43	Existing, unchanged	Primary seal vent cab D	Process gas	N/A	No limit under existing permit	Low emission dry gas seal system
A44		Secondary seal vent cab D				
A45	Existing, unchanged	Lubrication oil system demister vent cab D	Oil fume	Negligible	No limit under existing permit	-
A46	New	Unit E gas turbine exhaust (LCP No. TBC) [4]	NOx	<40 mg/Nm^3	50 mg/Nm^3	Modern Dry Low Emission (DLE) combustion system; natural gas fuel source
			SO_2	Negligible	-	Low sulphur natural gas fuel only
			CO	<50 mg/Nm^3	100 mg/Nm^3	Modern Dry Low Emission (DLE) combustion system; natural gas fuel source
A47	Proposed New	Lube oil breather vent, unit E	Oil fume	Negligible		-
A48	Proposed New	Fuel gas vent, unit E	Natural gas	Natural gas only, none proposed		-
A49	Proposed New	Primary dry gas seal vent, unit E	Natural gas	Natural gas only, none proposed		Low emission dry gas seal system

Emission Point Ref.	Status	Location	Emission	Expected Emission Concentration mg/Nm^3	Proposed Emission Limit Values mg/Nm^3	Techniques to minimise emissions
A50		Secondary dry gas seal vent, unit E				
A51	Proposed New	Unit E unit vent stack	Process gas	N/A	No limit proposed	Venting minimised through operational controls and Ofgem gas transporter licence incentives
A52	Proposed New	CEMS analyser vent, unit E	Unit E exhaust	As per A46	No limit proposed	Very low flow rate, ~50 l/hr
A53	Proposed New	CEMS bypass vent, unit E				Very low flow rate, ~150 l/hr
A54	Proposed New	Standby generator exhaust	NOx	Emergency use and testing only, none proposed		Engine control system
			PM			
			CO			
			SO_2			
A55	Proposed New	Standby generator diesel oil tank breather vent	Diesel fume	Negligible		-
-	Existing	Operation of gas actuated valve vents	Natural gas	Natural gas only, none proposed		-

Emission Point Ref.	Status	Location	Emission	Expected Emission Concentration mg/Nm^3	Proposed Emission Limit Values mg/Nm^3	Techniques to minimise emissions
-	Existing and proposed new	Operation of other relief valves where operating pressure is exceeded	Natural gas	Natural gas only, none proposed		-
-	Existing and proposed new	Local exhaust ventilation (LEV) emissions from LERs / workshop / store / amenity areas	Fume	Negligible		-

Notes:
1 Indicative estimate
2 Monthly mean of validated hourly averages, as per EPR/UP3333LL
3 95% of validated daily means withing a calendar year, as per EPR/UP3333LL
4 Derived from design data from the OEM

The following table proposes an optional re-numbering of the entire inventory, which would simplify future reporting and compliance, given the wide-ranging changes proposed to the inventory. Refer also to proposed improvement condition, where National Gas Transmission commits to provide a revised Figure 3 showing this new numbering, if requested by the Environment Agency.

Table C3: 2-3 Proposals for emission point re-numbering

Current numbering scheme	Proposed future numbering scheme (optional)	Description
A46	A1	Cab E gas turbine exhaust (LCP No. TBC)
A1	A2	Unit A gas turbine exhaust (LCP No. 238)
A51	A3	Cab E unit vent stack
A4	A4	Unit vent cab A
A39	A5	Cab D (VSD) compressor unit vent stack
A7	A6	Station vent
A8	A7	Primary seal vent cab A
A9	A8	Secondary seal vent cab A
A14	A9	Fuel gas vent cab A
A17	A10	Starter vent cab A
A20	A11	Lube oil breather vent cab A
A23	A12	Lube oil compressor tank breather vent cab A
A26	A13	Lube oil generator tank breather vent cab A
A29	A14	Surge recycle control valve vent cab A
A33	A15	Water bath heater vent (serving cab A only in future)
A37	A16	Lube oil storage tank breather vent (serving cab A only in future)
A43	A17	Primary seal vent cab D
A44	A18	Secondary seal vent cab D
A45	A19	Lubrication oil system demister vent cab D
A47	A20	Lube oil breather vent, cab E
A48	A21	Fuel gas vent, cab E
A49	A22	Primary dry gas seal vent, cab E
A50	A23	Secondary dry gas seal vent, cab E
A52	A24	CEMS analyser vent, cab E
A53	A25	CEMS bypass vent, cab E
A41	A26	Standby generator 1 exhaust stack
A42	A27	Standby generator 1 diesel tank breather vent
A54	A28	Standby generator 2 exhaust
A55	A29	Standby generator 2 diesel oil tank breather vent
A34	A30	Condensate tank vent
A35	A31	Condensate tank vent
A36	A32	Condensate tank vent

The Air Quality Impact Assessment (AQIA) considers the potential effects associated with the emissions to air from the existing and proposed combustion processes at the Hatton gas compressor station; the AQIA report is included in Appendix 5 of this application. Two scenarios have been assessed as follows:

- **Existing, worst case.** This is based on operation of two out of the three existing RB211 units (emission points A1 and A2) currently permitted at the station during peak site operations and represents the worst case air quality impacts at air quality receptors. This scenario provides a comparative case against which the emissions from future operations, including the proposed new plant, can be considered. The two existing RB211 units were assumed to operate continuously for the full year (i.e. 8,760 hours). This represents a significant overestimate of total running hours.
- **Future, worst case.** This represents a future scenario, with both the SGT-750 gas turbine (emission point A46) and one remaining RB211 unit (unit A – emission point A1) operating at the maximum anticipated load simultaneously. This is a 'worst case' scenario which would not occur in practice as the respective maximum loads for each unit occur for different gas compression scenarios. Whilst there could be occasions where very high gas flows require a maximum of two units to be run in parallel, there are no 'real world' gas demand conditions that would occur at the site that would require the use of both the existing RB211 unit A and proposed new SGT 750 gas turbine unit at full (i.e. 100% load). The new SGT-750 gas turbine was modelled for continuous operation for the full year (i.e. 8,760 hours) and the RB211 at its legal maximum operating allowance (i.e. 500 hours per annum), which is considerably higher than the actual anticipated operating hours. This case therefore represents an abundance of caution on behalf of National Gas Transmission for assessment purposes only. For this scenario, the SGT-750 gas turbine was modelled with a stack height of 25m. An assessment of alternative stack heights, which concluded that this height was

The AQIA considers:

- the potential effect on human health due to emissions of pollutants resulting from the combustion of natural gas by the gas turbines. The pollutants considered include nitrogen dioxide (NO_2) and carbon monoxide (CO); and
- the potential impact on vegetation and ecosystems due to emissions of NOx, including acid and nutrient nitrogen deposition.

The potential effects were assessed by comparison of the PC (Process Contribution) and PEC (predicted environmental concentration) to the EQS (environmental quality standard) or Critical Load (CL) in the case of deposition assessments. The PC is the estimated maximum environmental concentration of substances due to releases from the process alone. The PEC is the estimated maximum environmental concentration of substances due to releases from the process added to baseline levels of the released substance.

The results of the potential effects on human health are presented in table C3: 2-4 below. These results show the predicted ground level NO_2 (nitrogen dioxide) and CO concentrations modelled at the human receptor locations (for the assessment of the annual mean EQS (environmental quality standard)) and off-site locations (for the assessment of the hourly and 8-hour EQS) for the three scenarios. Full details of the assessment are provided in Appendix 5.

The environmental effects of releases from the site at the assessed ecological receptors has been determined by comparing predicted concentrations of released substances with the EQSs for the protection of vegetation (critical levels). The results of the detailed modelling at the ecological receptors are shown in Table C3: 2-5 and C3: 2-6. The results presented are the maximum predicted concentrations at the maximum SSSI and the maximum local nature site for the five years of meteorological data used in the study. The predicted concentrations at all other SSSIs and local natures sites would be less than those presented in Table C3: 2-5 and C3: 2-6.

The rate of deposition of acidic compounds and nitrogen containing species have been predicted at the assessed ecological receptors. This allows the potential for adverse effects to be evaluated by comparison with the relevant critical loads. Critical load functions for acid deposition are specified on the basis of both nitrogen-derived acid and sulphur-derived acid. The dispersion modelling results for the maximum SSSI and local nature site are set out in Table C3: 2-7 and C3: 2-8.

Table C3: 2-4: Dispersion modelling results – Maximum NO_2 and CO concentrations at human receptors for existing and proposed operations

Pollutant	Averaging period	Assessment location	Maximum receptor	EQS (µg/m^3)	Baseline air quality level (µg/m^3)	PC (µg/m^3)	PEC (µg/m^3)	PC / EQS (%)	PEC / EQS (%)	PC as a percentage of headroom (%)
Existing operation										
CO	Maximum 8-hour running mean	Sensitive locations	R14	10,000	202	42.2	244.7	0.4%	2.4%	0.4%
	Maximum 1-hour mean	Maximum off-site	-	30,000	202	236.8	438.4	0.8%	1.5%	0.8%
		Sensitive locations	R28	30,000	202	202.4	404.0	0.7%	1.3%	0.7%
NO_2	Annual mean	Sensitive locations	R5	40	7.7	4.8	12.5	11.9%	31.1%	-
	1-hour mean (99.79th percentile)	Maximum off-site	-	200	15.4	102.2	117.5	51.1%	58.8%	55.3%
		Sensitive locations	R29	200	15.4	102.2	117.5	51.1%	58.8%	55.3%
Proposed future operation										
CO	Maximum 8-hour running mean	Sensitive locations	R17	10,000	203	22.7	226.1	0.2%	2.3%	0.2%
	Maximum 1-hour mean	Maximum off-site	-	30,000	202	124.0	325.6	0.4%	1.1%	0.4%
		Sensitive locations	R28	30,000	202	119.2	320.8	0.4%	1.1%	0.4%
NO_2	Annual mean	Sensitive locations	R4	40	7.7	0.5	8.2	1.2%	20.4%	-
	1-hour mean (99.79th percentile)	Maximum off-site	-	200	15.4	52.9	68.2	26.4%	34.1%	28.6%
		Sensitive locations	R29	200	15.4	52.5	67.8	26.2%	33.9%	28.4%

Table C3: 2-5: Dispersion modelling results – Maximum annual mean NOx concentrations at ecological receptors for existing and proposed operations

Ref	Ecological Receptor	EQS ($\mu g/m^3$)	Baseline air quality level ($\mu g/m^3$)	PC ($\mu g/m^3$)	PEC ($\mu g/m^3$)	PC / EQS (%)	PEC / EQS (%)
Existing operation							
H11	Bardney Limewoods, Lincolnshire SSSI and Bardney Limewoods NNR	30	9.5	0.8	10.3	2.8%	34.4%
H19	Sotby Wood LWS		9.4	3.4	12.7	11.2%	42.4%
Proposed future operation							
H11	Bardney Limewoods, Lincolnshire SSSI and Bardney Limewoods NNR	30	9.5	0.1	9.6	0.4%	31.9%
H19	Sotby Wood LWS		9.4	0.4	9.7	1.2%	32.4%

Table C3: 2-6: Dispersion modelling results – Maximum 24-hour mean NOx concentrations at ecological receptors for existing and proposed operations

Ref	Ecological Receptor	EQS ($\mu g/m^3$)	Baseline air quality level ($\mu g/m^3$)	PC ($\mu g/m^3$)	PEC ($\mu g/m^3$)	PC / EQS (%)	PEC / EQS (%)
Existing operation							
H11	Bardney Limewoods, Lincolnshire SSSI and Bardney Limewoods NNR	75	18.9	15.9	34.9	21.2%	46.5%
H19	Sotby Wood LWS		18.8	19.6	38.3	26.1%	51.1%
Proposed future operation							
H11	Bardney Limewoods, Lincolnshire SSSI and Bardney Limewoods NNR	75	18.9	9.1	28.1	12.2%	37.4%
H19	Sotby Wood LWS		18.8	11.5	30.3	15.4%	40.4%

Table C3: 2-7: Dispersion modelling results – maximum nitrogen deposition at ecological receptors for existing and proposed operations

Rec ref	Protected conservation area	Vegetation type (for deposition velocity)	Minimum Critical Load (CL) (kgN/ha/year)	Nitrogen deposition (kgN/ha/year)				
				Existing deposition	PC	PEC	PC/CL (%)	PEC/CL (%)
Existing operation								
H11	Bardney Limewoods, Lincolnshire SSSI and Bardney Limewoods NNR	Tall	10	40.3	0.170	40.4	1.7%	404
H19	Sotby Wood LWS	Short	10	23.8	0.337	24.1	3.4%	241
		Tall	5	40.7	0.675	41.4	13.5%	828
Proposed future operation								
H11	Bardney Limewoods, Lincolnshire SSSI and Bardney Limewoods NNR	Tall	10	40.3	0.023	40.3	0.2%	403%
H19	Sotby Wood LWS	Short	10	23.8	0.035	23.8	0.3%	238%
		Tall	5	40.7	0.070	40.8	1.4%	816%

Table C3: 2-8: Dispersion modelling results – maximum acid deposition at ecological receptors for existing and proposed operations

Rec ref	Protected conservation area	Vegetation type (for deposition velocity)	Critical Load (CL) (kEqH+/ha/year)			Acid deposition (kEqH+/ha/year)					
			CLMaxS	CLMinN	CL MaxN	Existing deposition (N)	Existing deposition (S)	PC	PEC	PC/CL (%)	PEC/CL (%)
Existing operation											
H11	Bardney Limewoods, Lincolnshire SSSI and Bardney Limewoods NNR	Tall	8.2	0.4	8.6	2.9	0.2	0.0121	3.1	0.1%	35.6%
H19	Sotby Wood LWS	Short	4.0	1.1	5.1	1.7	0.1	0.0241	1.9	0.5%	36.8%
		Tall	8.3	0.4	8.6	2.9	0.2	0.0481	3.1	0.6%	36.3%
Proposed future operation											
H11	Bardney Limewoods, Lincolnshire SSSI and Bardney Limewoods NNR	Tall	8.2	0.4	8.6	2.9	0.2	0.0016	3.0	0.02%	35.5%
H19	Sotby Wood LWS	Short	4.0	1.1	5.1	1.7	0.1	0.0025	1.8	0.05%	36.3%
		Tall	8.3	0.4	8.6	2.9	0.2	0.0050	3.1	0.06%	35.8%

The results indicate that the predicted modelled off-site concentrations and predicted concentrations at sensitive human receptors do not exceed any relevant long-term or short-term EQS for the worst-case existing or proposed operations (for both NO_2 and CO). The proposed future worst-case operations represent an improvement compared to the existing worst case operation.

It should be noted that the remaining RB211 unit has the greatest influence on the maximum predicted 1-hour mean concentrations for the proposed future scenario. The RB211 is an existing unit which is consented and operating in full compliance with its existing EPR and planning approvals and subject to continuous emissions calculations and periodic emissions compliance tests.

In respect of ecological receptors, even taking account of a number of worst case assumptions related to operating hours and loads for the proposed operations, the detailed assessment indicates that the predicted NOx concentrations and nitrogen and acid deposition at the SSSIs within 15km and other local nature sites within 2km would be not significant.

The AQIA concludes that the operation of the assessed combustion plant for the future proposed operations scenario are acceptable from an air quality perspective. The assessment also showed that the proposed operations represent an improvement compared to the currently permitted operations, based on a comparison of the worst case scenarios

The assessment also demonstrates that, in line with the Environment Agency guidance[18], the assessed stack height of 25m would be acceptable from an air quality perspective and represents BAT.

Emissions to Water and Land

There are currently no emissions to sewer or land and the proposed changes to the Hatton installation will not alter this. Therefore, emissions to these media have not been considered further in this part of the variation.

Surface water management at the site will be modified as a result of the proposals reflecting the introduction of new hardstanding areas and expansion of the installation boundary to the east. This has necessitated the introduction of a third new discharge point for uncontaminated surface water (W3). As discussed in Section II: Proposed Changes a drainage strategy for the site extension has been developed based on the existing site philosophy, incorporating current legislative requirements, good practice (including SuDS principles where appropriate) and BAT in respect of pollution control measures. The latter has focused on:

- The protection of adjacent watercourses from contamination from activities on the new development.
- The control of potential oil leaks from plant or activities on the new development.
- Maintenance and operability of the new system.

[18] Environment Agency and Department for Environment, Food & Rural Affairs, Air emissions risk assessment for your environmental permit, February 2016, as amended.

Refer to Section II: Proposed Changes for further information and BAT summary. The proposed site drainage plan is provided as Figure 4.

Table C3: 2-9: Emission point to water

Emission Point Ref.	Source	Proposed Operations
W1	Surface water run-off (via interceptor) and treated domestic effluent discharged from the installation's bio-disc.	No change.
W2		
W3	New site drainage areas	The new site drainage areas will discharge from the installation via a third new W3 outfall also to the existing drainage stream channel Drainage catchment area increased (although SuDS drainage techniques will be applied to reduce run-off volumes and rates where appropriate to risk).

EP Form: Part C3: Question 3a - Technical Standards

Table 3 Technical standards

Installation Name	Hatton Compressor Station	
Description of the Schedule 1 activity or directly associated activity	**Relevant technical guidance note or BATs as described in BAT conclusion under IED**	**Document Reference**
Burning any fuel in an appliance with a rated thermal input of 50 or more megawatts. (Existing natural gas fired gas turbine engines)	COMMISSION IMPLEMENTING DECISION (EU) 2021/2326 of 30 November 2021 establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for large combustion plants.	Part II Proposed Changes Part III Supporting Information (C3 Question 2)
Installation of emissions testing provisions, access platforms, stairways and supporting steelwork work.	Guidance: Monitoring stack emissions: measurement locations (Updated 14 December 2022) *(Formerly TGN M1).*	Part II Proposed Changes Part C3: Question 4b
Quality assurance of continuous emissions monitoring systems - application of EN 14181	Technical Guidance Note (Monitoring) M20 (Version 5, April 2021).	Part II Proposed Changes Part C3: Question 4a

Table S1.2 of the current permit (VP3130GZ /V005) includes reference to documents which are superseded, or are supplemented, by documents contained within this permit variation application. This is summarised in Table C3: 3a1 below.

Table C3: 3a1 – Superseded Documents

Permit ref	Existing document reference (taken from Table 1.2 Operating Techniques)	Reason no longer valid	Reason no longer valid
UP3333LL	The response to section 2.1, 2.2, B2.10 and Appendix 8 in the application.	**Supplementary** information provided in this variation application, including retirement of certain emission points.	Supplemented by additional information included within this application: • Section II: Technical Description • Response to Form C3, Q 2 Emissions to Air, Water and Land • Response to Form C3, Q 4 Monitoring • Section IV: Figures
UP3333LL/V003	Sections II and III supporting information to the application.	**Supplementary** information provided in this variation application.	Note that V003 was concerned with the installation of the VSD (unit D). Unit D is not being altered by the addition of the proposed unit E, however operational interfaces (i.e. preferred running configurations will alter). Supplemented by additional information included within this application: • Section II: Technical Description • Section III: Supporting information

Permit ref	Existing document reference (taken from Table 1.2 Operating Techniques)	Reason no longer valid	Reason no longer valid
UP3333LL/V004	Confirmation of the compliance routes chosen for LCP 238 (<500hr), LCP 239 (LLD) and LCP 240 (LLD).	**Supplementary** information provided in this variation application.	Note that V004 was concerned with the Regulation 60 (1) notice to confirm compliance route for the existing LCP on site. These routes are not changing but this variation provides info on the planned retirement of units B and C under LLD. Supplemented by additional information included within this application: • Section **II**: Technical Description • Response to Form C3, Q 2 Emissions to Air, Water and Land.
UP3333LL/V005	Compliance and operating techniques identified in response to the BAT Conclusions for large combustion plant published on 17th August 2017.	**Supplementary** information provided in this variation application.	Note that V005 was concerned with compliance to the LCP BAT conclusions. Supplemented by additional information included within this application: • Section V: Appendix 8

EP Form: Part C3: Question 3b - General Requirements

Table 4 General requirements

Name of the Installation	Hatton Compressor Station
If the TGN or H1 assessment shows that emissions of substances not controlled by emission limits are an important issue, send us your plan for managing them.	See Table 4a below.
Where the technical guidance or your risk assessment shows that odours are an important issue, send us your odour management plan.	N/A
If the TGN or H1 assessment shows that noise or vibration are important issues, send us your noise or vibration management plan (or both).	See Table 4b below; and Appendix 4 Noise management plan.

Fugitive / Accidental Emissions

There will, overall, be an increase in the amount of pipework/valves associated with the proposed modifications to the installation (although the cessation of operation of units B and C will in part offset this); however, valve replacement and the selection of electro-hydraulic or electric valve actuation for new valves (as appropriate) will reduce potential fugitive emissions of process (natural) gas from the installation, resulting from valve passing (i.e. failure of valves to seat properly allowing gas to vent pass through the valve to atmosphere via unit vents) and emissions from gas actuated valves, respectively. None of the other proposed changes will materially alter fugitive emissions from the site.

A comprehensive assessment of accident hazards has been undertaken by the design team under National Gas Transmission's Formal Process Safety Assessment (FPSA) system. Initially, a Hazard Identification (HAZID) review was completed; this aims to identify potential hazards arising from the design, siting and operation of the plant. This process is undertaken in two stages; during HAZID1 the proposed design is systematically examined using a set of guidewords to generate free ranging discussion to identify potential safety or environmental issues. The HAZID2 study uses a checklist in order to ensure that all appropriate safety and environment issues have been addressed during the development of the design.

A series of Hazard and Operability (HAZOP) workshops were then completed between January 2022 and January 2023, which identified one hundred and eighty-five (185) HAZOP Actions. During these HAZOP workshops the proposed design was systematically examined, section by section, by a team of engineering and safety specialists to identify potential hazards and operability issues. For each hazard identified, the consequences of the hazard (including environmental considerations) were examined and remedial actions recommended. This allows potential hazards to be designed out wherever possible or if this is not possible for appropriate safeguards and mitigation measures to be incorporated into the design and operational controls.

Following the HAZOP stage, a Layers of Protection Analysis (LOPA) review was completed for key safety instrumentation and control systems, the aim being to undertake a quantified assessment of the probability of failure on demand of a safety or other control system and in doing so ensuring appropriate levels of protection are in place.

All of these FPSAs will be repeated, as required, as the detailed design is finalised.

Relevant information from HAZOP and HAZID activities has been reviewed and incorporated into the Accident Risk Assessment presented in Table 4a below. For clarity the proposed process activities have been broken down into key areas; this reflects the principle of the HAZOP stages where the plant is broken down into nodes in order to systematically assess potential hazards.

The Risk Assessment Methodology used for this accident assessment is included as Appendix 10.

Table 4a Accident risk assessment

What harm can be caused and who can be harmed			Managing the risk	Assessing the risk (after preventative controls)		
Hazard	**Receptor**	**Pathway**	**Risk management**	**Probability of exposure**	**Environmental Consequence**	**What is the overall risk?**
What has the potential to cause harm?	**What is at risk? What do I wish to protect?**	**How can the hazard get to the receptor?**	**What measures will you take to reduce the risk? If it occurs – who is responsible for what?**	**How likely is this contact?**	**What is the harm that can be caused?**	**What is the risk that still remains?**
Gas pipework, valves, vents						
Failure of pipework and valves (corrosion, cracks, material defects etc) leading to significant release of gas and fire / explosion risk	Nearby human receptors Local air quality and global climate impacts	Air	**Preventative controls** • Pipework is buried where possible, flange joints are minimised. • Buried pipework protected by cathodic protection system; above ground pipework has approved coatings applied. • Pipework stress and vibration analysis undertaken. • Corrosion allowance of 3mm on pipework. • Station limited (via control systems) to 70 barg pressure and new pipework designed for up to 75 barg. • 'Winterisation' procedures to protect pipework, valves and systems from low winter temperatures. **In the event of an incident/accident** • Safety control mechanisms in place to isolate pipework / equipment. • Sterile areas to prevent fire spread and approved separation distances to internal (site) and external (public) receptors. • Initiate fire, spill and emergency response procedures, cleaning up spill and disposal of wastes appropriately. • Activate penstock valve if any risk of contamination of surface water drainage system.	Highly unlikely	Medium	Low risk

What harm can be caused and who can be harmed			Managing the risk	Assessing the risk (after preventative controls)		
Hazard	**Receptor**	**Pathway**	**Risk management**	**Probability of exposure**	**Environmental Consequence**	**What is the overall risk?**
What has the potential to cause harm?	**What is at risk? What do I wish to protect?**	**How can the hazard get to the receptor?**	**What measures will you take to reduce the risk? If it occurs – who is responsible for what?**	**How likely is this contact?**	**What is the harm that can be caused?**	**What is the risk that still remains?**
Mechanical failure of a valve to seat fully resulting in valve passing process gas	Global climate	Air	**Preventative controls** • New valves being installed at key locations across the installation; valves typically leak after a significant number of years of service. • Regular maintenance and inspection of valves to ensure performance and condition is maintained. • Passing valves generate noise or will typically ice up (regardless of weather conditions) due to Joules-Thompson effect, helping to identify leaks. • Valve control logic and position reported on PLC process mimics. • Compressor unit monitors internal casing pressure to prevent a leaking isolation valve from unintentionally pressurising a unit. **In the event of an incident/accident** • Re-actuation, as valve seating failure can be temporary (e.g. due to dirt contamination of valve mating surface). • Repair of faulty valve.	Likely	Minor/Negligible	Low risk

What harm can be caused and who can be harmed			Managing the risk	Assessing the risk (after preventative controls)		
Hazard	**Receptor**	**Pathway**	**Risk management**	**Probability of exposure**	**Environmental Consequence**	**What is the overall risk?**
What has the potential to cause harm?	**What is at risk? What do I wish to protect?**	**How can the hazard get to the receptor?**	**What measures will you take to reduce the risk? If it occurs – who is responsible for what?**	**How likely is this contact?**	**What is the harm that can be caused?**	**What is the risk that still remains?**
Vent stack fire	Nearby human receptors Local air quality and global climate impacts	Air	**Preventative controls** • New vent stack designed and operated to reduce risks associated with lightning strike. • Venting only undertaken when operationally necessary. • Manual venting is never initiated in electrical storm conditions. • Vent designed to allow stack fires to burn safely without damage to equipment or risks to wider population / property. • Nitrogen snuffing systems installed. **In the event of an incident/accident** • Automatic interlocks and valves set to fail safe to ensure that only the minimum gas is vented and continued uncontrolled venting cannot occur. • Manual activation of nitrogen snuffing system for small vent stack fire (e.g. ignition of gas from a passing valve). • Sterile areas used to isolate vents from potential sources of ignition and combustible materials and prevent fire spread. A larger vent stack fire associated with ignition by lightning of an automatic unit or station vent would burn out quickly in a safe and controlled manner (it should be noted that a fire of this type has never occurred on any NTS site in some 50 years of overall operations).	Low likelihood	Mild	Low risk
Manual vents left open leading to excess venting of unburnt gas	Global climate	Air	**Preventative controls** • Manual venting controlled by permit system and operating procedures. • Staff training and competence assessments. **In the event of an incident/accident** • Close vents and reinforce training to operatives.	Low likelihood	Minor / negligible	Negligible risk

What harm can be caused and who can be harmed			Managing the risk	Assessing the risk (after preventative controls)		
Hazard	**Receptor**	**Pathway**	**Risk management**	**Probability of exposure**	**Environmental Consequence**	**What is the overall risk?**
What has the potential to cause harm?	**What is at risk? What do I wish to protect?**	**How can the hazard get to the receptor?**	**What measures will you take to reduce the risk? If it occurs – who is responsible for what?**	**How likely is this contact?**	**What is the harm that can be caused?**	**What is the risk that still remains?**
Excessive noise from venting activities	Nearby human receptors	Air	**Preventative controls** • In line vent stack silencer installed. • Venting only undertaken when operationally necessary. Vented shutdown is manually selected by the operator; automatic vented shutdowns are on unit safety trips only. (Not all unit trips result in a vent, other trips lock the unit safe in a pressurised state). **In the event of an incident/accident** • Investigate cause and implement preventive measures, which may include system interventions to repair vent silencer (internal baffles can break down after many years) or check and correct venting speed.	Low likelihood	Mild	Low risk

What harm can be caused and who can be harmed			Managing the risk	Assessing the risk (after preventative controls)		
Hazard	**Receptor**	**Pathway**	**Risk management**	**Probability of exposure**	**Environmental Consequence**	**What is the overall risk?**
What has the potential to cause harm?	**What is at risk? What do I wish to protect?**	**How can the hazard get to the receptor?**	**What measures will you take to reduce the risk? If it occurs – who is responsible for what?**	**How likely is this contact?**	**What is the harm that can be caused?**	**What is the risk that still remains?**
Exhaust stacks and emissions monitoring systems						
Operational problems (various, including failure of the DLE combustion system) leading to excessive emissions to air (NOx, CO), which exceed permit limits	Nearby human receptors Local air quality and global climate impacts	Air	**Preventative controls** • New gas turbine engine is fitted with the latest advanced DLE combustion system, designed to reduce the formation of NOx, CO and unburnt hydrocarbons compared to other technologies. • System operates over a wider power turndown accompanied by an emissions performance guarantee. • Multiple control systems and continuous system monitoring to detect and resolve operational problems. • PEMS and CEMS monitor key engine operational parameters to determine compliance with Emission Limit Values (ELVs). Proven effective over many years and validated by periodic extractive emissions testing. **In the event of an incident/accident** • Switch to an alternative gas turbine. • Isolate and carry out repairs.	Low likelihood	Mild	Low risk

What harm can be caused and who can be harmed			Managing the risk	Assessing the risk (after preventative controls)		
Hazard	**Receptor**	**Pathway**	**Risk management**	**Probability of exposure**	**Environmental Consequence**	**What is the overall risk?**
What has the potential to cause harm?	**What is at risk? What do I wish to protect?**	**How can the hazard get to the receptor?**	**What measures will you take to reduce the risk? If it occurs – who is responsible for what?**	**How likely is this contact?**	**What is the harm that can be caused?**	**What is the risk that still remains?**
Failure of CEMS system (including power failure, hardware or software failure), with the potential to result in increased emissions of NOx & CO from operations of the compressor to be emitted unnoticed	Nearby human receptors	Air	**Preventative controls** • Process control logic to alarm on the basis of CEMS failure. • Regular maintenance, inspection and calibration carried out. • CEMS power supplies taken from the cab power supplies (which is served by the standby generator), i.e. will not be possible to operate the compressor if there is no power to the cab. • CEMS would automatically reboot itself and restart in the event of a loss, then restoration of power supply. **In the event of an incident/accident** • Reboot if does not occur automatically. • Initiate repair / maintenance actions.	Low likelihood	Minor/Negligible	Negligible risk
Failure of PEMS system (e.g. power failure, hardware or software failure), with the potential to result in increased emissions of NO_x & CO from operation of the compressors to be emitted unnoticed or for emissions to be under-estimated	Nearby human receptors Local air quality and global climate impacts	Air	**Preventative controls** • Process control logic to alarm on the basis of PEMS failure. • Regular maintenance, inspection and calibration carried out. • PEMS would automatically reboot itself and restart in the event of a loss, then restoration of power supply. • New unit will continue to be subject to comprehensive remote monitoring and data logging via National Gas Transmission's Alert system and Central Healthcare Console (CHC), which provides a live dashboard to the Gas National Control Centre. • PEMS validated by periodic extractive emissions testing. Permanent access and sampling ports provided. **In the event of an incident/accident** • Reboot if does not occur automatically. • Initiate repair / maintenance actions.	Low likelihood	Minor/Negligible	Negligible risk

What harm can be caused and who can be harmed			Managing the risk	Assessing the risk (after preventative controls)		
Hazard	**Receptor**	**Pathway**	**Risk management**	**Probability of exposure**	**Environmental Consequence**	**What is the overall risk?**
What has the potential to cause harm?	**What is at risk? What do I wish to protect?**	**How can the hazard get to the receptor?**	**What measures will you take to reduce the risk? If it occurs – who is responsible for what?**	**How likely is this contact?**	**What is the harm that can be caused?**	**What is the risk that still remains?**
Excessive noise from compressor or exhaust stack	Nearby human receptors	Air	**Preventative controls** • Noise mitigation measures include engine and compressor primary noise enclosures as well as secondary / outer noise enclosure (cab building). • Exhaust is fitted with integrated high performance silencer. • Commissioning noise tests will be undertaken and noise guarantees in place on both the OEM and the main works contractor. • Very high sensitivity vibration monitoring on compressor machinery train, linked to automated unit trip. **In the event of an incident/accident** • Investigate cause an implement preventive measures, which may include system interventions to stack or compressor machinery train.	Low likelihood	Mild	Low risk
Compressor and fuel gas skid						
Damage to plant and equipment due to foreign bodies in pipework (e.g. from maintenance or commissioning works) leading to release of gas, potential fire and explosion risks, leaks / escape of oils or liquids	Nearby human receptors Local air quality and global climate impacts Ground / groundwater / surface waters	Air Overland runoff / infiltration / drainage systems	**Preventative controls** • Pre-commissioning procedures to ensure adequate pipework cleaning. • Strainer in place upstream of process equipment for first 12 months of operation. • Work permit system in operation to control maintenance and other activities. **In the event of an incident/accident** • Isolate systems as appropriate and initiate fire, spill and emergency response procedures, cleaning up spill and disposal of wastes appropriately. • Carry out repairs (as required).	Highly unlikely	Mild	Negligible risk

What harm can be caused and who can be harmed			Managing the risk	Assessing the risk (after preventative controls)		
Hazard	**Receptor**	**Pathway**	**Risk management**	**Probability of exposure**	**Environmental Consequence**	**What is the overall risk?**
What has the potential to cause harm?	**What is at risk? What do I wish to protect?**	**How can the hazard get to the receptor?**	**What measures will you take to reduce the risk? If it occurs – who is responsible for what?**	**How likely is this contact?**	**What is the harm that can be caused?**	**What is the risk that still remains?**
Gas escape from compressor and fire / explosion risk – various failure scenarios leading to over / under-pressurisation and/or equipment failures	Nearby human receptors Local air quality and global climate impacts	Air	**Preventative controls** • Compressor cab has fire and gas detection systems – SIL (safety integrity level) systems ensuring independent operation in the event of failure of other systems. • Multiple control systems: anti-surge systems, pressure relief valves, alarms, interlocks, backups and emergency shut-down systems in place. • No personnel access to compressor cab whilst units are running. • Full factory acceptance tests for unit control system, protection system, turbine, and gas compressor. • Advanced Eagle Burgmann tandem dry gas separation seal to be used on new compressor to reduce escape of pressurised gas. **In the event of an incident/accident** • Water mist system installed in compressor enclosure. • Initiate fire and or spill response procedures.	Highly unlikely	Medium	Low risk
Spillage / loss of containment – engine or power turbine lube oil, hydraulic fluids	Ground / groundwater / surface waters	Overland runoff / infiltration / drainage systems	**Preventative controls** • Lube oil cooler, fuel gas skid and compressor cab fully bunded and connected to below ground oil containment chamber designed to meet CIRIA 736 and which accommodates 110% of the total oil inventory within the compressor system (12,500 litres). • In the event of a spill / loss of containment, oils/fluids would be contained within this chamber prior to off-site disposal. • Chamber fitted with automatic dewatering system comprising float switch and oil detector to pump out only uncontaminated rainwater into the surface water drainage system.	Low likelihood	Mild	Low risk

What harm can be caused and who can be harmed			Managing the risk	Assessing the risk (after preventative controls)		
Hazard	**Receptor**	**Pathway**	**Risk management**	**Probability of exposure**	**Environmental Consequence**	**What is the overall risk?**
What has the potential to cause harm?	**What is at risk? What do I wish to protect?**	**How can the hazard get to the receptor?**	**What measures will you take to reduce the risk? If it occurs – who is responsible for what?**	**How likely is this contact?**	**What is the harm that can be caused?**	**What is the risk that still remains?**
			• Chamber designed to allow inspection from surface level and control of rainwater ingress. • Surface water runoff from all areas of site where potentially hazardous materials are stored or handled, including areas surrounding the lube oil cooler, fuel gas skid and compressor cab, as well as uncontaminated rainwater from within the below ground containment chamber, discharge via an oil and silt separator and attenuation tank. • Penstock valve located at the attenuation tank outfall as a last line of defence in case of contamination of the surface water drainage system and failure of other control measures. • Compressor cab bund system includes sealed junction between external cladding and floor slab, and channel drains across door thresholds. • Compressor cab designed with a small upstand (25mm) to the inner face of the channel drain to contain wash water (1000 litres) within the cab, preventing it from entering the oil containment chamber. • The compressor hardstanding area will be constructed in impermeable concrete and will extend to capture all equipment carrying lubricating oil external to the compressor enclosure. • Welded pipework construction – minimum number of flanged joints. • The material of construction for the system will be stainless steel which is highly corrosion & impact resistant. • The recirculating fluid is oil, will be continuously filtered and therefore corrosion & erosion are not considered to be an issue.			

What harm can be caused and who can be harmed			Managing the risk	Assessing the risk (after preventative controls)		
Hazard	**Receptor**	**Pathway**	**Risk management**	**Probability of exposure**	**Environmental Consequence**	**What is the overall risk?**
What has the potential to cause harm?	**What is at risk? What do I wish to protect?**	**How can the hazard get to the receptor?**	**What measures will you take to reduce the risk? If it occurs – who is responsible for what?**	**How likely is this contact?**	**What is the harm that can be caused?**	**What is the risk that still remains?**
			• Pipework will be externally coated to provide additional resistance to corrosion attack. Scheduled maintenance inspections will identify and rectify any corrosion at an early stage. • The lube oil lines feeding the heat recovery unit will all be above ground which will allow periodic full length inspection. • Welds will be used in preference to flanged joints on the connecting pipework between the fuel gas skid bund and the compressor enclosure. • Oil pressure is monitored, with automated unit trip. • Pipework stress & vibration analysis has been undertaken with appropriate support specified. • The system will be trace heated to provide 'Winterisation' protection. • Flange shields and weep holes fitted where required to direct any release to drip trays, absorbent mats or similar. **In the event of an incident/accident** • Isolate systems as appropriate and initiate spill response procedure, cleaning up spill and disposal of wastes appropriately. • If required, pump out any contaminated materials from below ground oil containment chamber and/or oil and silt separator and send off site for disposal. • Carry out repairs (as required). • Activate penstock valve if any risk of contamination of surface water drainage system.			

What harm can be caused and who can be harmed			Managing the risk	Assessing the risk (after preventative controls)		
Hazard	**Receptor**	**Pathway**	**Risk management**	**Probability of exposure**	**Environmental Consequence**	**What is the overall risk?**
What has the potential to cause harm?	**What is at risk? What do I wish to protect?**	**How can the hazard get to the receptor?**	**What measures will you take to reduce the risk? If it occurs – who is responsible for what?**	**How likely is this contact?**	**What is the harm that can be caused?**	**What is the risk that still remains?**
Spillage / loss of containment – turbine washings (water, detergents, contaminants e.g. hydrocarbons)	Ground / groundwater / surface waters	Overland runoff / infiltration / drainage systems	**Preventative controls** • Compressor skid bunded. • No drains within compressor skid and enclosure. • Compressor cab to have as small upstand (25mm) to the inner face of the channel drain to contain wash water (1000 litres), preventing it for entering the oil containment chamber. • Dedicated mobile turbine washing skid used. • Discharges collected and disposed of off-site by specialist contractor. Work permits and risk assessments completed. • Penstock valve fitted at surface water drainage discharge point (at attenuation tank outfall). **In the event of an incident/accident** • Isolate systems as appropriate and initiate spill response procedure, cleaning up spill and disposal of wastes appropriately. • Carry out repairs (as required).	Low likelihood	Minor / negligible	Negligible risk

What harm can be caused and who can be harmed			Managing the risk	Assessing the risk (after preventative controls)		
Hazard	**Receptor**	**Pathway**	**Risk management**	**Probability of exposure**	**Environmental Consequence**	**What is the overall risk?**
What has the potential to cause harm?	**What is at risk? What do I wish to protect?**	**How can the hazard get to the receptor?**	**What measures will you take to reduce the risk? If it occurs – who is responsible for what?**	**How likely is this contact?**	**What is the harm that can be caused?**	**What is the risk that still remains?**
Standby generator						
Excessive emissions to air from standby generator	Nearby human receptors Local air quality and global climate impacts	Air	**Preventative controls** • New standby generator to be installed (replacing the smaller of the two existing generators), fitted with modern engine management system to control combustion parameters. • Planned preventative maintenance in place for standby generator to ensure high standards of maintenance and clean burning. • Infrequent operation in the event of an electrical power failure. Monthly functional testing. **In the event of an incident/accident** • Investigate cause and implement preventive measures, which may include system maintenance interventions.	Low likelihood	Minor / negligible	Negligible risk

What harm can be caused and who can be harmed			Managing the risk	Assessing the risk (after preventative controls)		
Hazard	**Receptor**	**Pathway**	**Risk management**	**Probability of exposure**	**Environmental Consequence**	**What is the overall risk?**
What has the potential to cause harm?	**What is at risk? What do I wish to protect?**	**How can the hazard get to the receptor?**	**What measures will you take to reduce the risk? If it occurs – who is responsible for what?**	**How likely is this contact?**	**What is the harm that can be caused?**	**What is the risk that still remains?**
Spillage / loss of diesel containment – during storage, use or tank refilling	Ground / groundwater / surface waters	Overland runoff / infiltration / drainage systems	**Preventative controls** • Diesel storage tank fully bunded / double skinned. • Standby generator enclosure acts as bund for general fuel and oil inventory. • Pipework running between the diesel tank and standby generator will be double skinned. • Joints external to containment minimised and welded where practical. • Tank and pipework inspections undertaken. • Diesel loading area drained to a valved gully, connected to the potentially contaminated drainage system (which discharges via oil and silt separator and attenuation tank). This valve is normally open but is always closed during loading operations. • Surface water runoff in this area discharged via oil and silt separator and attenuation tank (full retention Class 1 interceptor). • Penstock valve fitted at surface water drainage discharge point (at attenuation tank outfall). **In the event of an incident/accident** • Isolate systems as appropriate and initiate spill response procedure, cleaning up spill and disposal of wastes appropriately. • If required, pump out any contaminated materials from oil and silt separator and send off site for disposal. • Carry out repairs (as required). • Activate penstock valve if any risk of contamination of surface water drainage system.	Low likelihood	Mild	Low risk

What harm can be caused and who can be harmed			Managing the risk	Assessing the risk (after preventative controls)		
Hazard	**Receptor**	**Pathway**	**Risk management**	**Probability of exposure**	**Environmental Consequence**	**What is the overall risk?**
What has the potential to cause harm?	**What is at risk? What do I wish to protect?**	**How can the hazard get to the receptor?**	**What measures will you take to reduce the risk? If it occurs – who is responsible for what?**	**How likely is this contact?**	**What is the harm that can be caused?**	**What is the risk that still remains?**
Excessive noise from standby generator	Nearby human receptors	Air	**Preventative controls** • Generator located within acoustic enclosure. • Infrequent operation in the event of an electrical power failure. Monthly functional testing. **In the event of an incident/accident** • Investigate cause and implement preventive measures, which may include system maintenance interventions.	Low likelihood	Mild	Low risk
Other – Site Wide						
Vehicle impact leading to loss of pressurised gas and explosion / fire risk	Nearby human receptors Contribution to local air pollution and global warming	Air	**Preventative controls** • Limited vehicle movements on site, largely restricted to low risk areas of the site. • Contractor vehicle movements covered by permit system and risk assessments. • Suitable barriers installed where appropriate. **In the event of an incident/accident** • Isolate systems as appropriate and initiate fire, spill and emergency response. procedures, cleaning up spill and disposal of wastes appropriately. • Carry out repairs (as required). • Activate penstock valve if any risk of contamination of surface water drainage system.	Highly unlikely	Medium	Low risk

<table>
<tr><th colspan="3">What harm can be caused and who can be harmed</th><th>Managing the risk</th><th colspan="3">Assessing the risk (after preventative controls)</th></tr>
<tr><th>Hazard</th><th>Receptor</th><th>Pathway</th><th>Risk management</th><th>Probability of exposure</th><th>Environmental Consequence</th><th>What is the overall risk?</th></tr>
<tr><th>What has the potential to cause harm?</th><th>What is at risk? What do I wish to protect?</th><th>How can the hazard get to the receptor?</th><th>What measures will you take to reduce the risk? If it occurs – who is responsible for what?</th><th>How likely is this contact?</th><th>What is the harm that can be caused?</th><th>What is the risk that still remains?</th></tr>
<tr><td>Vehicle impact leading to loss of containment of hazardous / polluting liquids</td><td>Ground / groundwater / surface waters</td><td>Overland runoff / infiltration / drainage systems</td><td>Preventative controls
• Low inventory of hazardous / potentially polluting liquids within the installation.
• Limited vehicle movements on site, largely restricted to low risk areas of the site.
• Contractor vehicle movements covered by permit system and risk assessments.
• Suitable barriers installed where appropriate.
• Surface water runoff from all areas of site where potentially hazardous materials are stored or handled discharge via oil and silt separator and attenuation tank.
In the event of an incident/accident
• Isolate systems as appropriate and initiate spill and emergency response procedures, cleaning up spill and disposal of wastes appropriately.
• If required, pump out any contaminated materials from oil and silt separator and send off site for disposal.
• Carry out repairs (as required).
• Activate penstock valve if any risk of contamination of surface water drainage system.</td><td>Highly unlikely</td><td>Medium</td><td>Low risk</td></tr>
</table>

What harm can be caused and who can be harmed			Managing the risk	Assessing the risk (after preventative controls)		
Hazard	**Receptor**	**Pathway**	**Risk management**	**Probability of exposure**	**Environmental Consequence**	**What is the overall risk?**
What has the potential to cause harm?	**What is at risk? What do I wish to protect?**	**How can the hazard get to the receptor?**	**What measures will you take to reduce the risk? If it occurs – who is responsible for what?**	**How likely is this contact?**	**What is the harm that can be caused?**	**What is the risk that still remains?**
Flood leading to mobilisation of polluting materials	Ground / groundwater / surface waters	Floodwaters / Infiltration	**Preventative controls** • Flood risk review undertaken. Areas of the site in which the new machinery will be located are at very low risk of flooding from surface water, rivers or seas (less than 0.1% each year). • Storage containers bunded. • Site emergency plan in place. **In the event of an incident/accident** • Initiate site emergency plan. • Remove mobile fuel/ chemical sources away from flood risk, if appropriate and safe to do so. • Instigate use of local flood control measures as required (e.g. sand bags).	Highly unlikely	Mild	Negligible risk
Excessive high or low temperatures leading to blockages or damage to pipework, valves or equipment and unplanned release of gas with fire / explosions risks and/or release of potentially polluting liquids	Nearby human receptors Local air quality and global climate impacts Ground / groundwater / surface waters	Air Overland runoff / infiltration / drainage systems	**Preventative controls** • 'Winterisation' procedures. • Bunding provided to environmentally critical plant and equipment. • Anti-icing system on compressor air intakes. **In the event of an incident/accident** • Isolate systems as appropriate and initiate fire, spill and emergency response procedures, cleaning up spill and disposal of wastes appropriately. • If required, pump out any contaminated materials from oil and silt separator and send off site for disposal. • Carry out repairs (as required). • Activate penstock valve if any risk of contamination of surface water drainage system.	Highly unlikely	Mild	Negligible risk

What harm can be caused and who can be harmed			Managing the risk	Assessing the risk (after preventative controls)		
Hazard	**Receptor**	**Pathway**	**Risk management**	**Probability of exposure**	**Environmental Consequence**	**What is the overall risk?**
What has the potential to cause harm?	**What is at risk? What do I wish to protect?**	**How can the hazard get to the receptor?**	**What measures will you take to reduce the risk? If it occurs – who is responsible for what?**	**How likely is this contact?**	**What is the harm that can be caused?**	**What is the risk that still remains?**
Vandalism / site security failure leading to unplanned release of gas with fire / explosions risks and/or release of potentially polluting liquids	Nearby human receptors Local air quality and global climate impacts Ground / groundwater / surface waters	Air Overland runoff / infiltration / drainage systems	**Preventative controls** • High level of security on site with 24 hr security monitoring, power (electrified) fence, double entry gate systems and locked cab and control unit. **In the event of an incident/accident** • Isolate systems as appropriate and initiate fire, spill and emergency response procedures, cleaning up spill and disposal of wastes appropriately. • If required, pump out any contaminated materials from oil and silt separator and send off site for disposal. • Carry out repairs (as required). • Activate penstock valve if any risk of contamination of surface water drainage system.	Highly unlikely	Medium	Low risk

As required under the terms of the existing permit, significant accidents and breaches of permit conditions will be reported to the EA as soon as practically possible and within 24 hours at the most. The requirements of the permit are consistent with National Gas Transmission's incident investigation and reporting procedures and guidance provided in the gas transmission Operational Environmental Management Handbook. The Lincolnshire Fire and Rescue Service are aware of the site and have been consulted in respect to fire prevention and provision of access to hydrants and key areas of the site.

The site maintains a pack of key documents which will be of importance in the event of an emergency, this includes:

- A copy of the Emergency Plan which contains emergency contact details;
- A list of key materials stored on site;
- Asbestos register; and
- Procedures for recording and reporting incidents and accidents.

Noise

The design of the Hatton Compressor Station has been developed in accordance with the National Grid Specification for Environmental Noise Assessment for Compressor Projects (T/SP/ENV/26) to ensure that potential environmental noise effects are minimised. A basic principle of T/SP/ENV/26 is that noise emissions are considered from the outset of the design process for gas compressor projects, and that preliminary noise assessments are undertaken to support the identification of BAT as the design progresses.

Specific examples of noise mitigation included in the scheme design include the following:

- The supply of bespoke high performance acoustic enclosure surrounding the main compressor machinery train, to create a multi-layer control system.
- Provision for high performance acoustic lagging, using modern elastomeric foam technology, on external gas pipework which may represent a noise source. Appropriate class designations have been set for equipment, in line with ISO 15665.
- Inclusion of high-performance baffles in the combustion exhaust stack.
- High performance vent silencer.
- Low noise variants of ancillary equipment (e.g. standby generator).

The noise reduction technologies included in the design are consistent with the recommendations made by the European Commission in respect of Large Combustion Plants.

A summary noise risk assessment is presented in Table 4b below. The Risk Assessment Methodology is included as Appendix 10.

A full Noise Impact Assessment is provided in Appendix 3 and a Noise Management Plan is provided in Appendix 4. Refer also to Section II: Proposed Changes for a summary of the compressor noise enclosure BAT assessment undertaken during the design process.

Table 4b **Noise risk assessment**

What harm can be caused and who can be harmed			Managing the risk	Assessing the risk		
Hazard	**Receptor**	**Pathway**	**Risk management**	**Probability of exposure**	**Environmental Consequence**	**What is the overall risk?**
What has the potential to cause harm?	**What is at risk? What do I wish to protect?**	**How can the hazard get to the receptor?**	**What measures will you take to reduce the risk? If it occurs – who is responsible for what?**	**How likely is this contact?**	**What is the harm that can be caused?**	**What is the risk that still remains?**
Normal operation of proposed new compressor units, and ancillary equipment (e.g. fuel gas skids, lube oil coolers, external above ground pipework, etc.)	Local residents	Transmission of sound though air	A detailed noise impact assessment has been undertaken which concludes the overall likelihood of adverse impact is considered to be low. Noise emissions have been considered from the outset of the design process, in order to minimise the potential for adverse noise impacts. The most substantial noise mitigation measures included in the design are an engineered close-fitting noise enclosure around the gas compressor unit, a bespoke secondary full cabinet (or ‘cab’) enclosure, and air intake/exhaust silencers with the best available noise attenuation performance for the selected model of compressor.	Likely	Minor/ Negligible; noise nuisance	Low risk
Occasional short gas venting events.	Local residents	Transmission of sound though air	Management of units to reduce the need for venting as far as is practicable. High performance vent stack attenuators are included in the design to reduce levels as far as practicable. Planned venting only to occur during daytime.	Likely	Minor/ Negligible; noise nuisance	Low risk

What harm can be caused and who can be harmed			Managing the risk	Assessing the risk		
Hazard	**Receptor**	**Pathway**	**Risk management**	**Probability of exposure**	**Environmental Consequence**	**What is the overall risk?**
What has the potential to cause harm?	**What is at risk? What do I wish to protect?**	**How can the hazard get to the receptor?**	**What measures will you take to reduce the risk? If it occurs – who is responsible for what?**	**How likely is this contact?**	**What is the harm that can be caused?**	**What is the risk that still remains?**
Abnormal operations e.g. failure of plant / equipment, or breakdown of stack attenuator structure.	Local residents	Transmission of sound though air	Planned preventative maintenance programme, in line with OEM requirements Very high sensitivity vibration monitoring on compressor machinery train, linked to automated unit trip. Periodic stack inspections, (inspection access hatches provided to allow internal inspection, including silencer bullet). Other options for inspection include the use of unmanned aerial vehicles (UAVs, or drones) fitted with high resolution cameras to simplify and improve visual stack inspections. Regular site housekeeping audits and inspections, which would include identification of plant operating abnormally and generating increased noise. Identification of potential noise problems early through this process would enable them to be rectified before they became a problem audible off-site.	Low likelihood	Minor/Negligible; noise nuisance (tonality)	Negligible risk

What harm can be caused and who can be harmed			Managing the risk	Assessing the risk		
Hazard	**Receptor**	**Pathway**	**Risk management**	**Probability of exposure**	**Environmental Consequence**	**What is the overall risk?**
What has the potential to cause harm?	**What is at risk? What do I wish to protect?**	**How can the hazard get to the receptor?**	**What measures will you take to reduce the risk? If it occurs – who is responsible for what?**	**How likely is this contact?**	**What is the harm that can be caused?**	**What is the risk that still remains?**
Human factors (i.e. leaving enclosure / equipment housing doors open, allowing units to operate without noise attenuation fitted, etc.).	Local residents	Transmission of sound though air	Comprehensive operator training, work instructions and work permit schemes. Human factors are a specific FPSA risk assessment covered under National Gas safety engineering procedures. Work instruction and permits include consideration of any circumstances where actions could impact on noise attenuation, for example, requirements to temporarily remove pipe lagging (e.g. to inspect pipes or valve bodies) or to temporarily remove pit covers (e.g. to facilitate maintenance access). The majority of noise attenuation is provided through permanently fitted equipment (e.g. the cab noise enclosure) thus removal for maintenance would render the equipment inoperable; noise attenuation would have to be reinstalled prior to returning the equipment to operability. Compressor cabs have safety interlocks and door alarms and must be closed during operation.	Low likelihood	Minor/Negligible; noise nuisance (tonality)	Negligible risk

EP Form: Part C3: Question 3c - Types and amounts of raw materials

Due to the nature of the process, there are a limited number of raw materials used within the process; these relate principally to maintenance functions. With the use of precision high speed machinery transporting pressurised gas, there are very strict quality standards placed on raw materials by plant manufacturers (e.g. oils, lubricants, detergents). All potentially hazardous raw materials in use within National Gas Transmission have to be assessed through a hazards and precautions procedure. This procedure includes consideration of environmental and health and safety aspects of all potentially hazardous raw materials used within the business.

The installation of the proposed new compressor unit and associated balance of plant will not materially alter the type of raw materials from those currently in use in the installation, although, for example, grades of oils and greases are likely to be specific to engine type. There are small quantities of new raw materials (compressed calibration gas cylinders) associated with the CEMs.

Although the proposed new unit will take the site lead duty with the existing unit D (VSD), existing unit A will need to be retained in a fully serviced state of operational readiness in the event that it is required for standby duty; overall running hours are anticipated to remain similar.

There will continue to be considerable variability year on year, as higher utilisation generally results in higher usage of certain raw materials. This is due to both usage in the system and the increase in maintenance. Higher running hours results in more frequent washing and maintenance requirements, along with lubricant usage. However, maintenance and gas turbine washing do not always take place in the same calendar year as compressor running hours and higher lubricant usage in any given year can also be down to engine changes. Lubricants are often only replaced once certain characteristics are found within the oil indicating that protection would be reduced.

Taking account of the LLD, the net change on site will see a reduction from four units to three, (with site duty continuing to be met by a maximum of two operating at any time, as per current operations) there may be an overall reduction in the usage of certain raw materials and consumables, although this hard to predict at this stage.

An updated summary of raw material usage at the installation is provided below, this updates the information submitted in previous permit application and identifies the likely key changes in materials storage and utilisation associated with the proposed changes.

Resource utilisation reviews are periodically carried out by National Gas Transmission, the most recent being in December 2022. National Gas Transmission commits to undertaking an updated resource efficiency review following commencement of normal operations at the site in the new configuration (See Proposed Improvement Programme).

Table 5 Types and amounts of raw materials associated with new unit E

Description of raw material and composition	Storage amount (Approx.)	Annual throughput (Approx.)	Anticipated future usage following implementation of proposed changes (indicative)	Description of the use of the raw material including any main hazards	Environmental hazards	Alternatives
Lubrication oils for power turbine, gas generator, and compressor comprising refined mineral oils, with additives and synthetic hydrocarbon lubricants with additives.	~600 litres	< 600 litres per annum	Different oil specifications will be required for new compressor unit, however quantities of existing oils associated with RB211 units are likely to decrease proportionately with their reduced usage and retirement of two units under LLD.	Lubrication system for the gas turbine drive train. Drum storage.	Polluting to watercourses / ground in the event of a spillage/loss	No viable alternative
Ionic surfactant based detergent	< 200 litres	< 200 litres	Turbine washing is a function of run hours, which are anticipated to remain similar. Different detergent specification may be required for new unit, so storage quantity may increase but will likely remain <200 litres.	Turbine washing fluid used for periodic washing of gas turbine internals during standard maintenance. Drum storage.	Polluting to watercourses in the event of a spillage/loss. Potential disruptor to function of oil / silt separator	No viable alternative
Petroleum hydrocarbon (diesel)	27,000 litres	<5,000 litres	Tank capacity of new generator will be 27,000 litres. Usage of diesel fuel unlikely to change, as primary demand will still be monthly testing. One of the existing generators will be retired.	Drum storage for plant and equipment. Bulk storage will be introduced for new standby diesel generator.	Polluting to watercourses / ground in the event of a spillage/loss	No viable alternative

Description of raw material and composition	Storage amount (Approx.)	Annual throughput (Approx.)	Anticipated future usage following implementation of proposed changes (indicative)	Description of the use of the raw material including any main hazards	Environmental hazards	Alternatives
Mineral oil / synthetic hydrocarbon lubrication oils.	~400 litres	<500 litres	Oil capacity of new generator not confirmed, but no significant change anticipated to current usage (top-up) levels. A different oil specification may be required due to it being a larger more modern unit than the one being replaced. Mobile plant maintenance and top-up usage will continue.	Engine oil for standby generator usage. Mobile plant maintenance and top up usage. Drum storage.	Polluting to watercourses / ground in the event of a spillage/loss	No viable alternative
Other mineral oil/synthetic hydrocarbon based compounds and oils with additives including lithium based greases, other synthetic lubrication compounds.	<20 kg	<20 kg	Potential small increase due to additional valves, actuators and general plant, although offsets associated with retirement of plant associated with LLD units.	Ball valve sealants; equipment maintenance.	Polluting to watercourses / ground in the event of a spillage/loss	No viable alternative
Highly refined mineral transformer oils	Sealed, small oil fill transformer. Replaced as required by electrical / specialist contractors.			Small transformer on site.	Polluting to watercourses / ground in the event of a spillage/loss	No viable alternative

Description of raw material and composition	Storage amount (Approx.)	Annual throughput (Approx.)	Anticipated future usage following implementation of proposed changes (indicative)	Description of the use of the raw material including any main hazards	Environmental hazards	Alternatives
Nitrogen gas.	6 no. (50 litre cylinders) (see also bottled calibration gases)	<60m^3	Increase in inventory anticipated to reflect additional vent stack provision. Unit E dry gas seals will use compressed air as separation gas in the barrier seals, not nitrogen, as is the case at some sites.	Safety purging of process pipework and vent stack snuffing. Cylinder storage.	None	No viable alternative
Bottled calibration gasses (nitrogen, carbon monoxide in a nitrogen carrier, nitrogen dioxide in a nitrogen carrier and oxygen).	Small format cylinders	<100 kg	New requirement (no existing CEMS system on site).	CEMS calibration and span gases.	Negligible	No viable alternative
Rock Salt.	~500 kg	<500 kg	Increase in surface area of hardstanding and walkways may increase usage, although primary variability is number of freezing nights over winter.	Gritting of essential roads and walkways. Pallet storage.	Polluting to watercourses in the event of a spillage/loss	No viable alternative

EP Form: Part C3: Question 4 – Monitoring

4a - Describe the measures you use for monitoring emissions by referring to each emission point in Table 2 above

Table C3: 4a-1 Emissions Monitoring Requirements to Air (existing and proposed)

Emission Point Ref.	Location	Emission Parameter	Frequency	Technique & standard	Notes
A1	Compressor unit A (LCP No. 238)	NOx CO	Continuous	Predictive emission monitoring system (PEMS)	Emergency use derogation plant. No change, frequency, technique and standard as defined in UP3333LL/V004
		NOx CO SO_2	Discontinuous	Concentration by calculation, every 4380 operational hours or 2 years, whichever is sooner. Method as agreed in writing with the Environment Agency.	
A2, A3	Due to be retired under LLD on or by 31st December 2023 (Refer to UP3333LL/V004) No change, frequency, technique and standard as defined in UP3333LL/V004 in interim period				
A4, A7, A8, A9, A14, A17	Vents from unit A	Process gas	No change; no monitoring undertaken and none proposed, as per UP3333LL/V004		
A5, A6, A10, A11, A12, A13, A15, A16, A18, A19	Vents from unit B and C	Process gas	No monitoring undertaken, emission points due to be retired under LLD on or by 31st December 2023 (Refer to UP3333LL/V004)		

Emission Point Ref.	Location	Emission Parameter	Frequency	Technique & standard	Notes
A20, A23, A26	Lube oil breather vents, unit A	Oil fume	No change; no monitoring undertaken and none proposed, as per UP3333LL/V004		
A21, A22, A24, A25, A27, A28	Lube oil breather vents, unit B and C	Oil fume	No monitoring undertaken, emission points due to be retired under LLD on or by 31st December 2023 (Refer to UP3333LL/V004)		
A29	Unit A surge recycle control valve vent	Process gas	No change; no monitoring undertaken and none proposed, as per UP3333LL/V004		
A30, A31	Unit B and C surge recycle control valve vent	Process gas	No monitoring undertaken, emission points due to be retired under LLD on or by 31st December 2023 (Refer to UP3333LL/V004)		
A32	Standby generator	NOx	Removed from service		
		PM			
		CO			
		SO_2			
A33		NOx	No change; no monitoring undertaken and none proposed, as per UP3333LL/V004		

Emission Point Ref.	Location	Emission Parameter	Frequency	Technique & standard	Notes
	Water bath heater	CO			
A34, A35, A36	Condensate tank vent	Process gas	No change; no monitoring undertaken and none proposed, as per UP3333LL/V004		
A37	Lube oil storage tank breather vent	Oil fume	No change; no monitoring undertaken and none proposed, as per UP3333LL/V004		
A38	Diesel tank breather vent	Oil fume	Removed from service		
A39	Cab D (VSD) compressor unit vent stack	Process gas	No change; no monitoring undertaken and none proposed, as per UP3333LL/V004		
A40	Cab D (VSD) compressor anti surge recycle valve	N/A	In current permit (no monitoring parameters set), but does not exist on site, included in error in V003		
A41		NOx	No change; no monitoring undertaken and none proposed, as per UP3333LL/V004		

Emission Point Ref.	Location	Emission Parameter	Frequency	Technique & standard	Notes
	Standby generator exhaust stack	PM			
		CO			
		SO_2			
A42	Standby generator diesel tank breather vent	Oil fume	No change; no monitoring undertaken and none proposed, as per UP3333LL/V004		
A43, A44	Vents from unit D	Process gas	No change; no monitoring undertaken and none proposed, as per UP3333LL/V004		
A45	Lubrication oil system vent cab D	Oil fume	No change; no monitoring undertaken and none proposed, as per UP3333LL/V004		

Emission Point Ref.	Location	Emission Parameter	Frequency	Technique & standard	Notes
A46	Compressor unit E (LCP No. TBC)	NOx CO	Continuous	Continuous Emissions Monitoring System (CEMS) BS EN 14181, TGN M20, BS EN 15267 MCERTS BS EN 15259	-
				PEMS	
		NOx	Discontinuous	Minimum of five distinct measurements taken at stable operating conditions. BS EN 14792	When operational hours in any year are less than or equal to 2,200 hours; discontinuous, every 2 years. When operational hours in any year are greater than 2,200 hours; discontinuous, every year or every 4,380 operational hours, whichever is sooner. Following any changes to process equipment, configurations or operating practices that may affect the accuracy of the data generated by the PEMS or CEMS; discontinuous.
		CO	Discontinuous	Minimum of five distinct measurements taken at stable operating conditions. BS EN 15058	
		Oxygen	Discontinuous	Minimum of five distinct measurements taken at stable operating conditions. BS EN 14789	
		Water vapour	Discontinuous	Minimum of five distinct measurements taken at stable operating conditions. BS EN 14790	

Emission Point Ref.	Location	Emission Parameter	Frequency	Technique & standard	Notes
A46 (cont…)	Compressor unit E (LCP No. TBC) (cont…)	SO_2	Discontinuous	Concentration by calculation, every 6 months.	Method as agreed in writing with the Environment Agency.
		Homogeneity	Pre-operation and when there is a significant operational change	BS EN 15259	As required by the Method Implementation Document for BS EN 15259
A47	Lube oil breather vent, unit E	Oil fume	No monitoring proposed, which is consistent with equivalent emissions points on existing units defined in UP3333LL/V004		
A48, A49, A50	Vents from unit E	Process gas			
A51	Unit E unit vent stack	Process gas			
A52, A53	CEMS vents, unit E	Unit E exhaust	Monitoring of unit E exhaust carried out as per A46		
A54	Standby generator exhaust stack	NOx	No monitoring proposed, which is consistent with equivalent emissions points on existing units defined in UP3333LL/V004		
		PM			
		CO			

Emission Point Ref.	Location	Emission Parameter	Frequency	Technique & standard	Notes
		SO_2			
A55	Standby generator diesel tank breather vent	Oil fume	No monitoring proposed, which is consistent with equivalent emissions points on existing units defined in UP3333LL/V004		
N/A	Operation of gas actuated valve vents	Process gas	No change; no monitoring undertaken and none proposed, as per UP3333LL/V004 Any additional unspecified points are similar in nature to existing.		
N/A	Operation of other relief valves where operating pressure is exceeded	Process gas			
N/A	Local exhaust ventilation (LEV) emissions from LERs / workshop / store / amenity areas	None specified			

	Existing		Retiring (LLD)		Removed		Proposed

There are no changes proposed in respect of emissions monitoring provision for emissions to water at the installation, which requires that there are no visible emissions of oils and greases from the drainage interceptor to the receiving environment via emissions point W1 and W2. Similar provisions are proposed for the planned new W3 discharge point. (See Figure 3).

Table C3: 4a-2 Emissions Monitoring Requirements to Water (existing and proposed)

Emission Point Ref.	Location	Emission	Existing Operations	Proposed Operations
			Frequency & technique	Frequency & technique
W1	Drainage channel	Uncontaminated surface water run-off and treated domestic effluent (via interceptor)	No visible emission of oils or greases Visual inspection Daily when site is manned or at frequency of no less than fortnightly Permanent sampling access not required.	No visible emission of oils or greases Visual inspection Daily when site is manned or at frequency of no less than fortnightly Permanent sampling access not required.
W2	Drainage channel	Uncontaminated surface water run-off and treated domestic effluent (via interceptor and or package treatment plant)	No visible emission of oils or greases Visual inspection Daily when site is manned or at frequency of no less than fortnightly Permanent sampling access not required.	No visible emission of oils or greases Visual inspection Daily when site is manned or at frequency of no less than fortnightly Permanent sampling access not required.
W3	*Drainage channel*	*Uncontaminated surface water run-off and treated domestic effluent (via interceptor and or package treatment plant)*	*N/A*	*No visible emission of oils or greases* *Visual inspection* *Daily when site is manned or at frequency of no less than fortnightly* *Permanent sampling access not required.*

Note – Changes are *italicised*

4b - Point source emissions to air only

This section provides an assessment of the sampling locations and facilities which will be used to measure emissions for the CEMS and during periodic extractive tests from the proposed new unit stack. This assessment is based on the requirements and recommendations provided in BS EN 15259 and Environment Agency M1[19]. The proposed sampling techniques/facilities are assessed against the main criteria below.

[19] Environment Agency Technical Guidance Note (Monitoring) M1 (2010), now superseded by online resource 'Guidance: Monitoring stack emissions: measurement locations'

C3: 4b-1 BS EN 15259 / TGN M1 Assessment – sampling requirements for proposed new plant

M1 Characteristic	BS EN 15259 relevant clauses	Requirement	Commentary
Sample plane location	6.2	As far downstream or upstream from any disturbance, which could produce a change in direction of flow (e.g. bends, fans)	Sampling ports are installed on a straight section of stack, substantially downstream of the 90 degree bend where the horizontal hot gas ductworks enters the stack and also the exhaust gas silencer. The sampling point is also sufficiently upstream of the stack termination point. The engine OEM designed and specified the stack and sampling configuration to meet the requirements of TGN M1 and the selected design approach is proven in use. Due to the large hydraulic diameter of the stack (2.8m) it is not practical or necessary to achieve the recommended number of diameter distances from the identified sources of disturbance. For example a sampling point located to achieve 5 hydraulic diameters from the tip would necessitate a further ~9m on the stack; this would result in unacceptable backpressure on the engine and would not have been permitted at the site location under local development planning rules. A constant cross-sectional area is present within the flues.
	6.2	In a section of duct with constant shape and cross sectional area	
	6.2	Recommend five hydraulic diameters upstream and two hydraulic diameters downstream (or five hydraulic diameters from the top of the stack)	
Sample plane orientation	6.2	Installation of sample plane in vertical stacks is preferred to horizontal ducts	The sampling plane is vertical
Exploratory survey	6.2	It is advised that an exploratory velocity traverse is carried out before committing to installation	The design and safety case necessitates installation of the ports and definition of the sampling locations prior top erection at site. An exploratory survey will be undertaken as part of the commissioning process, in the form of a homogeneity test in line with the requirements set out in BS EN 15259.
Flow criteria	6.2	Angle of gas flow less than 15° to duct axis	The engine OEM designed and specified the stack and sampling configuration to meet the requirements of TGN M1 and the selected design approach is proven in use. No particulate sampling is proposed due to the use of natural gas fuel.
	6.2	No local negative flow	
	6.2	Minimum velocity (a differential pressure of 5Pa, which equates to 3 ms-1)	
	6.2	Ratio of the highest to lowest gas velocity less than 3:1	

M1 Characteristic	BS EN 15259 relevant clauses	Requirement	Commentary
Measurement ports	6.2	Planned at design stage because retrofitting can be expensive (for example ducts may have protective linings)	The number, location and type of measurement ports are being designed having regard to TGN M1. Two sampling ports on perpendicular sampling planes are proposed.
	6.2	Allows access to sample points	The ports will be accessible via the platform for maintenance.
	Annex A	It is recommended that access ports have a minimum diameter of 125mm. For small stacks (less than 0.7m diameter) a smaller socket (for example 75mm may be necessary)	Sample ports have been sized appropriately to the equipment to be used for monitoring. This is typically conducted in-house by National Gas Transmission's MCERTS / UKAS accredited mobile emissions testing team.
	-	The port socket must not project into the gas stream	The number, location and type of measurement ports are being designed having regard to TGN M1.
	Annex B	Additional ports may be required to allow access for measurement of other quantities (for example velocity and water vapour)	Sufficient ports are provide to facilitate the continuous and discontinuous monitoring requirements.
	6.2	Additional ports may be required for CEMs	Sufficient ports are provide to facilitate the CEMS requirements.
	6.2	For large ducts four ports may be necessary	Sufficient ports are provide to facilitate the continuous and discontinuous monitoring requirements.
	6.2	For rectangular ducts the ports should be installed on the longer side	N/A
	-	The operator must maintain the ports in good condition and free them up prior to work being undertaken	The compressor installation and PEMS/CEMS system will be subject to a comprehensive maintenance programme.
Identification	6.2	Clearly identified and labelled measurement section	The ports will be clearly identified.
Load bearing capacity	6.2	Permanent and temporary working platforms must have a load bearing capacity sufficient to fulfil the measurement objective	A permanent working platform will be provided; the structure is being designed for appropriate loading for all sampling and maintenance activities.

M1 Characteristic	BS EN 15259 relevant clauses	Requirement	Commentary
	6.2	Some measurement objectives may require platforms that support up to six people plus up to 300 kg weight of equipment	
Position and working space	6.2	Sufficient working area to manipulate probe and operate the measuring instruments, without equipment overhanging guardrails	A suitable working platform will be provided, which will facilitate the use of probes without overhanging guardrails. The working area has being designed to provide safe and effective sampling.
	6.2	A sufficient depth of the working area is given by the internal diameter or depth of the duct and the wall thickness plus 1.5 m	
	6.2	If two opposite measurement ports are installed for one measurement line, a correspondingly smaller working area is required	
	6.2	Its recommended that vertical ducts have a working height from the platform to the ports of 1.2 to 1.5m	
	6.2	Provision of dual level sampling platform. These are necessary if the selected sample plane is located in a horizontal section of a large rectangular duct, and some of the sample points are positioned above a convenient and safe working height (nominally 1.5m maximum for sample probe handling).	N/A
	-	Removable chains or self-closing gates at the platform to prevent workers falling through access hatches or ladders.	A detailed Safe Working Design Study will be completed to understand potential risks associated with undertaking sampling; this will determine any specific additional requirements such as safe closing mechanisms.
	-	Prevent accumulation of free-standing water and, if necessary, provide drainage.	A grid surface will be provided which will allow free draining of any rainwater.

M1 Characteristic	BS EN 15259 relevant clauses	Requirement	Commentary
Fall prevention	-	Upper hand rails at a minimum of 950mm (910mm allowed for old handrails). Gaps in rail no bigger than 470mm. Toe boards required	Fixed guard rails will be provided on the stairs and platforms. A detailed Safe Working Design Study will be completed to understand potential risks associated with undertaking sampling; this will determine any specific additional requirements such as handrail gaps and personal protection requirements.
	-	Consider installing personal protection systems on vertical ladders	
Access	6.3	Easy and safe access available	A permanent staircase will be provided rather than ladder access, as required by National Gas Transmission's safety standards.
	-	Consider installing work restraint systems on vertical ladders	
Power supply	6.3	Single phase 110V electrical power of a suitable current provided by a suitable number of outdoor waterproof sockets at the platform	Adequate and safe electrical supply provisions will be made.
Lifting equipment	6.3	Lifting systems for raising and lowering of equipment, where access to the sampling platform is by vertical, or steeply inclined, ladders or stairs	A davit arm provision is being made to assist safe lifting. All fixed infrastructure is subject to formal National Gas Transmission inspection and maintenance provisions.
	-	Lifting systems (for example, hoists) and attachments (for example, eyes) must be inspected and maintained by a competent person	
	-	Installation of a support structure for securing portable lifting systems (handrails are not usually suitable for supporting lifting systems)	
Monorails	-	Consider sampling monorails above the sampling ports to enable certain designs of sampling train to be suspended	Not applicable
Exposure to gas	6.3	Avoid areas of sources which emit unexpectedly, for example rupture discs, overpressure valves and steam discharges	Compliant

M1 Characteristic	BS EN 15259 relevant clauses	Requirement	Commentary
Exposure to stack gas	6.3	Avoid areas of significant positive pressure	Entire gas turbine exhaust stack under positive pressure due to efflux velocity / volumetric flow associated with engines of this type. Sampling is external, but personnel will be located at ground level during the majority of the test runs.
Awareness	6.3	Consider how stack emission monitoring personnel are informed of operating faults that may endanger them?	Stack emissions tests are typically conducted in-house by National Gas Transmission's MCERTS / UKAS accredited mobile emissions testing team who are very familiar with gas turbine emission testing; other appropriately experienced contractors may also be utilised. All studies would be under a permit to work scheme, which includes a detailed Risk Assessment and Method Statement (RAMS).
Indoor location	-	Consider locating working platform within a building	Not applicable – external
Ventilation	-	Well ventilated	Not applicable – external
Heat and dust	6.3	Protection of the working area from heat and dust	Stack is insulated to reduce the temperature of the external surface to safe levels
Weather protection	6.3	Protective measures (for example, weather protection and heating to ensure conditions are appropriate for personnel and equipment)	None required
Lighting	-	Artificial lighting or facilities for temporary lighting	Emissions testing would be conducted as far as possible during daylight; RAMS would need to define any lighting requirements and their appropriate safe provision.

EP Form: Part C3: Question 6a – Describe the basic measures for improving how energy efficient your activities are

Energy efficiency is a major driver in respect of compressor operations on the NTS, and National Gas Transmission are required under the Gas Act 1995 to operate an efficient pipeline transport system. Given that energy efficiency of operations is inherently linked in with choice of compressor driver, it is considered that this aspect is addressed adequately through selection of appropriate compressor driver options. National Gas Transmission has limited capability to influence the way the compressor fleet is operated due to obligations to make available capacity regardless of the source and volume of gas the shipping community chooses to input based on their requirements. Fuel consumption and associated emissions of CO_2 were key factors in the BAT assessment (Appendix 6) forming a key component of the whole life cost and environmental aspect of the environmental-technical score; it should however be noted that the primary driver for this project was reduction in emissions on NOx and CO, not to delivery energy efficiency improvements. As explained below, modern turbine DLE emission control systems achieve their significant emissions reductions at the expense of realising the full potential energy efficiency gains associated with modern gas turbine designs.

The proposed implementation of the new Siemens SGT-750 compressor machinery train will allow increased efficiency of energy use at the installation due to a number of factors:

- Increased thermal efficiency of modern gas turbine engines, compared to the existing RB211 engines. It should be noted that the principle of operation (flame combustion temperature reduction through lean premixing of fuel and combustion air) inevitably has counter-efficiency effect compared to SAC type engines (such as the RB211) where higher flame temperatures promote complete combustion and higher efficiency. For this reason, low emissions performance via DLE systems and high engine thermal efficiency gains cannot be realised together. The stated gas turbine efficiency at ISO conditions for the SGT-750 unit is 41.55%; this compares to a thermal efficiency (when new) of 36% for an RB211-24C gas turbine, or approximately 32% assumed in operation at Hatton.
- The combined compressor machinery package (gas turbine, power turbine and centrifugal compressor) offer a more significant overall package energy efficiency gain, due to improvements in power turbine and centrifugal gas compressor design, combined with good speed matching between the power turbine and gas compressor and good compressor envelope matching to site process duty points. The overall efficiency of the Siemens STC-SV (17-2-A) gas compressor (as stated by the OEM) is up to 87.5% (depending on process duty points); efficiency of the current compressors is unlikely to exceed 80% (depending on process duty points).
- Lube oil heat recovery for fuel gas pre-heating prior to pressure let down on the fuel gas skid. Electric heating will still be required for a cold start, but when running at normal operating temperature no further supporting energy input will be required. The existing RB211 unit A will continue to use a gas fired water bath heat exchanger for fuel gas pre-heating.
- Opportunities to make improvements in energy efficiency associated with buildings and enclosures (for example through use of LED luminaires) have been considered through a series of BAT reviews during the design stage.

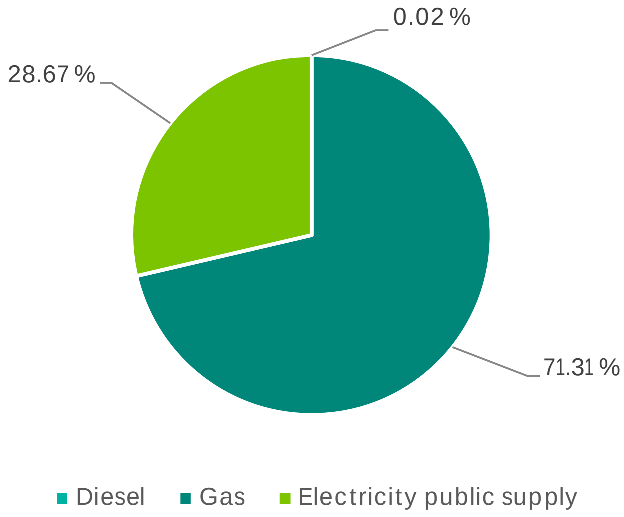
It should be noted that due to the complexity of all modern gas turbine compressor machinery packages, which utilise computer control and engine management systems, the electrical demand is considerably higher during normal operations, compared to older aero-derivative type engines, such as the RB211. Any such increase in electrical load demand is substantially outweighed by the combustion and compressor efficiency gains described above.

EP Form: Part C3: Question 6b – Provide a breakdown of any changes to the energy your activities use up and create

Figure C3.1 outlines typical energy consumption within the Hatton Compressor Station before the installation of the new compressor machinery. These figures are an average of 2021 and 2022 reporting data. The inherent variability associated with utilisation of the compressor drivers will still be the major determining factor in comparing energy consumption in any given year to another; energy consumption will ultimately be determined by National Gas Transmission's statutory gas obligations, which can vary significantly year on year. External geopolitical factors can also be a substantial influencer with Hatton station usage recently increasing in a support function associated with transfer of gas to continental Europe. The balance between electricity and gas used for compressor driver operation at Hatton will also vary in future depending on load patterns, optimising efficient plant selection and unit availability. In recent years the use of the VSD (unit D) has seen increased running, in preference to the older RB211 units A, B and C as hours have been conserved under the LLD rules. With the new LCP compliant BAT unit E available, GNCC will have increased flexibility to select and optimise the lead unit (between units D and E) for the given gas conditions.

In terms of direct comparison between the older RB211 units and the proposed new unit E, for any given operating hour, electricity use will increase marginally due to the additional engine electrical loads associated with modern industrial turbines, and the use of compressed air systems for instrumentation and certain on-skid valves. Furthermore the increased site area will introduce additional loads (additional power (electrified) fencing and lighting); these cannot be quantified accurately at this stage but will form part of routine future energy reporting under the permit. Energy usage is monitored and reported under several permitting and consenting regimes, and this will continue.

Figure C3.1 Typical primary energy consumption within the current installation



The typical energy consumption at the site for current operations is provided in Table 6b.

Table 6b(i) Typical energy consumption

Energy source	Energy consumption		
	Delivered (MWh)	Primary (MWh) [4]	% of total (Primary)
Electricity public supply [1]	14,507.84	37,720.37	28.67
Natural gas [2]	93,825.12	93,825.12	71.31
Diesel [3]	27.30	27.30	0.02
Total	108,360.26	131,572.79	100.00

Notes

1 Existing electricity consumption is based upon average site usage for the last two complete years (2021 – 2022, inclusive).

2 Existing gas consumption based on a two-year average from 2021 – 2022, inclusive. Comprises fuel gas and minor gas usage.

3 Existing diesel consumption based on a two-year average from 2021 – 2022, inclusive.

4 Delivered to primary conversion factor of 2.6 has been applied to electricity from the national grid (Climate Change Levy (CCL) conversion factor).

Global warming potential

Carbon dioxide (CO_2), a greenhouse gas, is emitted directly from the operation of the gas turbine driven compressors and indirectly through the use of electricity on the site in the VSD and other site consumers. Process gas (methane) emissions also directly contribute to the site's global warming potential (GWP).

The total GWP has been derived by calculating the total CO_2 emissions from the overall gas and electricity consumption together with the carbon dioxide equivalent (CO_2e) of methane releases. The results are illustrated in Table 6b(ii).

Table 6b(ii) Global warming potential

Substance	Energy source	Consumption (KWh)	Emission factor (kg CO_2 per KWh)[6, 7, 8]	Mass released (tonnes per year)	Global Warming Potential	Overall Global Warming Potential (tonnes CO_2 per year)
Carbon dioxide equivalent (CO_2e)	Electricity public supply[1]	14,507,835.00	0.19338	2,805.5251	1	2,805.53
	Natural gas fuel[2]	92,727,246.89	0.20227	18,755.9402	1	18,755.94
	Gas minor uses[3]	1,097,874.99	0.20227	222.0672	1	222.07
	Diesel[4]	27,301.12	0.26939	7.3546	1	7.35
	Methane[5]	n/a	n/a	109.0572	25	2,726
	Total					24,517

Notes

1 Existing electricity consumption is based upon average site usage for the last two complete years (2021 – 2022, inclusive).

2 Existing fuel gas consumption based on a two-year average from 2021 – 2022, inclusive.

3 Existing minor gas usage consumption based on a two-year average from 2021 – 2022, inclusive; minor gas consumption is primarily water bath heater usage and domestic heater usage. The site is planning to move to electrical heating for domestic uses in future.

4 Existing diesel consumption based on a two-year average from 2021 – 2022, inclusive; diesel consumption usage is standby generators, mobile air compressors and pressure washers.

5 Existing methane direct emissions, five-year average from 2021 – 2022, inclusive. Updated 2015 DEFRA Global Warming Potential (GWP) of 25 for methane used.

6 Electricity public supply conversion factor for Electricity generated factor for kwh/Total kg CO2e per unit obtained from UK Greenhouse gas reporting: conversion factors 2022, https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2022 (UK electricity worksheet), accessed on 04 May 2023.

7 Natural gas conversion factor for Natural gas kWh (Net CV)/Total kg CO2e per unit obtained from UK Greenhouse gas reporting: conversion factors 2022, https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2022 (Fuels worksheet) , accessed on 04 May 2023.

8 Diesel conversion factor for Diesel (100% mineral diesel) kWh (Net CV)/Total kg CO2e per unit obtained from UK Greenhouse gas reporting: conversion factors 2022, https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2022 (Fuels worksheet), accessed on 04 May 2023.

The forecast GWP is a small percentage of the total GWP estimated from the UK emissions of 426.5 million tonnes carbon dioxide equivalent ($MtCO_2e$) per year in 2021[20]. The GWP calculated for operations of the site is less than 0.006% of the UK GWP from carbon dioxide.

20 Department for Business, Energy & Industrial Strategy (BEIS). Statistical release: 2021 UK Greenhouse Gas Emissions, Final Figures, 7th February 2023

EP Form: Part C3: Question 6c – Have you entered into, or will you enter into, a climate change levy agreement?

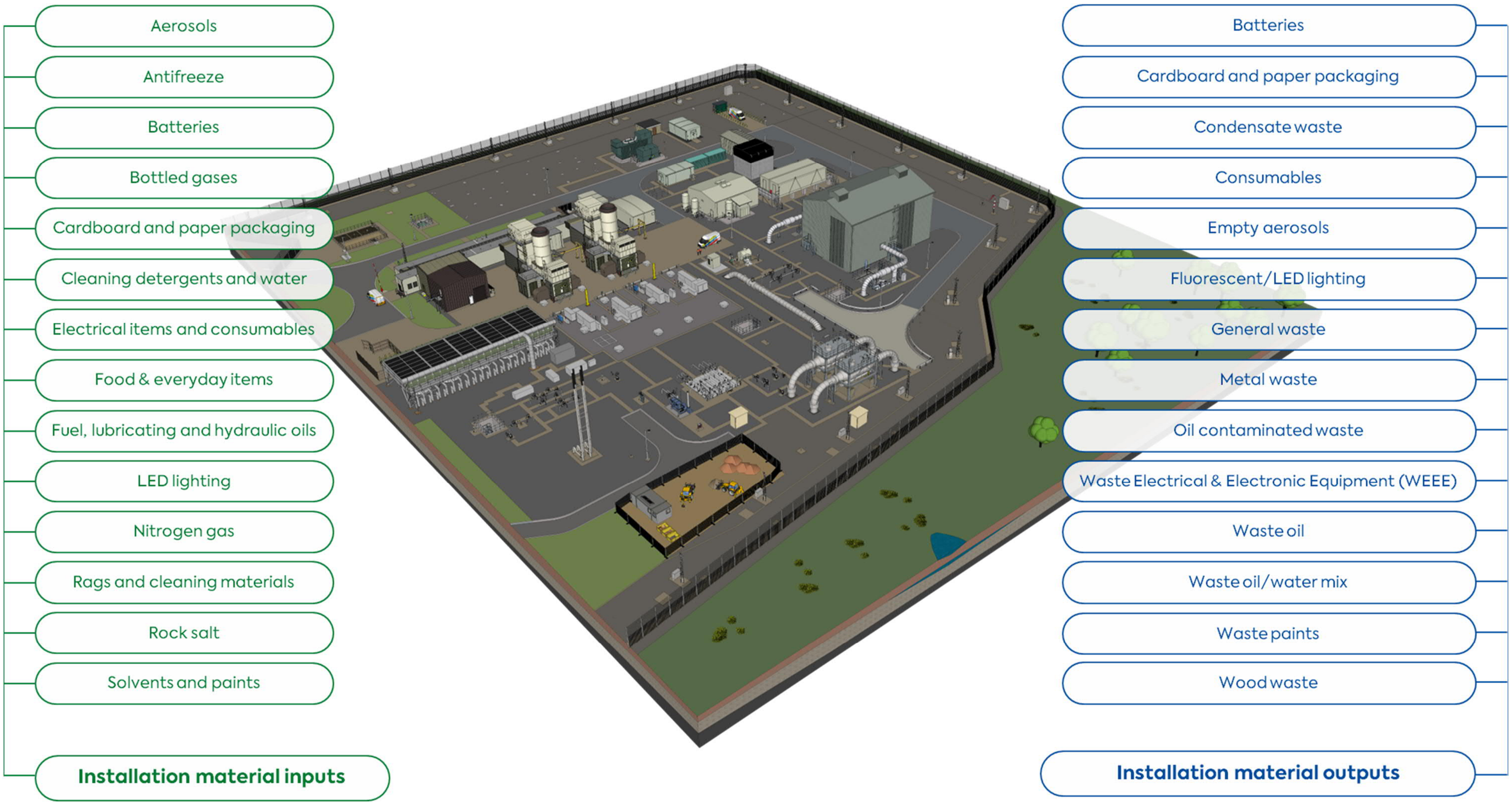
No. The Hatton installation remains subject to permit under the United Kingdom Emissions Trading System (UK ETS).

EP Form: Part C3: Question 6d – Explain and justify the raw and other materials, other substances and water that you will use

There are no significant changes to raw materials selection, handling or quality assurance procedures in use at the installation since the original permit was issued. All existing commitments in respect of improvements to raw materials selection and usage remain unchanged. As described in the original PPC application, due regard has been given to maximising material usage efficiency in design of the proposed plant and equipment. The raw materials associated with the new equipment are the same or similar to the raw materials currently used at the installation. There is a change in overall number of operational units from four to three, albeit it one of those (unit E) being substantially larger than the existing units (A, B and C). On this this basis, overall raw material usage is not anticipated to materially alter as a result of the changes proposed to the installation.

Resource utilisation reviews are periodically carried out by National Gas Transmission, the most recent being in December 2022. National Gas Transmission commits to undertaking an updated resource efficiency review following commencement of normal operations at the site in the new configuration (See Proposed Improvement Programme). Principal material inputs and outputs are illustrated in Figure C3.3.

Figure C3.3 Indicative principal material inputs and outputs associated with the installation



EP Form: Part C3: Question 6e – Describe how you avoid producing waste in line with Council Directive 2006/12 EC on waste

There are no proposed changes to the original application in terms of waste minimisation. National Gas Transmission will continue to work to minimise waste produced on the installation where the strict constraints allow. Waste Minimisation Audits are carried out periodically by National Gas Transmission; the most recent being completed in 2022 (and submitted to the EA).

There are no significant changes predicted to waste generation from the installation as a result of the proposed changes. The nature and volumes of waste materials are anticipated to be similar, despite the addition of the new compressor machinery trains.

A summary of the waste generated as a result of the activities associated with the new compressor and machinery train is provided in Table C3 6e-1 below.

Table C3 6e-1 – Waste Streams

Waste Type	Nature of material	Storage arrangements	Treatment / disposal method	Annual production
Waste oil	Hazardous	Stored in existing designated location within the installation prior to removal.	Collected by approved waste contractor for off-site disposal.	No material change in quantities generated in predicted.
General waste	Non-hazardous	Dedicated skips and smaller containers, located at designated points within the installation.	Collected by approved waste contractor for off-site disposal.	
Empty drums and intermediary containers	Non-hazardous	Stored in designated locations within the installation prior to removal.	Collected by approved waste contractor for off-site disposal.	
Oil contaminated absorbents	Hazardous	Dedicated containers within designated area prior to removal.	Collected by approved waste contractor for off-site disposal.	
Turbine wash water	Hazardous (oily water with surfactants)	Compressor skid fully bunded, no drains in compressor skid enclosure, dedicated mobile washing equipment used with discharges collected during washing and transferred to a 1,000 litre bunded tank inside the outer cab enclosure.	Collected by approved waste contractor for off-site disposal.	
Continuous emissions monitoring system (CEMS) Condensate	Non-Hazardous (mildly acidic water)	Collected in a dedicated container (c. 5 litres) with level detection, mounted internally in the analysis cabinet.	Periodic manual transfer to the waste wash water tank in the cab, from where it will be disposed of off-site.	Maximum of 200 litres per year.

EP Form: Part C3: Appendix 1 – Specific questions for the combustion sector

1 Identify the type of fuel burned in your combustion units

Type of fuel	When run as normal	When started up	When shut down
New gas turbine compressor (unit E), retained gas turbine compressor unit A			
Natural gas	Yes	Yes, fired on gas	Yes
New diesel standby generator, retained diesel standby generator			
Gas oil (Class D for stationary installations)	Only used to fuel standby generator which will only typically be required in the event of interruption of the electricity supply and for testing.	Yes (generator start-up)	Yes (generator shutdown)

2 Give the composition range of any fuels you are currently allowed to burn in your combustion plant

Fuel use		
Parameter	**Natural gas**	**Diesel**
Maximum percentage of gross thermal input	100% (gas turbines)	100% (used to fire the standby generators)
Natural Gas Analysis		
Component	*Concentration (mol%)*[1]	*Uncertainty (mol%)*
Nitrogen	2.0082	0.0139
CO_2	1.2599	0.0055
Methane	90.46077	0.2442
Ethane	4.4671	0.0054
Propane	1.1311	0.0021
iso-butane	0.2123	0.0048
n-butane	0.2169	0.0074
neo-pentane	0.0033	
iso-pentane	0.0642	0.0035
n-pentane	0.0521	0.0021
Cyclopentane	0.004	
Hexanes	0.0448	0.0066
Methylcyclopentane	0.0097	
Benzene	0.0189	
Cyclohexane	0.0152	
Heptanes	0.0135	
Methylcyclohexane	0.0105	
Toluene	0.0047	
Octanes	0.0028	
Nonanes	0	
Decanes	0	
Undecanes+	0	
Hydrogen sulphide	0.00003	0.0000008

Notes:
[1] Gas analysis provided is based on a sample from Aylesbury fuel gas system; actual composition will vary slightly by location due to natural variation in source (Source: GL Noble Denton)

3 If NOx factors are necessary for reporting purposes (that is, if you do not need to monitor emissions), please provide the factors associated with burning relevant fuels

Not applicable; PEMS calculated figures used (unit A and E), CEMS monitoring (unit E).

6 If you run more than one type of plant or a number of the same type of plant on your installation, please list them in the table below

Type of Plant	LCP Status	Number within Installation
Rolls-Royce (Siemens) RB211-24C	Existing	Current: 3 (units A, B and C) Future: 1 (unit A retained under LCP emergency use derogation, units B and C to be retired under LCP LLD)
Siemens SGT-750	New-new	Unit E

12 Have you carried out a cost–benefit assessment (CBA) of opportunities for cogeneration (combined heat and power) or district heating under Article 14 of the Energy Efficiency Directive?

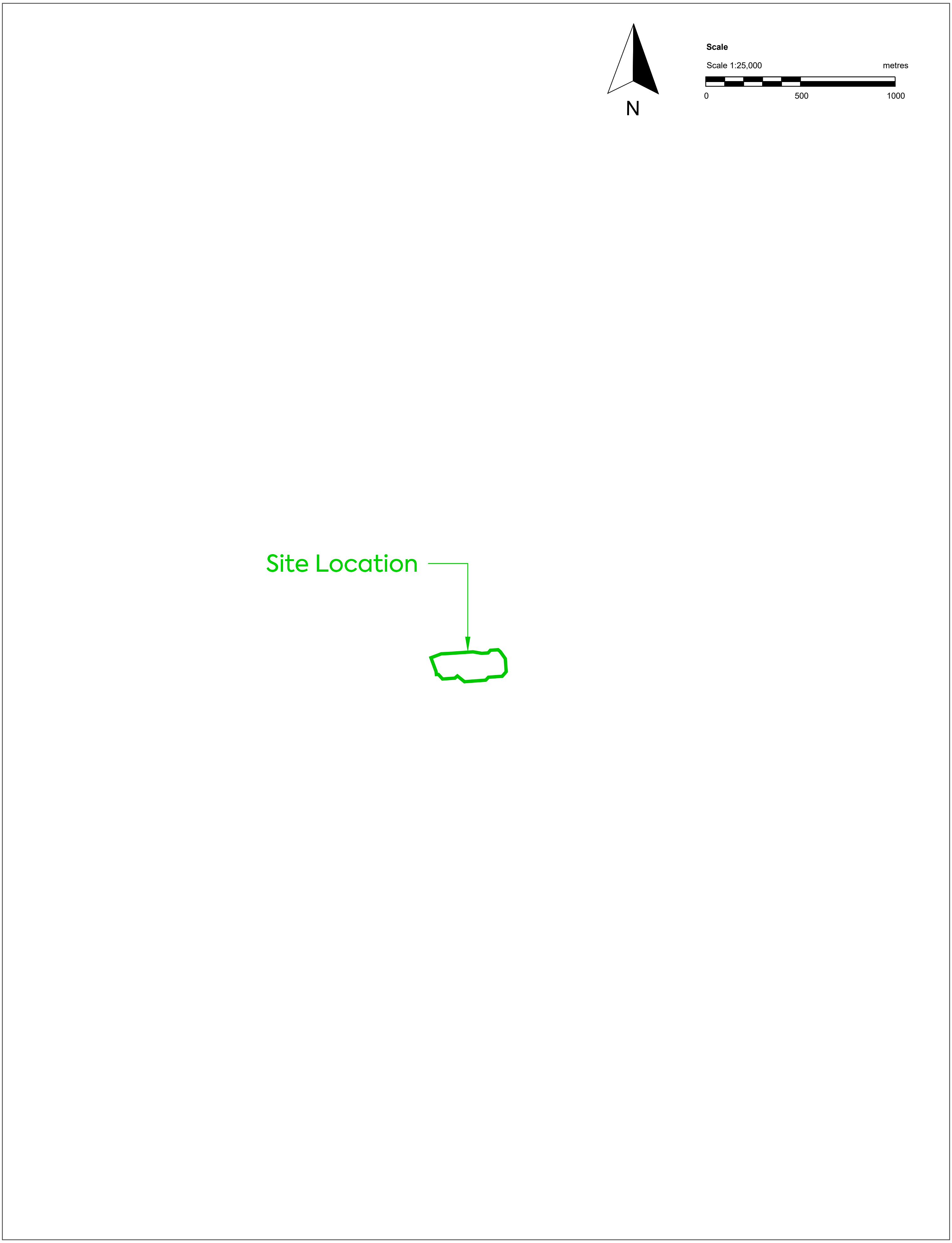
Opportunities for co-generation (combined heat and power) are not viable for existing or new LCP at Hatton Compressor Station for a range of technical and regulatory reasons. These are summarised below:

Technical considerations	Regulatory considerations
• Open cycle mechanical drive only, no generation set installed. • No steam or water circuits. • Sporadic operation, unreliable for heat users. • Intentionally located away from higher density residential populations for safety reasons. • No nearby industrial heat users. • Site heat demand is low, new unit will include heat recovery for fuel gas treatment.	• Gas transporter license prohibits the export of energy. • Ofgem funding approval only facilitates value-based investment for gas transport customers. • Critical National Infrastructure, legislative gas supply obligations would prohibit any non-core activities. • Any costs associated with additional fuel use to maximise heat yield could not be passed through under gas transporter licence.

Section IV: Figures

Figure 1: Site Location Plan

national gas transmission



national gas transmission

Project Environmental Solutions

Date	May 2023
Revision	FINAL (Rev 0)
Scale	1:25,000 @ A4
PESL No.	NGT.036.b

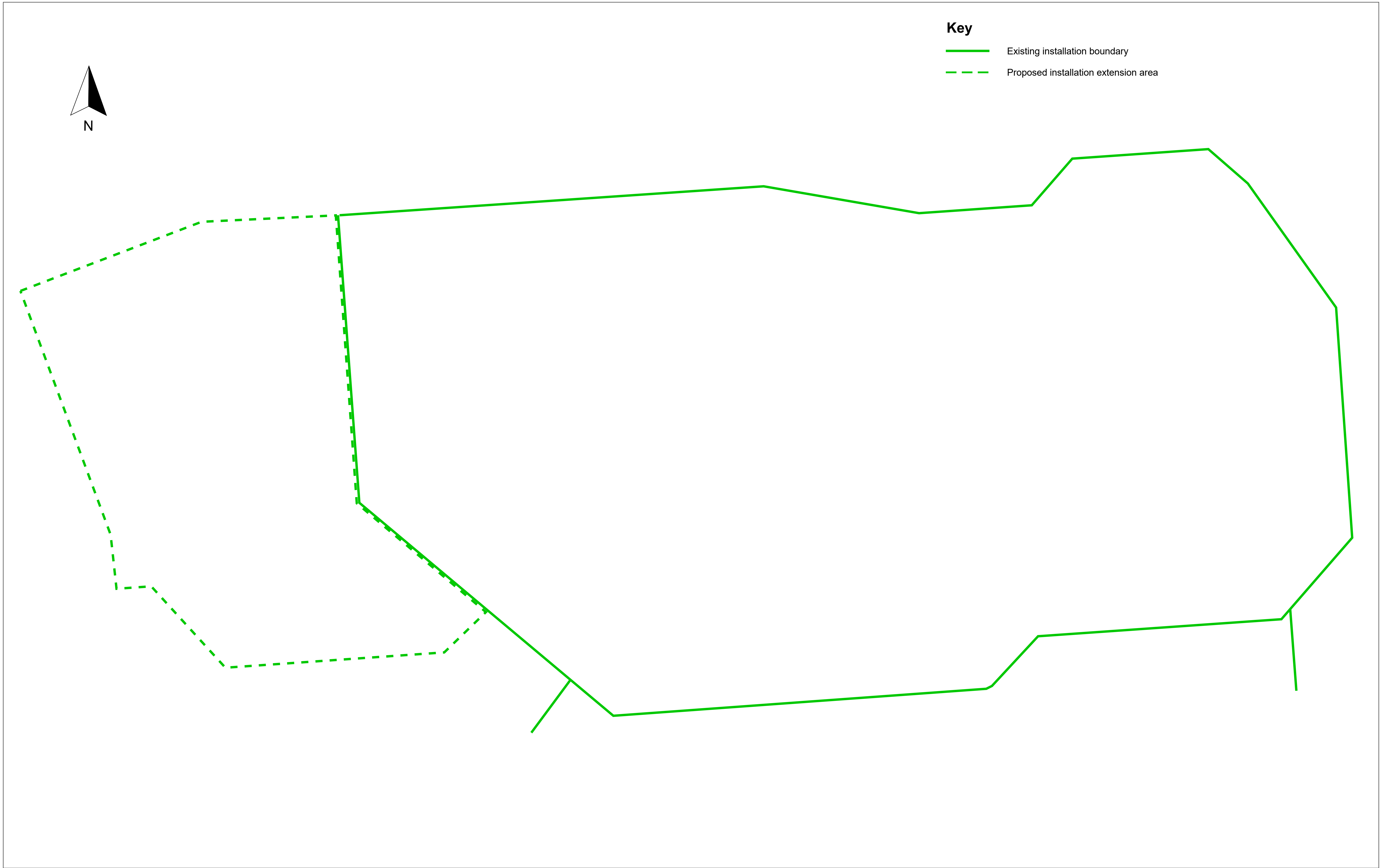
Project

Hatton Compressor Station - Application for an Environmental Permit Variation

Drawing title

Figure 1: Site location plan

Figure 2: Installation Layout, key activities and installation boundary



Scale

Scale 1:1000

0 10 20 30 40 50 100
metres

national gas transmission

Project Environmental Solutions

Date	May 2023
Revision	FINAL (Rev 0)
Scale	1:1,000 @ A3
PESL No.	NGT.036.b

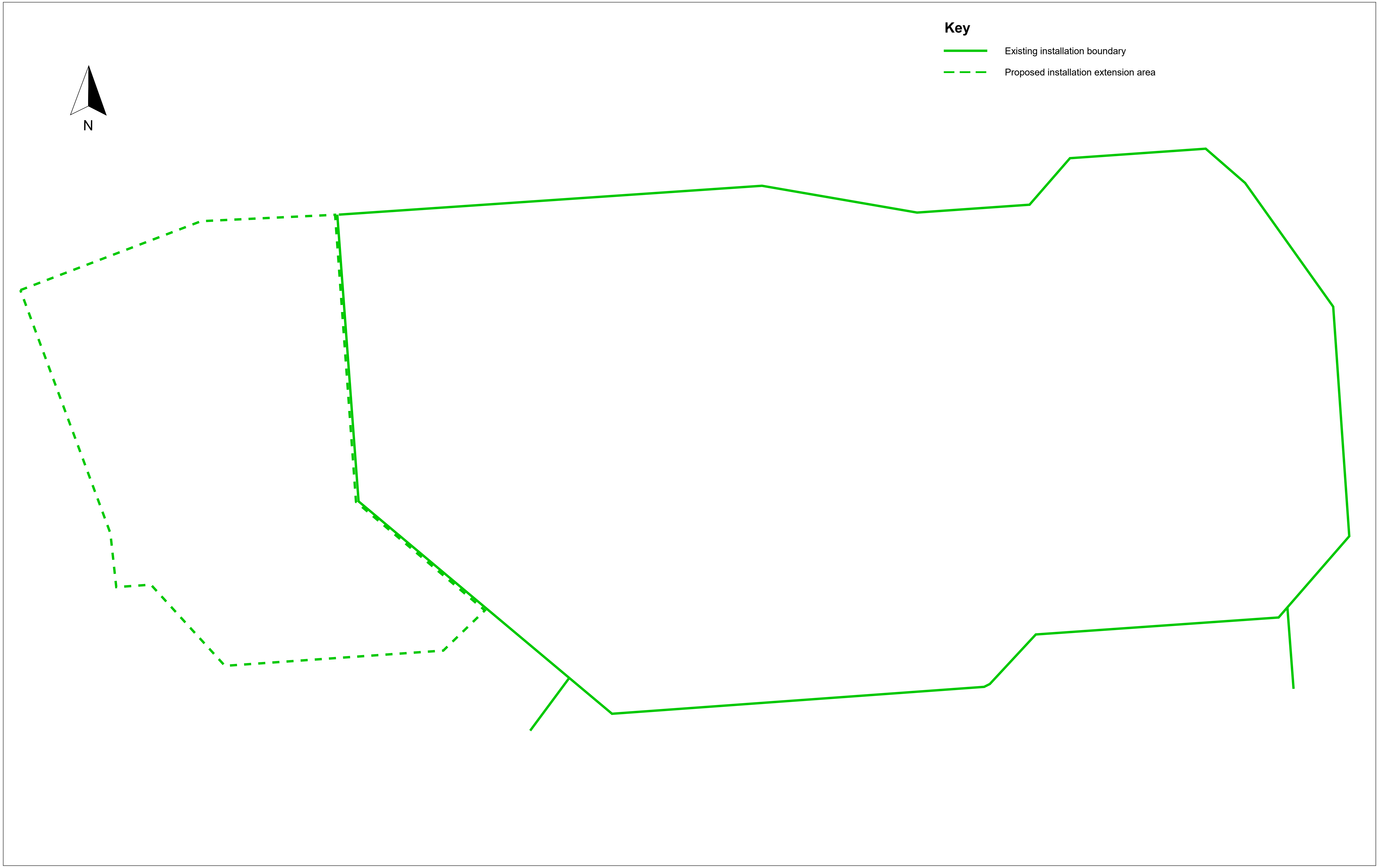
Project

Hatton Compressor Station - Application for an Environmental Permit Variation

Drawing title

Figure 2: Installation layout

Figure 3: Installation layout showing principal release points



Scale

Scale 1:1000

0 10 20 30 40 50 100

metres

national gas transmission

Project Environmental Solutions

Date	May 2023
Revision	FINAL (Rev 0)
Scale	1:1,000 @ A3
PESL No.	NGT.036.b

Project

Hatton Compressor Station - Application for an Environmental Permit Variation

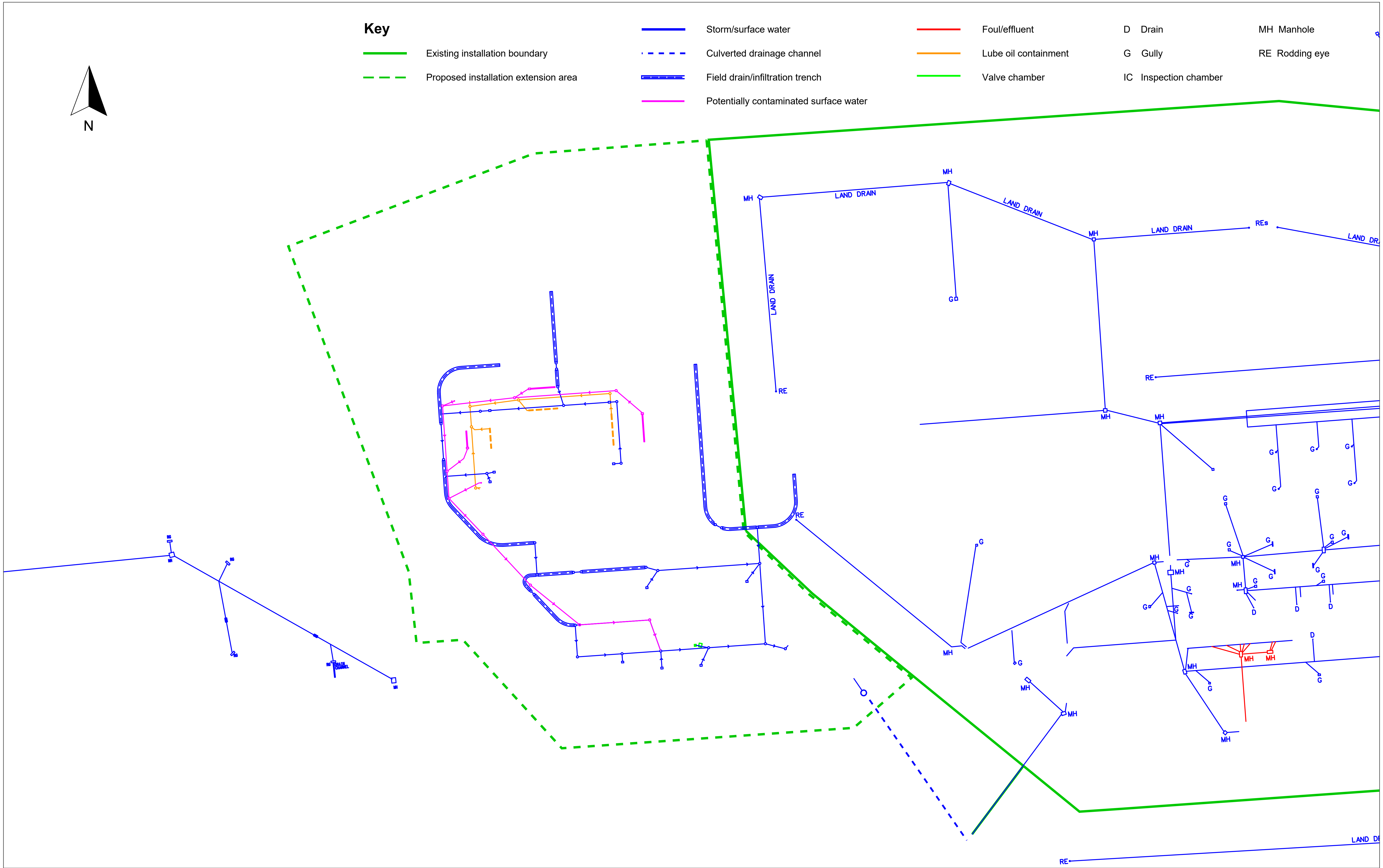
Drawing title

Figure 3: Installation layout showing key emission points

Figure 4: Site drainage plan

Key

Existing installation boundary	Storm/surface water	Foul/effluent	D Drain	MH Manhole
Proposed installation extension area	Culverted drainage channel	Lube oil containment	G Gully	RE Rodding eye
	Field drain/infiltration trench	Valve chamber	IC Inspection chamber	
	Potentially contaminated surface water			



Scale

Scale 1:750 metres

0 10 20 30 40 50

national gas transmission

Project Environmental Solutions

Date	May 2023
Revision	FINAL (Rev 0)
Scale	1:750 @ A3
PESL No.	NGT.036.b

Project

Hatton Compressor Station - Application for an Environmental Permit Variation

Drawing title

Figure 4: Site drainage plan

Section V: Appendices

Appendix 1: Certificate of Incorporation

National Grid House
Warwick technology Park
Gallows Hill, Warwick
CV34 6DA

+44 (0) 1926 65 3000
nationalgas.com

To Whom It May Concern

7 February 2023

This is to confirm that on 6 February 2023, National Grid Gas plc changed its name to National Gas Transmission plc. Enclosed is the Certificate of Incorporation on Change of Name issued by Companies House.

Yours sincerely

Sofia Bernsand
Company Secretary
National Gas Transmission plc

CERTIFICATE OF INCORPORATION
ON CHANGE OF NAME

Company Number 2006000

The Registrar of Companies for England and Wales hereby certifies that under the Companies Act 2006:

NATIONAL GRID GAS PLC

a company incorporated as public limited by shares, having its registered office situated in England and Wales, has changed its name to:

NATIONAL GAS TRANSMISSION PLC

Given at Companies House on **6th February 2023.**

The above information was communicated by electronic means and authenticated by the Registrar of Companies under section 1115 of the Companies Act 2006

Companies House

REGISTRAR OF COMPANIES FOR ENGLAND AND WALES

THE OFFICIAL SEAL OF THE REGISTRAR OF COMPANIES

Appendix 2: Site condition report

Site Condition Report, Extension to Hatton Gas Compressor Station

National Gas Transmission plc

May 2023

Project Environmental Solutions
www.peslconsulting.com

Quality control sheet

Project details

Project number	NGG.036.b
Project name	Hatton Compressor IED upgrade
Date	24 May 2023

Client details

Client contact	Matthew Wilson
Client name	National Gas Transmission plc
Client address	Warwick Technology Park Gallows Hill Warwick CV34 6DA

Document details

Document title	Hatton_SCR_Final_vISSUE_PR
Document version	Final_vISSUE
Review author	Alan White
Reviewed by	Philip Smith
Approved by	Philip Smith
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Contents

Executive summary

This document presents the Site Condition Report (SCR) for an extension to the Hatton Compressor Station operated by National Gas Transmission Plc (NGT), it forms part of an application to the Environment Agency (EA) for a permit variation to operate a new gas turbine driven compressor and related activities under the Environmental Permitting (England and Wales) Regulations 2016 (EPR).

The role of the SCR is to document the baseline conditions present at the start of the permit variation, assess the likelihood of ground contamination occurring during the life of the permit, and to prevent and control contamination of the ground during operation of the permitted activity. The compressor station already has an Environmental Permit, as such this SCR is to be presented as an addendum to incorporate the installation extension area.

This assessment has involved a desk study review, including records of site reconnaissance and intrusive investigation and has been produced in accordance with the EA's Technical Guidance Note, H5 (2013). Records of the site and surrounding area have been reviewed in order to describe the condition of the installation extension and, in particular, to identify any substance in, on or under the land that may constitute a pollution risk to land or groundwater. Pollution prevention measures have been identified and an assessment of pollution potential to land has been undertaken. This information has been used to produce a conceptual model.

The main findings of the SCR are as follows:

- Permitted activities involve operation of a new gas turbine compressor on an area of land adjacent to the existing compressor station, the new operations will be undertaken on land which is an extension to the existing installation – the "installation extension".
- A drainage channel is present within south eastern corner of the installation extension which joins further surface water features to the south forming part of the Tile House Beck catchment. The surface water features represent receptors at potential risk of pollution. The Water Framework Directive assessment for the catchment area indicates an overall Moderate quality for the 2019 assessment (EA, 2023).
- Superficial geology underlying the installation is comprised of low permeability Till which is classified as a Secondary (undifferentiated) Aquifer.
- The underlying solid geology comprises of Kimmeridge Clay Formation, also low permeability and from a groundwater perspective is classified as Unproductive.
- Groundwater has not been identified in shallow strata beneath the installation extension, although locally perched and discontinuous groundwater has been identified in the vicinity. Any groundwater is unlikely to be in hydraulic continuity with surface waters in the area.
- The installation extension is not within a Drinking Water Safeguard Zone and is not located within a groundwater Source Protection Zone (EA, 2023).
- The installation extension area has never been developed but has formed part of the landholding for the surrounding gas compressor station since the 1970s with below ground gas transmission infrastructure crossing the area. The area has been used for storage of soil arisings from previous construction phases at the compressor station, the arisings have been removed from site following sampling which confirmed the absence of contamination. The conceptual site model has identified potential pollutant linkages which pre-date the proposed environmental permit variation as well as those associated with the extension.

Results of an intrusive ground investigation have been used to determine conditions prior to operation of the new activities under the environmental permitting regime, this has been supplemented, where appropriate, with data from previous ground investigations.

The SCR confirms that the installation presents a moderate/low to low risk[1] of future pollution occurring at the installation as a result of the storage and use of raw materials and wastes under the proposed permit, given the proposed management practices and mitigation measures, which effectively manage the risks to the identified receptors.

[1] CIRIA C552 Contaminated Land Risk Assessment: A guide to good practice

1 Introduction

This document supports the permit variation application made under the Environmental Permitting Regulations 2016 (England & Wales) (EPR), as amended, to operate the Hatton Compressor Station which is operated by National Gas Transmission Plc (NGT).

1.1 EP Regime

This application for an Environmental Permit variation (Substantial Change) under the Environmental Permitting (England and Wales) Regulations (EPR) (2016, as amended) is in relation NGTs Hatton Compressor Station.

A new gas turbine driven compressor is to be installed at the compressor station on land outside of the current installation boundary. Therefore, this application will vary the permit to extend the installation boundary to the west on NGT land.

This report uses the term 'installation extension' to describe the area of operation associated with the permit variation as defined in the technical description of the main application and outlined by the green line boundary. The wider NGT permitted area and land holding are referred to and delineated where appropriate. The existing installation boundary and proposed installation extension boundary are shown on Figure A1 of this SCR.

1.2 Site Condition Report (SCR)

The purpose of this SCR is to describe and record the condition of the land and groundwater within the installation on commencement of the permitted activities and to demonstrate that land and groundwater are protected during the lifetime of the permit, ultimately so that the site is in a 'satisfactory state' when the permit is surrendered.

As detailed in the EA's Technical Guidance Note, H5 (2013) the intention is that this is demonstrated by the following sequence of events:

- Producing the application part of the SCR when applying for an environmental permit (or permit variation);
- Updating the SCR during the lifetime of the permit; and
- Completing the surrender SCR and submitting the full completed SCR when applying to surrender the permit.

This SCR will gather information from available sources to provide supporting information against which any future surrender can be assessed. The report will discuss land use history, activities undertaken by NGT during their long-term ownership, present historical and recent site investigation information, and discuss the potential for permitted activities to impact on land quality given the containment, mitigation and management systems in place.

2 Site details

2.1 Site location

Table 1 Site details

Aspect	Details
Details of facility	Hatton Compressor Station forms part of the National Transmission System (NTS) which includes a network of compressor stations enabling natural gas from the North Sea and other regions across the world to be transported to consumers across the UK. Within this system, compressor stations are used to compress the gas being transported, to maintain safe system operating pressures. Gas turbine driven compressors are used in all but a few of the compressor stations, the others being driven by variable speed electric motors. Where gas turbines are used they are all fueled by natural gas from the NTS. Hatton Compressor Station operates under an existing Environmental Permit (reference EPR/UP3333LL) and operates both gas turbine and electric motor driven compressors. A new gas turbine driven compressor and associated ancillary equipment will be built on land outside of the current installation boundary. Therefore, the installation boundary will be extended westwards to incorporate the new compressor area. The installation extension area comprises approximately 1 hectare at an elevation of around 30m above Ordnance Datum (aOD).
Main Facility Components	The changes to be made to the existing permit, within the installation extension area, as described in the permit variation application, include: • Installation of one new gas turbine driven compressor unit; • Installation of new vent and exhaust stack; • Installation of new diesel standby generator and bunded fuel tank; • Installation of a new bunded fuel gas pre-treatment skid (including lube oil heat recovery); • Extensions and alterations to the security fence, to accommodate the boundary extension. The location and layout of these activities is illustrated in Figure A2.
Surrounding land uses	The installation extension area is located within the central part of the wider Hatton gas transmission facility, between the existing compressor compound to the east, and the gas valve compound (known as the AGI (Above Ground Installation)) to the west. Surrounding land uses beyond the compressor station are as follows: • The northern boundary is formed by a minor road with agricultural land beyond. • To the east is agricultural land. • To the south is agricultural land and a small watercourse. • To the west is agricultural land.

2.2 Identification of Potentially Polluting Substances

An assessment of the pollution potential of substances associated with the activities forming the permit variation has been made based upon their properties, toxicity and the volume stored.

Materials have been screened according to their potential to cause concern in respect of future soil and/or groundwater contamination. The potential to pollute, and for any contaminant linkage pathway to be realised, is influenced by the physio-chemical nature of the substance; materials of low mobility are less likely to be transmitted through soil or groundwater if released, and materials of low persistence in soil and groundwater may be of lower impact with regards identified receptors. This approach has been used in Table 2 (Raw Materials), and Table 3 (Waste Materials) to screen substances of potential concern in relation to their toxicity, mobility or persistence in the soil or groundwater environment. The location of material storage is illustrated in Figure A2.

Table 2 Raw materials associated with the facility and their potential to pollute

Substance (contaminants)	Use	State	Storage arrangements	Toxicity/ fate/ mobility	Potential pollutant?
Lubrication oils (refined mineral oils, with additives and synthetic hydrocarbon lubricants with additives).	Lubrication system for the gas turbine drive train.	Liquid	Drum storage within bunded area or over drip trays. Storage volume estimated to be *c.*2,000 litres in total. Main storage to be within existing installation area in dedicated COSHH store.	Polluting to soil, groundwater and watercourses in the event of a spillage/loss	✓
Ionic surfactant based detergent.	Turbine washing fluid used for periodic washing of gas turbine internals during standard maintenance.	Liquid	Drum storage within bunded area or over drip trays. Storage volume less than 200 litres in total. Main storage to be within existing installation area in dedicated COSHH store.	Polluting to soil, groundwater and watercourses in the event of a spillage/loss	✓
Petroleum hydrocarbon (diesel)	Fuel for plant and equipment plus fuel for standby generator.	Liquid	Bunded bulk storage tank with a capacity of 27,000 litres for standby generator, pipework will be double skinned and located within service ducts for ease of inspection. Drum storage within bunded area or over drip trays for plant and equipment.	Polluting to soil, groundwater and watercourses in the event of a spillage/loss	✓
Mineral oil / synthetic hydrocarbon lubrication oils.	Engine oil for standby generator usage. Mobile plant maintenance and top up usage.	Liquid	Drum storage within bunded area or over drip trays. Storage volume less than 500 litres in total. Main storage to be within existing installation area in dedicated COSHH store.	Polluting to soil, groundwater and watercourses in the event of a spillage/loss	✓
Other mineral oil/synthetic hydrocarbon based compounds and oils with additives including lithium based greases, other synthetic lubrication compounds.	Ball valve sealants; equipment maintenance.	Liquid / grease	Small containers in dedicated storage area, total quantity anticipated to be <20kg. Main storage to be within existing installation area in dedicated COSHH store.	Polluting to soil, groundwater and watercourses in the event of a spillage/loss	✓
Highly refined mineral transformer oils	One new 1.6MVA transformer on site.	Liquid	Small volumes held within a sealed transformer, replaced as required by electrical / specialist contractors.	Polluting to soil, groundwater and watercourses in the event of a spillage/loss	✓

Substance (contaminants)	Use	State	Storage arrangements	Toxicity/ fate/ mobility	Potential pollutant?
Nitrogen gas. Bottled gasses (acetylene, oxygen, methane, propane, helium, carbon monoxide, nitrogen dioxide). Compressed air.	Various process and safety uses (including fire snuffing, calibration of continuous emissions monitoring analyser).	Gas	Cylinders, bottles and generated on site.	Gaseous state, therefore non-polluting to soil, groundwater and watercourses in the event of a spillage/loss	×
Rock Salt.	Gritting of essential roads and walkways.	Solid	Pallet storage <500kg for whole installation.	Readily soluble, potentially polluting to watercourses in large quantities.	✓
Absorbent granules.	Spill containment and clean up	Solid	Small containers at points of use, total quantity anticipated to be ~ 250 kg.	Non-polluting to soil, groundwater and watercourses in the event of a spillage/loss	×
Miscellaneous maintenance chemicals (various).	Small amounts of various aerosols, oils, grease etc. used for maintenance work.	Liquid, grease gas.	Stored in workshop hazardous substances cupboards.	Polluting to soil, groundwater and watercourses in the event of a spillage/loss	✓

The installation extension area will not have any new waste storage areas. There will be small scale local waste storage at the point of generation prior to being transferred to the current storage areas within the existing installation. Waste storage areas will not be connected to the drainage system and will be designed with fall, kerbs or blind sumps as required to facilitate the containment and collection of any potentially contaminated run-off. All waste materials are stored in accordance with NGT Environmental Management System (Reference 1). Table 3 provides details of wastes within the extension area.

Table 3 Wastes and potential to pollute

Waste type	Nature of material	Storage arrangements	Disposal method	Potential pollutant?
Waste oil	Hazardous	Stored in small containers (<50 litres) within bunded areas/containers before removal by maintenance contractors	Collected by approved waste contractor for off-site disposal	✓
General waste	Non-hazardous	Dedicated skips and smaller containers, located at designated points within the installation	Collected by approved waste contractor for off-site disposal	✓
Empty drums and intermediary containers	Non-hazardous	Stored in designated locations within the installation prior to removal	Collected by approved waste contractor for off-site disposal	×
Oil contaminated absorbents	Hazardous	Dedicated containers within designated area prior to removal	Collected by approved waste contractor for off-site disposal	✓
Turbine wash water	Hazardous (oily water with surfactants)	Compressor skid fully bunded, no drains in compressor skid enclosure, dedicated mobile washing equipment used with discharges collected during washing and transferred to a 1,000 litre bunded tank inside the outer cab enclosure.	Collected by approved waste contractor for off-site disposal	✓
Continuous emissions monitoring system (CEMS) Condensate	Non-Hazardous (mildly acidic water)	Collected in a dedicated container (c. 5 litres) with level detection, mounted internally in the analysis cabinet.	Periodic manual transfer to the waste wash water tank in the cab, from where it will be disposed of off-site. Maximum of 200 litres per year.	×

2.3 Site drainage

The installation extension includes new buildings, hardstanding areas and roadways. A drainage strategy for the site has been developed which incorporates current legislative requirements, good practice (including SuDS principles were appropriate) and BAT in respect of pollution control measures with a focus on:

- Protection of adjacent watercourses from contamination from activities on the new development;
- Control of potential oil leaks from plant or activities on the new development; and
- Maintenance and operability of the new system.

There are no sources of foul effluent requiring treatment arising within the development area. There are no process effluent discharges made from the site, any liquid wastes arising are contained and disposed of off-site only.

The following drainage system elements are proposed:

- **Clean (uncontaminated) rainwater** from low risk roadway areas and roofs, will be routed through a SuDS compliant field drain system to maximise infiltration to the ground at source, in line with best practice design principles. Excess run-off will be routed through an oil / silt interceptor to an attenuation basin to manage flows at greenfield rates prior to discharge to surface water.
- **Potentially contaminated rainwater system**, from areas of roads where standing vehicles may be regularly present will be collected via drainage channels and routed through an oil / silt interceptor to the attenuation basin prior to discharge to surface water.

2.4 Surfacing

The majority (approximately 75%) of the installation extension is soft surfaced (gravel and pebbles), the remainder of the area is hard surfaced (buildings/structures and roadways). Site surfacing within the installation extension area is illustrated on Figure A4.

2.5 Electrical transformers and sub-stations

There is an oil filled electricity transformer located in the south of the site.

3 Site History

Ordnance Survey (OS) historical maps have been reviewed to provide information relating to the historical development of the installation and surrounding area. The historical maps are provided in Appendix 1. In addition, other sources of information have been used including aerial photography (Google, 2023).

The summary of land condition within this report places emphasis on the proposed permit installation extension boundary and outlines potentially contaminative historical land uses or sensitive land uses within the installation extension and in the immediately surrounding area. It will discuss land use history, activities undertaken by NGT (and their forerunner companies) during their long-term ownership of the wider area, present site investigation information, and discuss the potential for the proposed permit activities to impact on land quality given the containment, mitigation and management systems in place. This will provide a robust SCR and set a baseline against which any future permit surrender can be assessed.

3.1 Historical land use

Historical maps for the installation and surrounding area are available between 1886 and 2023; these have been reviewed and the findings are presented in Table 4. Descriptions of 'on-site' refer to areas situated within the proposed installation extension boundary[2]. All other areas of NGT landholding, and the wider locale, are 'off-site'.

[2] The boundary shown on the historical mapping may cover a slightly different area than the actual installation extension boundary and as such should not be used to show an accurate representation of the installation extension boundary.

Table 4 Historical map review

Historical Map	On Site	Off Site
1886 (1:10,560) 1887 (1:2,500)	The site is occupied by fields, with a field boundary cutting through the eastern area in a generally northwest to southeast orientation.	Land in the immediate vicinity is open and undeveloped fields. A road is present approximately 15m to the north. A footpath (F.P.) is shown to the south east. Approximately 320m to the west a smithy is annotated along with a well. Approximately 475m to the north west ponds are shown associated with the Hatton Brick and Tile Works. A road is present approximately 250-300m to the west. A building is shown approximately 300m to the south west, opposite what is the current entrance to the compressor station.
1805 (1:10,560) 1806 (1:2,500)	No significant change.	The surrounding land use is unchanged, with the exception of the Hatton Brick and Tile Works which is no longer annotated. A number of wells are annotated within 500m of the site.
1948 (1:10,560)	No significant change.	No significant change.
1951 (1:10,560)	No significant change.	No significant change.
1975 (1:2,500)	No significant change.	The AGI is now shown (labelled as a Gas Valve Compound) immediately to the west of the site. The footpath to the south east is no longer annotated.
1981 (1: 10,000)	No significant change.	The land surrounding the site remains relatively unchanged. Residential properties are shown approximately 300m to the west and a linear surface water feature is shown approximately 180m to the south east, flowing in a south westerly direction.
1994 (1:2,500)	A mound is now shown through the central area of the site with the abbreviation Nc (suggesting non-coniferous vegetation). The former field boundary is shown as a drain with a slight realignment in the south east of the site.	The Compressor Station is now shown (labelled as a Depot) immediately to the east of the site. Mound features are present to the east of the Compressor Station and extending to the north off the site. An electrical substation is shown immediately to the south of the site and an access road is present to the south.
2001 (1:10,000)	No significant change.	No significant change.
2003 (1:1,250)	No significant change.	No significant change.
2003, 2005, 2007 (Google Earth aerial photography)	No significant change.	No significant change.

Historical Map	On Site	Off Site
2010 (1:10,000)	No significant change.	No significant change.
2016 (Google Earth aerial photography)	The central western area of the site is clear of vegetation.	The AGI to the west has been extended to the south. A number of what appear to be containers are located on land to the south west of the site. The Compressor Station has been extended to the east. Approximately 200m to the south west, near the entrance to the Compressor Station a vegetation free mound is present.
2019 (Google Earth aerial photography)	The central western area is now vegetated.	The containers to the south are no longer present and the mound to the south west is now vegetated.
2022 (Google Earth aerial photography)	The site has been cleared. Part of the drain in the east of the site appears to have been in-filed or culverted.	An area approximately 75m to the south east has been cleared and the mound area to the south west has also been cleared and there appear to be containers located on this area.
2023 (1:10,000)	No significant change.	No significant change, although additional infrastructure (not shown on earlier mapping, but known to be present) is now shown at the AGI and Compressor Station.

Other information gathered during previous assessments supplements and / or confirms the historical mapping as follows:

- The AGI was constructed and commissioned during the 1970s;
- The Compressor Station was constructed in the 1980s, compressors were temporarily located in the north western area of the current installation boundary before being moved to their current location when the main development was completed in the 1980s.. The mound on site was first shown on mapping from 1994 which suggests that it is likely to have been created during construction of the Compressor Station in the 1980s.
- Around 2010 the Compressor Station was extended towards the east, with the addition of three variable speed drive (VSD) electric compressor units which were fully commissioned in 2016.
- The mound of soil in the vicinity of the entrance to the Compressor Station is associated with construction of the Integrated Security System (ISS) – new fence around the operational compressor area constructed around 2016.

4 Environmental Setting

The following information was derived from information contained within the previous site investigations and assessments along with other published sources (referenced within).

4.1 Geology and Hydrogeology

Geological map extracts taken from the British Geological Survey (BGS) digital geological map of Great Britain (BGS, 2023) have been reviewed. A summary of the geological maps is discussed below.

4.1.1 Artificial Ground

The geological map does not indicate the presence of artificial ground beneath the site.

However, historical mapping and site reconnaissance observations confirm the presence of a mound on the site which is understood to be comprised of re-worked natural materials excavated during previous phases of construction at the compressor station. Ground investigation undertaken during 2020 confirmed the mound to be comprised of reworked natural material of gravelly clay with rootlets – the mound has now been removed ahead of construction, following chemical testing which proved the absence of contamination.

4.1.2 Superficial Deposits

Superficial deposits of Till are mapped beneath the whole of the installation area. Two nearby BGS boreholes (drilled by Norwest Holst Soil Engineering Ltd in 1980) located to the south west of the installation extension within NGT land, describe the Till as stiff to very stiff silty clay with occasional chalk and flint gravel. Till was present to the full depth of the boreholes at 8 m below ground level (bgl).

4.1.3 Solid Geology

The installation and surrounding area is underlain by the Kimmeridge Clay Formation – Mudstone.

4.2 Previous Investigations and Exploratory Hole Records

There are no publicly available BGS borehole records for the installation extension area, although two nearby records are available which are summarised above.

Records of ground conditions encountered during two intrusive site investigations undertaken on the land associated with the Hatton Compressor Station, but outside of the installation extension area, are summarised below:

- ***1988, Exploration Associates***: eight cable percussion boreholes (BH1 to BH8) drilled to a maximum depth of 10.20 m bgl; five trial pits were also excavated although details of these are not known.
- ***2009, Soil Mechanics***: seven cable percussion boreholes (BH1 to BH7) drilled to a maximum depth of 10.00 mbgl.

All of the previous ground investigation borehole records (presented in Appendix 2) confirm the presence of clay directly beneath the local area. Although the logs do not name the individual geological units the descriptions appear to describe Till to between approximately 5.50 m and 8.38 m bgl and then Kimmeridge Clay (generally described as stiff to very stiff bluish grey silty clay with occasional marine shell fragments). A layer of silty fine sand was encountered in one borehole (BH7 – 1988) between 7.60 and 8.20 m bgl, at the base of the Till.

4.3 Hydrogeology

4.3.1 Aquifer Classification

The superficial geology of Till is classified by the Environment Agency as a Secondary (undifferentiated) Aquifer (MAGIC, 2023). These are assigned where it has not been possible to attribute either category A or B to a rock type. In most cases this means that the layer in question has variable characteristics.

The solid geology of the Kimmeridge Clay Formation is classified by the Environment Agency as Unproductive (MAGIC, 2022). These are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

4.3.2 Groundwater Quality

The installation is not located within a groundwater Source Protection Zone (SPZ) and is not located within a groundwater drinking water safeguard zone.

4.3.3 Groundwater Abstraction

There are no reported active licenced groundwater abstractions with 500 m of the installation.

4.3.4 Groundwater Flooding

The installation is within an area with low potential for groundwater flooding to occur (Groundsure, 2023).

4.3.5 Previous Groundwater Observations

A summary of the groundwater observations recorded in the historical boreholes is provided in Table 5. Groundwater was typically absent, although seepages were recorded in three boreholes at depths between 2.20 and 4.70 m bgl indicative of potentially discontinuous perched groundwater with the Till.

Anecdotal evidence also confirms that there has been no groundwater inundation of deep excavations noted during early construction activities within the installation extension area.

Table 5 Summary of groundwater strikes in the historical borehole records

Material / description	BH name/ reference	Year	Strike depth (mbgl)	Rest water level (mbgl)	Ground level (maOD)	Rest water level (m aOD)
Till	BH2	1988	4.70	Seepage only	34.15	-
	BH4	1988	4.20	Seepage only	33.55	-
	BH5	1988	2.70	Seepage only	33.43	-
	All of the other fourteen boreholes remained dry throughout drilling					
Kimmeridge Clay	Groundwater was not encountered within the solid geology					

4.4 Hydrology

4.4.1 Surface Water Features

A drainage channel is present in the south east corner of the site which flows in a south easterly direction towards a confluence with a stream on the southern boundary of the compressor station. This stream subsequently flows towards the south west. The drainage system is part of the Tile House Beck Catchment according to the Environment Agency's online catchment data explorer (2023). During previous assessments at the compressor station it was determined that the drainage channel within the installation extension area is typically dry, except during heavy rainfall events.

Other surface waters in the vicinity include field drains and ditches and small isolated ponds. Ponds associated with the Hatton Fish Farm are located approximately 480m to the north west of the site; these ponds are located adjacent to an unnamed stream flowing in a south westerly direction.

Areas of standing water form after rain at a number of locations across the compressor station and some can stand for a number of days, this is indicative of the anticipated low permeability geology.

There is unlikely to be hydraulic continuity between underlying groundwater and the surface water features.

4.4.2 Flooding

The EA's Flood Map for Planning shows that the whole of the site is located within a Flood Zone 1, defined by the EA as having a low probability (less than 0.1% chance in any year) of flooding from rivers and the sea. This area is not shown to be within an area benefiting from flood defences.

The EA's map of surface water flooding indicates that the installation extension is not susceptible to surface water flooding but there are areas within 50m to the east that are.

4.4.3 Surface Water Quality

The EA's catchment data explorer indicates that the site is located within the Tile House Beck water body catchment[3]. This catchment received a Water Framework Directive (WFD) classification of Moderate in 2019 (the most recent assignment). This classification can be further broken down into a rating of Moderate for ecological quality and Fail for chemical quality.

4.4.4 Surface Water Abstractions

The Groundsure report (2023) indicates that there are no licences for surface water abstraction located within 500m of the installation extension.

[3] https://environment.data.gov.uk/catchment-planning/WaterBody/GB105030062230

5 Environmental Data and Regulatory Information

A summary of the various regulatory and other environmental data is presented below, based on the data obtained in the Groundsure Enviro+Geo Insight report (Appendix 1).

5.1 Discharge Consents

Two historical licenced discharge consents listed for the wider compressor station, these are now covered under the environmental permits. Both relate to sewage discharges – final/treated effluent. The discharge points associated with the consents are located approximately 40 m to the south east of the installation extension area.

Two further discharge consents are listed within 500 m of the installation extension, the closest of these is located approximately 375 m to the south west and is no longer active. Further details of these discharge consents can be found in the Groundsure report (2023) provided in Appendix 1.

5.2 Permitted Industrial Activities / Pollution Prevention and Control

The Groundsure report (2023) records four superseded and one active records for Part A(1) installations regulated under the Environmental Permitting Regulations for release of substances to the environment within 500 m of the installation extension area. These are all associated with the compressor station.

There are no further permitted Pollution Prevention and Control activities listed in the Groundsure report with the 250 m of the installation extension.

5.3 Pollution Incidents

The Groundsure report records no pollution incidents ((category 1 (major) and category 2 (significant)) within 500 m of the installation boundary.

NGT have recorded eleven minor pollution incidents on the NGT incident register on the following dates in relation to the Hatton compressor station, all of which were noted and rectified immediately before any significant release to land or water was possible:

- 11/10/2022
- 15/06/2022
- 11/10/2021
- 11/06/2018
- 12/08/2015 (x2)
- 16/07/2015
- 12/04/2015
- 01/04/2015
- 24/03/2015
- 08/09/2014

5.4 Landfills and Waste Management Sites

There are no historical or current landfills or waste management sites listed within 500 m of the installation.

There are 41 listed activities involving the storage, treatment, use or disposal of waste that are exempt from needing a permit (waste exemptions). Four of these are associated with the Hatton Compressor Station. Further details of these waste exemptions can be found in the Groundsure report (2023) provided in Appendix 1 which includes pollution inventory waste transfers.

5.5 Recent Industrial Land Uses

The Groundsure report (2023) lists five current potentially contaminative industrial land uses within 250 m, the closest are an electricity substation to the south of the installation extension and the adjacent compressor station.

5.6 Hazardous Substance Storage/Use

The Groundsure report (2023) lists three consents granted for a site to hold certain quantities of hazardous substances at or above defined limits in accordance with Planning (Hazardous Substances) Regulations. All three are associated with the Hatton Compressor Station and further details can be found in the Groundsure report (2023) provided in Appendix 1.

5.7 COMAH Sites

The Groundsure report (2023) does not list any current or historical Control of Major Accident Hazards (COMAH) sites within 500 m of the installation extension area. There is one historical Notification of Installation Handling Hazardous Substances (NIHSS) record, this is associated with the Hatton Compressor Station.

5.8 Contaminated Land Register Entries and Notices

There are no sites on the Contaminated Land register entries or notices within 500 m of the installation extension.

5.9 Fuel Station Entries

There are no active fuel station entries within 500 m of the installation extension. There is a record from 1994 of a historical petrol station located approximately 440 m to the west of the installation extension.

5.10 Sensitive Land Use

The following sensitive land uses have been identified within 2 km of the installation extension:

- Bardney Limewood Site of Special Scientific Interest (SSSI) located approximately 985 m to the south west of the installation extension at its closest point. This SSSI is also designated as a National Nature Reserve (NNR).
- Four areas of designated Ancient Woodland are located between 1,300 m and 1,990 m to the south west of the installation extension.
- The installation extension is also located within three SSSI Impact Risk Zones.

6 Conceptual Site Model

The guiding principle of IED is to accept no further deterioration of land during the lifetime of the permit. The aim of the SCR is therefore to develop a conceptual site model (CSM) which identifies past and future potential sources of contamination and assesses the vulnerability of the site and sets a baseline against which any potential future deterioration of site condition can be judged at the point of surrender.

The information presented in previous sections of this report have been collated and evaluated to develop the CSM for the installation. This has been undertaken following procedures outlined in 'Land Contamination: Risk Management (LCRM) published by the EA (EA, 2020) and EA's Technical Guidance Note H5 (2013). The CSM outlines:

- Sources: substances that are capable of causing pollution or harm;
- Pathways: routes by which the contaminant can reach a receptor;
- Receptors: something which could be adversely affected by the contaminant including human health, properties and controlled waters.

The establishment of pollutant linkages and assessment of pollution potential enables pollution prevention measures to be identified which will mitigate any potential environment impacts of the permitted activities.

6.1 Sources

A number of potential sources of contamination (PSCs) have been identified on site and in the surrounding area which may have impacted soil and groundwater quality in the areas where the permitted activities will take place, both historically, and which could potentially impact land quality in the future. The following PSCs have been identified within 250 m of the installation extension:

6.1.1 Historical

On-Site:

- Historical agricultural land-use; and
- Mound associated with former phases of construction at the surrounding compressor station.

Off-site:

- Activities associated with the surrounding Hatton Compressor Station.

Potential contaminants that may impact soils and groundwater beneath the installation derived from these historical land uses include metals, petroleum hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), Volatile Organic Compounds (VOCs), coolants (glycols) and asbestos.

6.1.2 Potential Contaminant Sources Associated with Permitted Activities

Potential sources of pollution which are present as a result of activities covered by the scope of this permit variation application have been outlined in Section 2. These include raw materials (Table 2) and waste materials (Table 3).

6.2 Pathways and Receptors

- Human health exposure via direct contact with contamination, ingestion of contamination and inhalation of contaminated dust or vapours. For site users and operational staff, building cover, hardstanding ground cover or appropriate working procedures are expected to break any potential pathway in respect of this risk. Human health is not a focus of the H5 methodology.
- Human health exposure to potential volatile contaminants (vapours) beneath the site (if present) may impact site users and operational staff via the inhalation pathway. Human health is not a focus of the H5 methodology.
- Leaching and migration of contaminants within shallow soils beneath the site to the underlying Secondary (undifferentiated) Aquifer and surface waters of the Tile House Beck catchment. Contaminants may also migrate off-site within groundwater in shallow permeable soils and impact off-site human health receptors via direct contact, ingestion and vapour inhalation pathways, although the primary pathway is likely to be towards surface waters. Contaminants and vapours may also migrate onto site from potential current and historical off-site sources.
- Infrastructure, including pipelines and drains, are considered to be a potential pathway to receptors.
- Ecologically designated sites are considered receptors, although these are a significant distance from the site.

6.3 Vulnerability of the Site to Contamination

Sensitive aspects of the site setting are identified in Table 6.

Table 6 Sensitivity of environmental receptors in the vicinity of the site

Receptor Type	Receptor(s)	Sensitivity	Reasoning
Groundwater	Secondary (undifferentiated) Aquifer underlying the whole site (superficial Till deposits)	Low	Installation underlain by a Secondary (undifferentiated) Aquifer and the underlying bedrock is Unproductive strata. The installation extension is not located within a groundwater Source Protection Zone and there are no licensed groundwater abstractions recorded in the vicinity. Intrusive investigation records suggest that groundwater within the Secondary (undifferentiated) Aquifer is potentially locally perched and discontinuous and unlikely to be in hydraulic continuity with nearby surface waters, given the depth encountered.
Surface water	Drainage channels / stream within the Tile House Beck catchment	Moderately High	Located directly within, and to the south east of the installation extension boundary. There are no licensed surface water abstractions recorded within 500 m. Surface water quality monitoring indicates a requirement for improvement at a catchment level.
Ecological	Designated SSSI, NNR and Ancient Woodland	Low	The designated sites are located a considerable distance from the site. The SSSI is the closest feature and is approximately 985 m to the south west at its closest point.

6.4 Assessment of Pollution Potential from Installation Activities

An environmental risk assessment in line with H1 guidance[4] has been completed to identify the possibility of land or groundwater pollution from facility activities to impact the sensitive environmental receptors identified in Table 6. This is presented in Table 7.

[4] Horizontal Guidance Note H1. V2.1. Environment Agency Dec 2011 (Withdrawn 1/2/2016)

Table 7 H1 risk assessment of pollution potential from activities within the installation

Potentially Polluting Substance Relevant System / Activity			Managing the risk	Assessment of Risk		
Hazard	Pathway	Receptor	Pollution prevention measures	Probability	Consequence	Overall Risk
Spillage / loss of lube oil or hydraulic oil containment in fuel gas pre-treatment system (heat exchanger)	Infiltration / run-off	Land, surface water groundwater	Storage tanks bunded, pipework above ground within bunds or over hardstanding. Compressor skid fully bunded and connected to below ground oil containment chamber designed to meet CIRIA 736 and which accommodates 110% of the total oil inventory within the compressor system (12,500 litres). Regular inspections undertaken and management procedures in place. Physical isolation systems and spill response in place to prevent / minimize any losses in the event of a leak or spill.	Low likelihood	Impact on soil and/or groundwater and/or surface water quality [Medium]	Moderate / low risk
Spillage / loss of containment – engine or power turbine lube oil, hydraulic fluids associated with compressor	Infiltration / run-off	Land, surface water groundwater	Compressor skid fully bunded and connected to below ground oil containment chamber designed to meet CIRIA 736 and which accommodates 110% of the total oil inventory within the compressor system (12,500 litres), tank and pipework above ground, regular inspections undertaken and management procedures in place. Physical isolation systems and spill response in place to prevent / minimize any losses in the event of a leak or spill, any spilled liquids collected for off site disposal.	Low likelihood	Impact on soil and/or groundwater and/or surface water quality [Medium]	Moderate / low risk

Potentially Polluting Substance Relevant System / Activity			Managing the risk	Assessment of Risk		
Hazard	Pathway	Receptor	Pollution prevention measures	Probability	Consequence	Overall Risk
Spillage / loss of containment – turbine washings (water, detergents, contaminants e.g. hydrocarbons)	Infiltration / run-off	Land, surface water groundwater	Compressor skid fully bunded, no drains in compressor skid enclosure, lipped slab to contain any lost washwater, dedicated mobile washing equipment used with discharges collected, in a 1,000 litre bunded tank inside the enclosure, for offsite disposal. Management procedures in place. Physical isolation systems and spill response in place to prevent / minimize any losses in the event of a leak or spill.	Low likelihood	Impact on soil and/or groundwater and/or surface water quality [Medium]	Moderate / low risk
Spillage / loss of diesel containment associated with standby generator – during storage, use or tank refilling	Infiltration / run-off	Land, surface water groundwater	Diesel storage tank fully bunded, standby generator enclosure acts as a bund for general fuel and oil inventory, pipework between tank and generator is double skinned, regular inspections undertaken and management procedures in place. Physical isolation systems and spill response in place to prevent / minimize any losses in the event of a leak or spill.	Low likelihood	Impact on soil and/or groundwater and/or surface water quality [Medium]	Moderate / low risk
Vandalism / site security failure leading to unplanned release of potentially polluting liquids	Infiltration / run-off	Land, surface water groundwater	High level of security on site with 24 hr security monitoring, power (electrified) fence, double entry gate systems and locked cabs and control units. Physical isolation systems and spill response in place to prevent / minimize any losses in the event of a leak or spill.	Low likelihood	Impact on soil and/or groundwater and/or surface water quality [Medium]	Moderate / low risk
Contamination of surface water (runoff)	Direct site drainage / outfall	Surface water	All surface water drainage from areas of hardstanding and roofs is routed through appropriate SuDS features for treatment prior to discharge to surface water.	Unlikely	Impact surface water quality [Mild]	Very Low risk

Potentially Polluting Substance Relevant System / Activity			Managing the risk	Assessment of Risk		
Hazard	Pathway	Receptor	Pollution prevention measures	Probability	Consequence	Overall Risk
Damage to plant and equipment due to foreign bodies in pipework (e.g. from maintenance or commissioning works) leading to release of gas, potential fire and explosion risks, leaks / escape of oils or liquids	Infiltration / run-off	Land, surface water groundwater	Management procedures in place controlling maintenance and commissioning activities to ensure work undertaken correctly. Physical isolation systems and spill response in place to prevent / minimize any losses in the event of a leak or spill.	Low likelihood	Impact on soil and/or groundwater and/or surface water quality [Medium]	Moderate / low risk

Table 8 Risk assessment methodology

Consequence	Severe	Short-term (acute) risk to human health likely to result in “significant harm” as defined in the Environmental Protection Act, Part IIA. Short-term risk of pollution of sensitive water resource (note: Water Resources Act contains no scope for considering significance of pollution). Catastrophic damage to buildings/property. A short-term risk to a particular ecosystem, or organism forming part of such ecosystem (note: the definitions of ecological systems within the Draft Circular on Contaminated Land, DETR, 2000)
	Medium	Chronic damage to Human Health (“significant harm” as defined in DETR, 2000). Pollution of sensitive water resources (note: Water Resources Act 1991 contains no scope for considering significance of pollution). A significant change in a particular ecosystem, or organism forming part of such ecosystem. (note: the definitions of ecological systems within Draft Circular on Contaminated Land, DETR, 2000)
	Mild	Pollution of non-sensitive water resources. Significant damage to crops, buildings, structures and services (“significant harm” as defined in the Draft Circular on Contaminated Land, DETR, 2000). Damage to sensitive buildings/services or the environment
	Minor	Harm, although not necessarily significant, which may result in a financial loss, or expenditure to resolve. Non-permanent health effects to human health (easily prevented by means such as personal protective clothing etc.). Easily repairable effects of damage to buildings, structures and services.
Probability	High likelihood	There is a contaminant linkage and an event that either appears very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution
	Likely	There is a contaminant linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.
	Low Likelihood	There is a contaminant linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such an event would take place, and is less likely in the shorter term.
	Unlikely	There is a contaminant linkage but circumstances are such that it is improbable that an event would occur even in the very long term.

Risk level

		Consequence			
Probability		Severe	Medium	Mild	Minor
	High Likelihood	Very high risk	High risk	Moderate risk	Moderate low risk
	Likely	High risk	Moderate risk	Moderate low risk	Low risk
	Low Likelihood	Moderate risk	Moderate low risk	Low risk	Very low risk
	Unlikely	Moderate low risk	Low risk	Very low risk	Very low risk

Risk description	Very high	There is a high probability that severe harm could arise to a designated receptor from an identified hazard, OR, there is evidence that severe harm to the designated receptor is currently happening. Urgent investigation (if not undertaken already) and remediation are likely to be required
	High	Harm is likely to arise to a designated receptor from an identified hazard. Urgent investigation (if not undertaken already) is required and remedial works may be necessary in the short term and are likely in the long term.

	Moderate	It is possible that harm could arise to a designated receptor for an identified hazard. However, if it is either unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild. Investigation (if not already undertaken) is normally required to clarify the risk, and to determine the potential liability. Some remedial works may be required in the long term.
	Moderate low	It is possible that harm could arise to a designated receptor for an identified hazard, but it is likely that this harm, if realised, would at worst be mild
	Low	There is a low possibility that harm could arise to a receptor. In the event of such harm being realised, it is not likely to be severe.

Source: CIRIA document 552: 'Contaminated Land Risk Assessment; A Guide to good practice'.

The risk assessment indicates that the risk of pollution potential from activities to be operated within the facility is moderate/low to low.

A separate Accident Management Plan has been prepared which assesses other accidental / unexpected events which could increase the risk of release of a potential polluting substance (Reference 2).

7 Protection of Land and Groundwater During Operation

7.1 Site Operational Controls

The Hatton Compressor Station installation is operated in accordance with an Environmental Management System (EMS) and controls to minimise point source and fugitive emissions to air, water and land. The NGT EMS is certified to ISO14001 and a planned maintenance and inspection programme is in place to optimise the operation of plant. Control measures specific to the containment of raw materials include:

- Diesel tank filling is a manual supervised activity with local drain valve to be closed during filling and access roads routed to restrict vehicular access to the area;
- On the compressor lube oil system there are level and pressure sensors with automatic trip and alarms triggered in the event of a level drop;
- Planned infrastructure inspection programme with reporting as required to Gas National Control Centre (GNCC).

An Accident Management Plan (Reference 2) is also in place to assess risks and identify controls associated with accidents and other unplanned events.

7.2 Waste Handling

EMS procedures specify appropriate measures to ensure compliance with applicable legislation and to control and minimise pollution risks in relation to the generation, storage and disposal of wastes. Controls to minimise environmental risks associated with waste storage, handling and transfer include:

- Waste materials arising from the process are stored within the installation for the minimum period of time, in suitable, fit for purpose containers located on areas of hardstanding and away from sensitive receptors and potential pathways. Waste containers are clearly labelled with their intended contents and container storage capacities are not permitted to be exceeded. Site housekeeping inspections are undertaken to ensure these standards are maintained.
- Very limited quantities of hazardous waste are generated by site activities. This is limited to items such as batteries, waste oil and fluorescent tubes. Hazardous waste is always stored in secure containers, away from sensitive receptors and segregated from other waste types. Wastes generated within the installation extension will be stored temporarily at the point of production before being moved to the main existing waste management area.
- Procedures are in place to ensure waste ‘duty of care’ requirements are met including ensuring that waste is only removed from site by contractors properly licenced and approved for use and accompanied by a fully completed waste transfer or hazardous waste consignment note. Waste transfer and consignment note records are retained electronically or as paper copies on site. Effective implementation of these procedures is supported by training for NGT personnel as appropriate.

7.3 Environmental Monitoring Programme

The objectives of the monitoring programme are:

- To demonstrate that the pollution prevention measures will be inspected, tested and maintained over the lifetime of the permit; and
- To ensure that future pollution to land is not caused by installation activities.

Environmental monitoring of groundwater, surface water, soil and soil vapour is not considered to be required over the lifetime of the permit. It is considered that formalised inspection and testing procedures of the pollution prevention infrastructure will be sufficient to control the risk of future pollution from activities with the potential for releases to ground.

7.3.1 Infrastructure

All tanks and vessels are included on inspection programmes and will be:

- Impermeable and resistant to the stored materials;
- Subject to visual inspection for rusting, leakage or other damage; and
- Subject to programmed inspection incorporating visual examinations and non-destructive testing (e.g. ultrasonic thickness measurements).

Bunded areas will:

- Be impermeable and resistant to the stored materials;
- Be designed to catch leaks from the tanks or fittings;
- Be subject to regular visual inspection and any contents pumped out or otherwise removed under manual control after checking for contamination;
- Have fill points within the bund where possible or otherwise provide adequate additional containment;
- Have a routine programmed inspection of bunds (normally visual but extending to water testing where structural integrity is in doubt); and
- An aquasentry device will be used for pumping out uncontaminated rainwater from the sub-surface containment sump.

7.4 Infrastructure Monitoring Programme

NGT will formally inspect and maintain site infrastructure in line with the requirements of the site's EMS and Inspection Procedures. This includes a programme of visual inspections by site staff of all tanks and bunds, pipework, drainage and hardstanding. The Site Controller is also responsible for ensuring regular inspections on site to identify any potential issues and arrange resolution as necessary. All inspections are recorded in a site log and action taken as required. The log also records the work that has been carried out and any other issues noted within the operating period. Table 9 details the infrastructure inspection and testing programme which will continue to be utilised on site. The inspections will be carried out on a frequency defined in maintenance and management procedures and will primarily be visual to identify any signs of corrosion, cracks or other damage.

Table 9 Details of infrastructure inspection and testing

Activity	Specific Activities	Inspection & Testing Details	Frequency
Oil / fuel storage and pipework	Storage and use of diesel, lubricating oil and waste oil	Tank bunds will be visually checked for accumulated rainwater. Visual checks of the pipe work and connections, and any leaks, corrosion or damage rectified as appropriate.	Monthly (more frequently in periods of high rainfall).
		Visual checks of the tank/ bund to check integrity, if the integrity of the bund is suspect then water testing of the bund will be undertaken.	Monthly
Surface water drains	Operation of oil / silt interceptor.	The oil / silt interceptor will be visually checked for accumulated silt and presence of oils and cleaned out as appropriate.	Monthly (more frequently in periods of high rainfall).
	Attenuation Tank	The attenuation tank and discharge point will be visually checked for accumulated silts and organic debris, and cleaned out as appropriate.	Monthly (more frequently in periods of high rainfall).
Surfacing	All areas within the installation extension including around bulk storage tanks and fill points.	Areas of hardstanding inspected by detailed visual inspection to assess condition, wear, cracks and surface break up.	Periodic checks.
Process equipment operation and maintenance	Routine operation and maintenance to process equipment	Extensive programme of inspection in place for whole machinery train.	As per manufacturer requirements and more often when necessary due to identified defects. Standard inspection frequencies also listed in management document T/PM/ MAINT/6.

7.5 Personnel Issues

Personnel responsible for the inspection, testing and maintenance of pollution prevention infrastructure will be trained to an appropriate level to ensure compliance with the infrastructure monitoring programme.

Staff will be trained in the use of spill kits and spillage response procedures as part of the site's Environmental Management System. For further information, reference should be made to the management system summary section of NGT's response to 'Question 3d Management systems' on Form C2.

7.5.1 Reporting Procedure

A log of site inspections will be maintained for the life of the permit. Any maintenance or actions identified during inspections will be recorded using the current procedures for environmental incident reporting. Subsequent actions taken (such as repair of damaged structures and leaking containers) will be recorded in the site log.

At time of surrender, the site's inspection and maintenance records are to be made available for inspection by the EA to demonstrate that the containment and risk control mitigation measures have been maintained for the duration of the permit, such that no deterioration of land or water quality has occurred as a result of the site's activities. The evidence will need to show that:

- Measures to protect land and groundwater have worked;
- Pollution incidents that may have affected the land were investigated and remediated; and
- Any risk of pollution by decommissioning has been investigated and remediated.

7.6 Installation Baseline Conditions

In addition to the processes, procedures and records described above, baseline conditions, for soil and groundwater, have been gathered against which any future site surrender investigation can be compared. The baseline conditions are described below.

In 2020 Advisian (Worley Group) (Reference 3) was instructed by National Grid (now NGT) to carry out a geo-environmental site investigation at the Hatton Compressor Station including the installation extension area. One of the objectives of the investigation was 'to assess the potential risks posed by possible soil and/or groundwater contamination to receptors during and after development'. This objective enabled collection of site specific information suitable to support the Environmental Permit application in setting baseline conditions. The fieldwork undertaken within the installation extension area was carried out between 19th and 23rd October 2020 and comprised of:

- 3 No. window sample boreholes to depths up to 1 m bgl;
- 3 No. dynamic sampling and rotary coring boreholes to depths of 7.50 m bgl;
- 5 No. machine excavated trial pits to depths of up to 2.20 m bgl;
- 5 No. hand excavated pits to depths of up to 0.96 m bgl;
- Geo-environmental laboratory analysis on soils.

Excavation locations provide coverage across the installation extension area and are shown on Figure A5. Three other exploratory holes were also excavated in an area to the south east of the installation extension (TP20-06, 07 and 08), as these were outside of the installation extension they have not been summarised below but results are included in Appendix 3 for completeness.

A report on the ground investigation is available (Reference 3) and includes a full description of the works undertaken, boreholes logs, figures, monitoring results and a full set of chemical analysis results. A summary of the investigation, including ground and groundwater conditions is presented in the following sections.

The ground conditions encountered are summarised in Table 10.

Table 10 Summary of ground conditions (2020) (taken directly from Reference 3)

Material and Description	Depth to base (m bgl)	Thickness (m)
Topsoil: encountered as either a gravelly fine sand or a gravelly silty clay	0.10 – 0.60	0.10 – 0.60
Made Ground: encountered in BH20-01 to BH20-03, TP20-02 and TP20-04. Typically encountered as a firm medium plastic gravelly sandy clay. Less frequently encountered as a gravelly sand. Gravel commonly comprised sandstone and occasional concrete.	0.51 to 1.00	0.31 to 1.00
Till: encountered in BH20-01 to BH20-03, TP20-01 to TP20-05 as low to medium plastic firm to hard slightly gravelly to gravelly clay. Less frequently encountered as a gravelly silty clay.	1.00 to 7.50	0.75 to 6.99
Kimmeridge Clay: Not encountered during the investigation.	Not recorded	Not recorded-
The Mound *(see historical land use section)*: The mound is a man-made feature, therefore all the material encountered is considered to be reworked natural material. The material typically encountered is described as a low to medium plastic gravelly clay with occasional rootlets.	Not proven (advanced between 0.48 and 1.00)	Not proven (advanced up to 1.00)

No visual or olfactory evidence of contamination was observed within the installation extension area.

The geology encountered during the 2020 investigation mirrors that encountered in previous investigations confirming low permeability geological conditions.

Groundwater was not encountered in any of the boreholes during drilling. Water was encountered in one of the trial pits (TP20-01) at 1.15 m bgl. This was suggested to be associated with the drainage pipe identified within this trial pit.

The groundwater observations during the 2020 investigation mirror that encountered in previous investigations with no significant groundwater being encountered within low permeability strata. As no groundwater was encountered during drilling no groundwater monitoring infrastructure was installed.

7.6.1 Chemical Analysis

Geo-environmental testing was undertaken on a maximum of 25 soil samples from the installation extension area. These samples were tested for a range of determinands as detailed in Appendix 3 and summarised in the Table 11. Appendix 3 includes additional results, the majority of which are reported at less than the laboratory limit of detection (LoD) and are therefore not summarised here.

Table 11 Summary of soil analysis

Compound	Units	No.	Min	Max	Mean*	Location of Max	
							mbgl
Asbestos in Soil	Type	15	Not detected				
pH - Automated	pH Units	25	7	8.6	8.1	BH20-02	0.4
Total Cyanide	mg/kg	25	<1	<1	<1		
Sulphate (Water Soluble 2:1)	mg/kg	25	49	6800	1846	TP20-05	1.8
Chloride (Water Soluble 2:1)	mg/kg	25	3.6	82	20.15	BH20-01	7.0
Elemental Sulphur	mg/kg	25	<5	28	6.16	TP20-05	1.8
Ammonium as NH4	mg/kg	25	<0.5	5.6	0.95	BH20-01	7.0
Loss on Ignition @ 450oC	%	25	0.7	4.9	2.38	HP20-05	0.60-0.85
Speciated Total EPA-16 PAHs	mg/kg	25	<0.8	53.7	2.98	TP20-05	1.8
Arsenic	mg/kg	25	9.4	31	14.9	HP20-05	0.60-0.85
Boron	mg/kg	25	0.5	5	1.34	BH20-01	7.0
Cadmium	mg/kg	25	<0.2	0.6	0.22	TP20-02	0.8
Chromium	mg/kg	25	12	27	20.9	TP20-04, 05	0.6, 0.7
Copper	mg/kg	25	6.4	35	16.1	TP20-05	0.7
Lead	mg/kg	25	7.4	23	14.6	TP20-02	2.0
Mercury	mg/kg	25	<0.3	<0.3	<0.30		
Nickel	mg/kg	25	12	31	23.4	TP20-02	2.0
Selenium	mg/kg	25	<1	1.5	1.02	BH20-03	0.3
Zinc	mg/kg	25	33	76	54.3	TP20-01	0.1
Total Petroleum Hydrocarbons (C10 - C40)	mg/kg	25	<10	160	21.8	BH20-01	7.0
Phenols		25	Not detected above laboratory LoD				
BTEX & MTBE		25	Not detected above laboratory LoD				

* summary has included results which are less than the LoD as though they are at the limit of detection – see Appendix 3 for full dataset.

Leachability testing was also undertaken on selected soil samples. The majority of the results were below the laboratory limits of detection, Appendix 3 provides the full set of results.

Statement of Site Condition

The SCR is based on a desk study review of the historical land use, current and historical ground investigations, and observations made during a site reconnaissance visit. It has confirmed the following ground conditions:

- Historically a mound of re-worked natural clay material was present within the installation extension area, this has been cleared for development.
- Superficial geological deposits underlying the installation extension comprise of Till which at this location is characterised by low permeability clay to a depth in excess of 7.50 m bgl.
- The underlying bedrock geology comprises of Kimmeridge Clay, also characterised by low permeability clay.
- Groundwater was not encountered beneath the installation extension area. Previous investigations in the surrounding area also did not encounter significant groundwater. Any groundwater present within the Till is likely to be perched and discontinuous and is considered unlikely to be in hydraulic continuity with the surface waters on site and in the surrounding area, which are part of the Tile House Beck catchment.
- Given that the surrounding land has been used as a gas compressor station since the 1970s and that the installation extension area has formed part of the land holding, although undeveloped, legacy contamination including metals, organic compounds including petroleum hydrocarbons and poly-aromatic hydrocarbons, and asbestos is potentially present and plausible pathways to potential receptors have been identified.
- The proposed installation extension will result in the storage and use of number of potentially contaminative materials, including and diesel, oils and lubricants.
- The principal potential receptors for existing and future contamination are considered to comprise operational staff and visitors, soil, groundwater and surface waters of the Tile House Beck catchment.
- The permitted activities include a range of containment and management measures which will limit the potential for spills or leaching of pollutants from the installation directly to the underlying soils, groundwater and nearby surface water.
- Soil samples recovered during an intrusive ground investigation across the installation extension area were subjected to a suite of chemical analysis, the results of which provide an indication of the baseline conditions at the start of the permit.
- It is considered that the permitted activities to be undertaken at the installation will not present a significant risk of pollution or harm due to the various containment measures provided by site infrastructure and the implementation of a planned preventative maintenance programme.

8 References

1. NGT Environmental Management System.

2. NGT: Hatton Compressor Station Accident Management Plan.

3. Advisian (Worley Group) (2021) Geo-Environmental Site Assessment, Hatton Gas Compressor Station, Hatton, Lincolnshire. Project Reference: 415013 - 00011

4. Environment Agency (2023). MagicMap. Accessed from http://magic.defra.gov.uk/MagicMap.aspx

5. British Geological Survey (2023). Geology of Britain viewer. Accessed from http://mappaps.bgs.ac.uk/geologyofbritain/home.html

6. Environment Agency (2023). Flood map for Planning. Accessed from https://flood-map-for-planningservice.gov.uk/

Other studies cited:

A. Kirkpatrick and Partners (1988) Hatton Compressor Station, Recommendations for Earthworks and Foundation Design. Report Reference 3414/PJ/WMK/MKJ) Borehole records by Exploration Associates.

B. Soil Mechanics (2009) Hatton Compressor Station, Lincolnshire, Factual report on Ground Investigation. Report Reference: A8161.

Figures

Figure A1 Full Installation Layout

Scale

Scale 1:1000

0 10 20 30 40 50 100

metres

national gas transmission

Project Environmental Solutions

Date	May 2023
Revision	FINAL (Rev 0)
Scale	
PESL No.	NGT.036.b

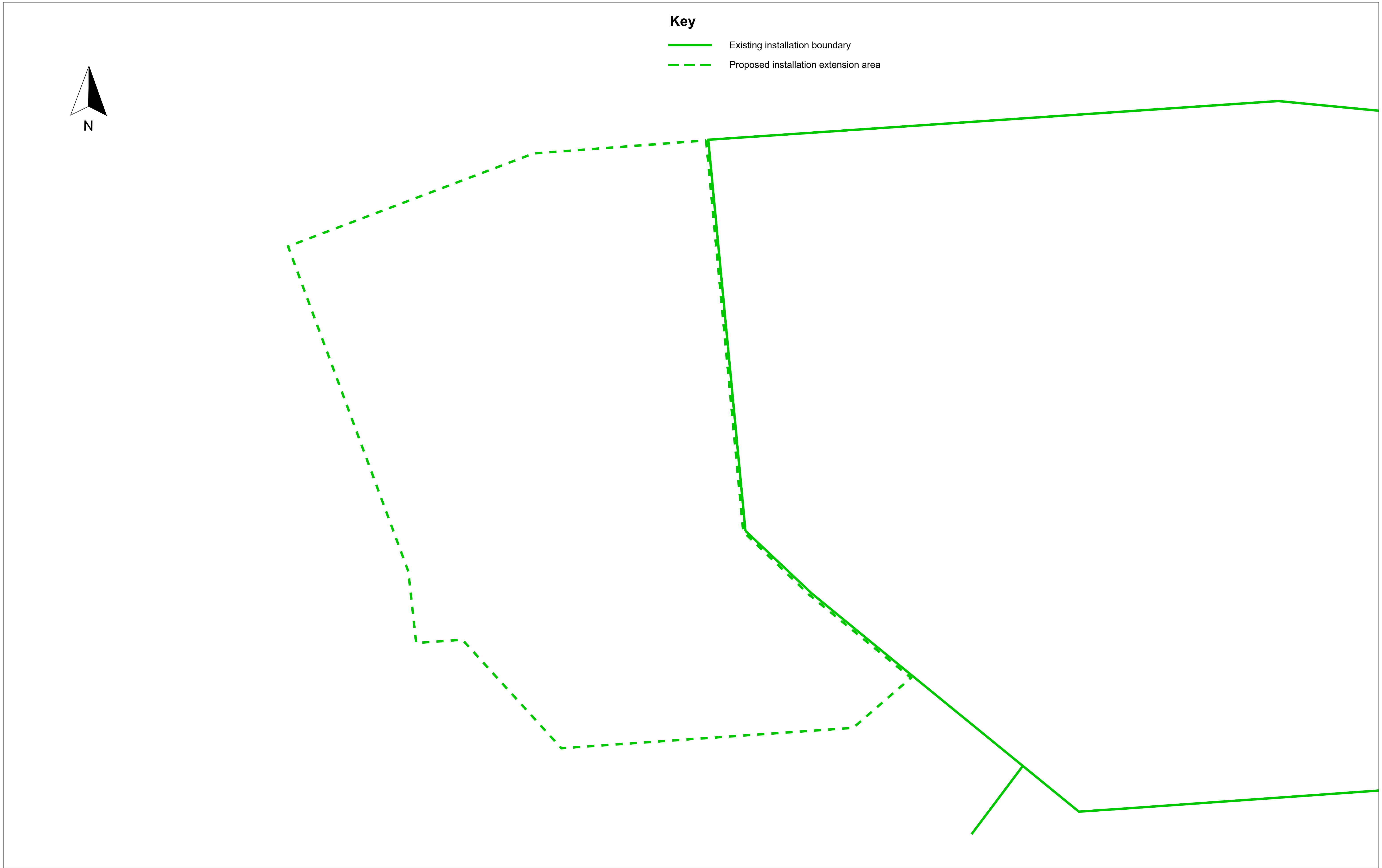
Project

Hatton Compressor Station, Application for an Environmental Permit Variation – Site Condition Report

Drawing title

Figure A1 – Full Installation Layout

Figure A2 Installation Extension Layout



Scale

Scale 1:750 metres

0 10 20 30 40 50

national gas transmission

Project Environmental Solutions

Date	May 2023
Revision	FINAL (Rev 0)
Scale	1:750 @ A3
PESL No.	NGT.036.b

Project

Hatton Compressor Station, Application for an Environmental Permit Variation – Site Condition Report

Drawing title

Figure A2 – Installation Extension Layout

Figure A3 Potential Sources of Pollution

Scale

Scale 1:750 metres

0 10 20 30 40 50

national gas transmission

Project Environmental Solutions

Date	May 2023
Revision	FINAL (Rev 0)
Scale	1:750 @ A3
PESL No.	NGT.036.b

Project

Hatton Compressor Station, Application for an Environmental Permit Variation – Site Condition Report

Drawing title

Figure A3 – Potential Sources of Pollution

Figure A4 Site Surfacing

Scale

Scale 1:750 metres

0 10 20 30 40 50

national gas transmission

Project Environmental Solutions

Date	May 2023
Revision	FINAL (Rev 0)
Scale	1:750 @ A3
PESL No.	NGT.036.b

Project

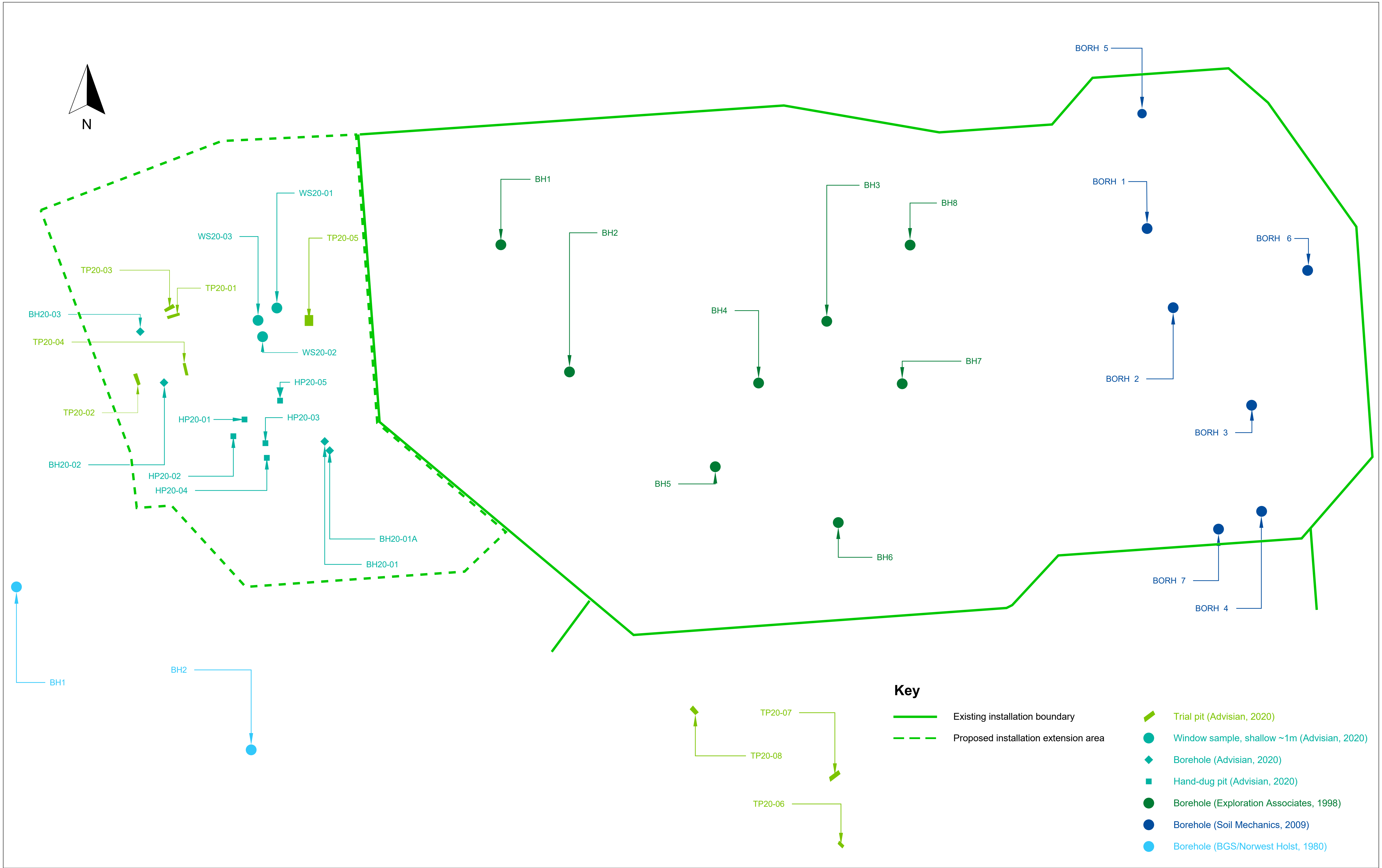
Hatton Compressor Station, Application for an Environmental Permit Variation – Site Condition Report

Drawing title

Figure A4 – Site surfacing

Figure A5 Historical Borehole Location Plan

Figure A5 shows the locations of the exploratory hole logs included as Appendix 2



Scale

Scale 1:1000

0 10 20 30 40 50 100
metres

national gas transmission

Project Environmental Solutions

Date	May 2023
Revision	FINAL (Rev 0)
Scale	1:1,000 @ A3
PESL No.	NGT.036.b

Project

Hatton Compressor Station, Application for an Environmental Permit Variation – Site Condition Report

Drawing title

Figure A5 – Historical Borehole Locations

Appendices

Appendix 1 Groundsure Report (2023)

Summary of findings

Page	Section	Past land use	On site	0-50m	50-250m	250-500m	500-2000m
13	1.1	Historical industrial land uses	0	1	0	4	-
14	1.2	Historical tanks	0	0	0	0	-
14	1.3	Historical energy features	0	1	0	0	-
15	1.4	Historical petrol stations	0	0	0	1	-
15	1.5	Historical garages	0	0	0	0	-
15	1.6	Historical military land	0	0	0	0	-
Page	**Section**	**Past land use - un-grouped**	**On site**	**0-50m**	**50-250m**	**250-500m**	**500-2000m**
16	2.1	Historical industrial land uses	0	1	0	6	-
17	2.2	Historical tanks	0	0	0	0	-
17	2.3	Historical energy features	0	1	0	0	-
17	2.4	Historical petrol stations	0	0	0	1	-
18	2.5	Historical garages	0	0	0	0	-
Page	**Section**	**Waste and landfill**	**On site**	**0-50m**	**50-250m**	**250-500m**	**500-2000m**
19	3.1	Active or recent landfill	0	0	0	0	-
19	3.2	Historical landfill (BGS records)	0	0	0	0	-
20	3.3	Historical landfill (LA/mapping records)	0	0	0	0	-
20	3.4	Historical landfill (EA/NRW records)	0	0	0	0	-
20	3.5	Historical waste sites	0	0	0	0	-
20	3.6	Licensed waste sites	0	0	0	0	-
20	3.7	Waste exemptions	0	0	4	37	-
Page	**Section**	**Current industrial land use**	**On site**	**0-50m**	**50-250m**	**250-500m**	**500-2000m**
25	4.1	Recent industrial land uses	0	2	3	-	-
26	4.2	Current or recent petrol stations	0	0	0	0	-
26	4.3	Electricity cables	0	0	0	0	-
26	4.4	Gas pipelines	1	3	5	0	-
27	4.5	Sites determined as Contaminated Land	0	0	0	0	-

28	**4.6**	**Control of Major Accident Hazards (COMAH)**	0	0	1	0	-
28	4.7	Regulated explosive sites	0	0	0	0	-
28	**4.8**	**Hazardous substance storage/usage**	0	3	0	0	-
29	4.9	Historical licensed industrial activities (IPC)	0	0	0	0	-
29	**4.10**	**Licensed industrial activities (Part A(1))**	0	0	5	0	-
30	4.11	Licensed pollutant release (Part A(2)/B)	0	0	0	0	-
30	4.12	Radioactive Substance Authorisations	0	0	0	0	-
30	**4.13**	**Licensed Discharges to controlled waters**	0	2	0	2	-
31	4.14	Pollutant release to surface waters (Red List)	0	0	0	0	-
31	4.15	Pollutant release to public sewer	0	0	0	0	-
32	4.16	List 1 Dangerous Substances	0	0	0	0	-
32	4.17	List 2 Dangerous Substances	0	0	0	0	-
32	4.18	Pollution Incidents (EA/NRW)	0	0	0	0	-
32	**4.19**	**Pollution inventory substances**	0	0	2	0	-
33	**4.20**	**Pollution inventory waste transfers**	0	0	1	0	-
35	4.21	Pollution inventory radioactive waste	0	0	0	0	-
Page	Section	Hydrogeology	On site	0-50m	50-250m	250-500m	500-2000m
36	**5.1**	**Superficial aquifer**	Identified (within 500m)				
38	**5.2**	**Bedrock aquifer**	Identified (within 500m)				
39	**5.3**	**Groundwater vulnerability**	Identified (within 50m)				
40	5.4	Groundwater vulnerability- soluble rock risk	None (within 0m)				
40	5.5	Groundwater vulnerability- local information	None (within 0m)				
41	5.6	Groundwater abstractions	0	0	0	0	0
42	**5.7**	**Surface water abstractions**	0	0	0	0	5
43	5.8	Potable abstractions	0	0	0	0	0
43	5.9	Source Protection Zones	0	0	0	0	-
43	5.10	Source Protection Zones (confined aquifer)	0	0	0	0	-
Page	Section	Hydrology	On site	0-50m	50-250m	250-500m	500-2000m
44	**6.1**	**Water Network (OS MasterMap)**	2	0	2	-	-

45	**6.2**	**Surface water features**	1	1	2	-	-
45	**6.3**	**WFD Surface water body catchments**	1	-	-	-	-
46	**6.4**	**WFD Surface water bodies**	0	0	0	-	-
46	6.5	WFD Groundwater bodies	0	-	-	-	-
Page	Section	River and coastal flooding	On site	0-50m	50-250m	250-500m	500-2000m
47	7.1	Risk of flooding from rivers and the sea	None (within 50m)				
47	7.2	Historical Flood Events	0	0	0	-	-
47	7.3	Flood Defences	0	0	0	-	-
48	7.4	Areas Benefiting from Flood Defences	0	0	0	-	-
48	7.5	Flood Storage Areas	0	0	0	-	-
49	7.6	Flood Zone 2	None (within 50m)				
49	7.7	Flood Zone 3	None (within 50m)				
Page	Section	Surface water flooding					
50	**8.1**	**Surface water flooding**	1 in 30 year, 0.1m - 0.3m (within 50m)				
Page	Section	Groundwater flooding					
52	**9.1**	**Groundwater flooding**	Low (within 50m)				
Page	Section	Environmental designations	On site	0-50m	50-250m	250-500m	500-2000m
53	**10.1**	**Sites of Special Scientific Interest (SSSI)**	0	0	0	0	1
54	10.2	Conserved wetland sites (Ramsar sites)	0	0	0	0	0
54	10.3	Special Areas of Conservation (SAC)	0	0	0	0	0
54	10.4	Special Protection Areas (SPA)	0	0	0	0	0
54	**10.5**	**National Nature Reserves (NNR)**	0	0	0	0	1
55	10.6	Local Nature Reserves (LNR)	0	0	0	0	0
55	**10.7**	**Designated Ancient Woodland**	0	0	0	0	4
55	10.8	Biosphere Reserves	0	0	0	0	0
56	10.9	Forest Parks	0	0	0	0	0
56	10.10	Marine Conservation Zones	0	0	0	0	0
56	10.11	Green Belt	0	0	0	0	0
56	10.12	Proposed Ramsar sites	0	0	0	0	0

56	10.13	Possible Special Areas of Conservation (pSAC)	0	0	0	0	0
57	10.14	Potential Special Protection Areas (pSPA)	0	0	0	0	0
57	10.15	Nitrate Sensitive Areas	0	0	0	0	0
57	**10.16**	**Nitrate Vulnerable Zones**	1	0	1	0	0
58	**10.17**	**SSSI Impact Risk Zones**	3	-	-	-	-
60	**10.18**	**SSSI Units**	0	0	0	0	1
Page	Section	Visual and cultural designations	On site	0-50m	50-250m	250-500m	500-2000m
61	11.1	World Heritage Sites	0	0	0	-	-
61	11.2	Area of Outstanding Natural Beauty	0	0	0	-	-
61	11.3	National Parks	0	0	0	-	-
61	11.4	Listed Buildings	0	0	0	-	-
62	11.5	Conservation Areas	0	0	0	-	-
62	11.6	Scheduled Ancient Monuments	0	0	0	-	-
62	11.7	Registered Parks and Gardens	0	0	0	-	-
Page	Section	Agricultural designations	On site	0-50m	50-250m	250-500m	500-2000m
63	**12.1**	**Agricultural Land Classification**	Grade 3 (within 250m)				
64	12.2	Open Access Land	0	0	0	-	-
64	12.3	Tree Felling Licences	0	0	0	-	-
64	**12.4**	**Environmental Stewardship Schemes**	0	0	1	-	-
64	**12.5**	**Countryside Stewardship Schemes**	0	1	0	-	-
Page	Section	Habitat designations	On site	0-50m	50-250m	250-500m	500-2000m
66	**13.1**	**Priority Habitat Inventory**	3	0	0	-	-
67	13.2	Habitat Networks	0	0	0	-	-
67	13.3	Open Mosaic Habitat	0	0	0	-	-
67	13.4	Limestone Pavement Orders	0	0	0	-	-
Page	Section	Geology 1:10,000 scale	On site	0-50m	50-250m	250-500m	500-2000m
68	**14.1**	**10k Availability**	Identified (within 500m)				
69	14.2	Artificial and made ground (10k)	0	0	0	0	-
70	14.3	Superficial geology (10k)	0	0	0	0	-

70	14.4	Landslip (10k)	0	0	0	0	-
71	14.5	Bedrock geology (10k)	0	0	0	0	-
71	14.6	Bedrock faults and other linear features (10k)	0	0	0	0	-
Page	Section	Geology 1:50,000 scale	On site	0-50m	50-250m	250-500m	500-2000m
72	**15.1**	**50k Availability**	Identified (within 500m)				
73	15.2	Artificial and made ground (50k)	0	0	0	0	-
73	15.3	Artificial ground permeability (50k)	0	0	-	-	-
74	**15.4**	**Superficial geology (50k)**	1	0	0	1	-
75	**15.5**	**Superficial permeability (50k)**	Identified (within 50m)				
75	15.6	Landslip (50k)	0	0	0	0	-
75	15.7	Landslip permeability (50k)	None (within 50m)				
76	**15.8**	**Bedrock geology (50k)**	1	0	0	0	-
77	**15.9**	**Bedrock permeability (50k)**	Identified (within 50m)				
77	15.10	Bedrock faults and other linear features (50k)	0	0	0	0	-
Page	Section	Boreholes	On site	0-50m	50-250m	250-500m	500-2000m
78	**16.1**	**BGS Boreholes**	0	1	1	-	-
Page	Section	Natural ground subsidence					
79	**17.1**	**Shrink swell clays**	Low (within 50m)				
80	**17.2**	**Running sands**	Very low (within 50m)				
81	**17.3**	**Compressible deposits**	Negligible (within 50m)				
82	**17.4**	**Collapsible deposits**	Very low (within 50m)				
83	**17.5**	**Landslides**	Very low (within 50m)				
84	**17.6**	**Ground dissolution of soluble rocks**	Negligible (within 50m)				
Page	Section	Mining, ground workings and natural cavities	On site	0-50m	50-250m	250-500m	500-2000m
85	18.1	Natural cavities	0	0	0	0	-
85	18.2	BritPits	0	0	0	0	-
85	18.3	Surface ground workings	0	0	0	-	-
85	18.4	Underground workings	0	0	0	0	0
86	18.5	Historical Mineral Planning Areas	0	0	0	0	-

86	18.6	Non-coal mining	0	0	0	0	0
86	18.7	Mining cavities	0	0	0	0	0
86	18.8	JPB mining areas	None (within 0m)				
86	18.9	Coal mining	None (within 0m)				
87	18.10	Brine areas	None (within 0m)				
87	18.11	Gypsum areas	None (within 0m)				
87	18.12	Tin mining	None (within 0m)				
87	18.13	Clay mining	None (within 0m)				
Page	**Section**	**Radon**					
88	**19.1**	**Radon**	Less than 1% (within 0m)				
Page	**Section**	**Soil chemistry**	**On site**	**0-50m**	**50-250m**	**250-500m**	**500-2000m**
90	**20.1**	**BGS Estimated Background Soil Chemistry**	1	0	-	-	-
90	20.2	BGS Estimated Urban Soil Chemistry	0	0	-	-	-
90	20.3	BGS Measured Urban Soil Chemistry	0	0	-	-	-
Page	**Section**	**Railway infrastructure and projects**	**On site**	**0-50m**	**50-250m**	**250-500m**	**500-2000m**
91	21.1	Underground railways (London)	0	0	0	-	-
91	21.2	Underground railways (Non-London)	0	0	0	-	-
91	21.3	Railway tunnels	0	0	0	-	-
91	21.4	Historical railway and tunnel features	0	0	0	-	-
91	21.5	Royal Mail tunnels	0	0	0	-	-
92	21.6	Historical railways	0	0	0	-	-
92	21.7	Railways	0	0	0	-	-
92	21.8	Crossrail 1	0	0	0	0	-
92	21.9	Crossrail 2	0	0	0	0	-
92	21.10	HS2	0	0	0	0	-

Appendix 2 Historical Exploratory Hole Records

Exploratory hole logs have been extracted from the BGS web site and the following reports:

- BGS records – source Norwest Holst Soil Engineering Ltd (1980).
- Kirkpatrick and Partners (1988) Hatton Compressor Station, Recommendations for Earthworks and Foundation Design. Report Reference 3414/PJ/WMK/MKJ) Borehole records by Exploration Associates.
- Soil Mechanics (2009) Hatton Compressor Station, Lincolnshire, Factual report on Ground Investigation. Report Reference: A8161.
- Advisian (Worley Group) (2021) Geo-Environmental Site Assessment, Hatton Gas Compressor Station, Hatton, Lincolnshire. Project Reference: 415013 - 00011

Norwest Holst Soil Engineering Ltd.

Borehole No. **1**

BOREHOLE LOG

Contract No. F4517
Location Hatton to Peterborough
Client British Gas
Method of Boring Percussion
Diameter of Borehole 150mm

Sheet 1 of 1
Chainage
Ground Level m.A.O.D.
Date 6/5/80

Description of Strata	Legend	Depth Below G.L.(m)	O.D. Level (m)	Casing Depth	Sampling and Coring	"N"/ R.Q.D.%	Daily Progress
TOPSOIL		0.30					
Brown sandy CLAY.		0.50			0.50	(60)	
Stiff olive green and grey becoming grey below 2.0m silty CLAY with much fine to coarse chalk gravel.				150mm to 1.50	1.50	(60)	
					2.50	(75)	
					4.00	(80)	
					5.50	(110)	
					7.50	(120)	
		8.00					

Type of Sample

Is S.P.T. ▮ Undisturbed
Ic. C.P.T. × Vane
O Jar Δ Water
● Bulk Piezometer

Remarks (Observations of Ground Water etc.)
( ) blows to drive U samples
Borehole dry.

Norwest Holst Soil Engineering Ltd.

BOREHOLE LOG

Borehole No. **2**

Contract No. F4517
Location Hatton to Peterborough
Client British Gas
Method of Boring Percussion
Diameter of Borehole 150mm

Sheet 1 of 1
Chainage
Ground Level m.A.O.D.
Date 6/5/80

Description of Strata	Legend	Depth Below G.L.(m)	O.D. Level (m)	Casing Depth	Sampling and Coring	"N"/ R.Q.D.%	Daily Progress
TOPSOIL		0.30					
Brown CLAY with occasional fine gravel.		0.50			0.50	(70)	
Stiff brown and grey mottled silty CLAY with occasional fine to coarse sub-rounded chalk gravel and occasional flints ..Below 4.0 becoming hard grey.				150mm to 2.00	1.50	(70)	
					2.50	(85)	
					4.00	(90)	
					5.50	(110)	
		8.00			7.50	(120)	

Type of Sample

- Is S.P.T.
- Ic. C.P.T.
- O Jar
- ● Bulk
- ■ Undisturbed
- × Vane
- Δ Water
- Piezometer

Remarks (Observations of Ground Water etc.)

( ) Blows to drive U samples.
Borehole dry during drilling.

Depth	Type	Cu kPa	w%	SPT N
0.30	D			
0.50-0.95	U(24)	102		15
1.00	D			
1.40	D			
1.60-2.05	U(35)			
1.60-2.05	B			
2.10-2.55	U(37)	99		22
2.60	D			
2.60-3.05	U(36)			
3.10	D			
3.50	D			
4.00-4.45	U(40)	240		15
4.50	D			
5.00	D			
5.50-5.95	U(45)			
6.00	D			
6.50	D			
7.00	D			
7.50-7.95	U(50)			
8.00	D			

Description	Depth	Level	Legend
	G.L.	34.51	
TOPSOIL.**	0.20	34.31	
Soft to firm light brown and grey brown slightly sandy silty CLAY with some fine to medium chalk and flint gravel.	0.70	33.81	
Firm to stiff and stiff grey and brown mottled fissured silty CLAY with some fine to medium chalk and flint gravel and small sand pockets.	2.50	32.01	
Very stiff dark grey with occasional green brown mottling, fissured carbonaceous silty CLAY with some fine to medium occasionally coarse chalk, flint, sandstone and mudstone gravel. At 4.50m layer of very stiff light grey fissured clayey silt.	8.00	26.51	
End of Borehole			

Drilling

Type	From	To	Size	Fluid
Cable Percussion	G.L.	8.00	0.15	–

Groundwater

Struck	Behaviour	Sealed	Date	Hole	Cased	Water
–			8.2.88	G.L.	–	–
			8.2.88	8.00	4.50	Dry

Remarks

Borehole Record

Project

British Gas plc
Proposed Compressor Station Hatton

Contract E7593

Borehole 1 (1 of 1)

exploration associates

Depth	Type	Cu kPa	w%	SPT N
0.30	D			
0.50–0.95	U(25)			
1.00	D			
1.50–1.95	U(32)	79	21	
2.00	D			
2.50–2.95	U(50)	143	17	
3.00	D			
3.50	D			
4.00–4.45	U(45)	190	16	
4.50	D			
5.00	D			
5.50–5.95	U(45)			
6.00	D			
6.50	D			
7.00	D			
7.50–7.95	U(80)			
8.00	D			

Description	Depth	Level	Legend
	G.L.	34.15	
TOPSOIL.**	0.20	33.95	
Firm grey and brown mottled sandy silty CLAY with occasional chalk and flint gravel.	0.80	33.35	
Firm to stiff becoming stiff grey and grey brown mottled fissured silty CLAY with some fine to medium chalk, flint and mudstone gravel.	2.80	31.35	
Intermixed irregular lenses, laminae and pockets of very stiff and stiff light grey SILT and grey silty CLAY with occasional gravel.	3.75	30.40	
Very stiff grey fissured silty CLAY with some irregular silt pockets and occasional gravel.	5.70	28.45	
Very stiff dark grey fissured carbonaceous silty CLAY with some fine to medium chalk, flint and mudstone gravel.	8.00	26.15	
End of Borehole			

Drilling

Type	From	To	Size	Fluid
Cable Percussion	G.L.	8.00	0.15	–

Groundwater

Struck	Behaviour	Sealed	Date	Hole	Cased	Water
4.70	Seepage		9.2.88	G.L.	–	–
			9.2.88	8.00	1.50	Dry

Remarks

Borehole Record	Project	Contract
	British Gas plc Proposed Compressor Station Hatton	E7593
exploration associates		Borehole 2 (1 of 1)

Sampling / Properties

Depth	Type	Cu kPa	w%	SPT N
0.40	D			
0.50–0.95	U(20)			
1.00	D			
1.50–1.95	U(30)	108	21	
2.00	D			
2.50–2.95	U(35)			
3.00	D			
3.50	D			
4.00–4.20	U(75)			
4.00–5.40	B			
5.00	D			
5.50–5.95	U(55)	190	16	
6.00	D			
6.50	D			
7.00–7.45	U(60)			
7.50	D			
8.00	D			
8.50–8.95	U(70)			
9.00	D			

Strata

Description	Depth	Level	Legend
	G.L.	33.86	
TOPSOIL.**	0.30	33.56	
Firm brown and orange brown sandy silty CLAY with occasional flint and chalk gravel.	0.80	33.06	
Firm to stiff becoming stiff grey and brown mottled fissured silty CLAY with some fine to medium chalk and flint gravel.	2.70	31.16	
Very stiff dark grey fissured carbonaceous silty CLAY with some fine to medium occasionally coarse chalk, flint and mudstone gravel.	9.00	24.86	
End of Borehole			

Drilling

Type	From	To	Size	Fluid
Cable Percussion	G.L.	9.00	0.15	–

Groundwater

Struck	Behaviour	Sealed	Date	Hole	Cased	Water
–			12.2.88	G.L.	–	–
			12.2.88	9.00	1.50	Dry

Remarks Cobble or boulder at 4.20m pushed to 5.40m

Borehole Record

exploration associates

Project
British Gas plc
Proposed Compressor Station Hatton

Contract E7593

Borehole 3 (1 of 1)

Sampling Depth	Type	Cu kPa	w%	SPT N
0.40	D			
0.50-0.95	B(16)			
1.00	D			
1.50-1.95	U(21)	80	21	
2.00	D			
2.50-2.95	U(35)	148	19	
3.00	D			
3.50	D			
4.00-4.45	U(50)	189	12	
4.50	D			
5.20	D			
5.30-5.75	B(55)			
5.80	D			
6.50	D			
7.00	D			
7.50-7.95	U(65)			
8.00	D			
9.00	D			
9.70	D			
9.70-10.15	B(70)			
10.20	D			

Strata

Description	Depth	Level
	G.L.	33.55
TOPSOIL.**	0.30	33.25
Firm brown sandy silty CLAY with occasional fine to medium chalk and flint gravel.	0.80	32.75
Firm to stiff becoming stiff grey and brown mottled silty CLAY with some fine to medium chalk and flint gravel.	2.70	30.85
Intermixed irregular lenses laminae and pockets of very stiff and stiff light grey SILT with some grey silty clay.	4.25	29.30
Very stiff grey silty CLAY with some light grey silt pockets.	5.10	28.45
Very stiff dark grey fissured carbonaceous silty CLAY with some fine to medium occasionally coarse chalk, flint and mudstone gravel. Boulder at 9.30m.		
End of Borehole	10.20	23.35

Drilling

Type	From	To	Size	Fluid
Cable Percussion	G.L.	10.20	0.15	–

Groundwater

Struck	Behaviour	Sealed	Date	Hole	Cased	Water
4.20	Seepage		10.2.88	G.L.	–	–
			10.2.88	10.20	1.50	Dry

Remarks Chiselled on cobble or boulder 9.30m to 9.70m (½ hr)

Borehole Record

exploration associates

Project British Gas plc
Proposed Compressor Station Hatton

Contract E7593

Borehole 4 (1 of 1)

Sampling / Properties / Strata

Depth	Type	Cu kPa	w%	SPT N
0.40	D			
0.50-0.95	U(15)	53	25	
1.00	D			
1.50-1.95	U(27)	109	19	
2.00	D			
2.40	D			
2.50-2.95	U(35)	145	19	
3.00	D			
3.50-3.95	U(50)			
4.00	D			
4.50	D			
5.00	D			
5.50-5.95	U(55)			
6.00	D			
6.50	D			
7.00	D			
7.50-7.95	U(75)			
8.00	D			

Description	Depth	Level
	G.L.	33.43
TOPSOIL.**	0.30	33.13
Firm grey brown and brown mottled sandy silty CLAY with occasional chalk and flint gravel.	0.90	32.53
Firm to stiff becoming stiff grey and brown mottled fissured silty CLAY with some chalk and flint gravel. Some sand pockets above 1.50m.	2.90	30.53
Intermixed irregular lenses, laminae and pockets of very stiff light brown SILT and grey silty CLAY.	3.50	29.93
Very stiff dark grey fissured carbonaceous silty CLAY with some chalk, flint and mudstone gravel.	8.00	25.43
End of Borehole		

Drilling

Type	From	To	Size	Fluid
Cable Percussion	G.L.	8.00	0.15	-

Groundwater

Struck	Behaviour	Sealed	Date	Hole	Cased	Water
2.70	Seepage		9.2.88	G.L.	-	-
			9.2.88	8.00	1.50	Dry

Remarks

Borehole Record

exploration associates

Project
British Gas plc
Proposed Compressor Station Hatton

Contract E7593

Borehole 5 (1 of 1)

Depth	Type	Cu kPa	w%	SPT N	Description	Depth	Level
					TOPSOIL.**	G.L.	32.17
0.40	D				Soft brown sandy CLAY.**	0.30	31.87
0.50-0.95	U(23)				Firm brown and dark brown fissured sandy silty CLAY with occasional gravel.	0.40	31.77
1.00	D				Stiff grey and brown mottled fissured silty CLAY with some fine to medium chalk and flint gravel.	0.80	31.37
1.40-1.85	U(27)						
1.90	D						
2.50-2.95	U(35)	138	18				
3.00	D				Very stiff light grey very closely fissured clayey SILT. Fissures ironstained.	2.70	29.47
3.20	D						
3.30-3.75	U(45)				Very stiff dark grey fissured carbonaceous silty CLAY with some fine to medium chalk, flint and mudstone gravel.	3.20	28.97
3.80	D						
4.20	D						
4.80-5.25	U(50)	230	16				
5.30	D						
6.00	D						
6.50-6.95	U(60)	230	16				
7.00	D				End of Borehole	7.00	25.17

Drilling

Type	From	To	Size	Fluid
Cable Percussion	G.L.	7.00	0.15	–

Groundwater

Struck	Behaviour	Sealed	Date	Hole	Cased	Water
			11.2.88	G.L.	–	–
			11.2.88	7.00	1.50	Dry

Remarks

Borehole Record

exploration associates

Project
British Gas plc
Proposed Compressor Station Hatton

Contract E7593

Borehole 6 (1 of 1)

Sampling / Properties / Strata

Depth	Type	Cu kPa	w%	SPT N
0.40	D			
0.50-0.95	U(20)			
1.00	D			
1.50-1.95	U(20)			
2.00	D			
2.50-2.95	U(40)	116	20	
3.00	D			
3.50	D			
4.00-4.45	U(45)			
4.50	D			
5.00	D			
5.50-5.95	U(70)			
6.00	D			
6.50	D			
7.00	D			
7.50-7.95	U(80)			
8.00	D			
8.40	D			

Description	Depth	Level
	G.L.	33.07
TOPSOIL.**	0.30	32.77
Soft to firm brown very sandy silty CLAY with occasional gravel.	0.70	32.17
Firm grey and brown mottled silty CLAY with many pockets of brown fine to medium sand and some gravel.	1.20	31.87
Firm to stiff brown and grey mottled fissured silty CLAY with occasional chalk and flint gravel.	2.20	30.87
Stiff becoming very stiff dark grey fissured carbonaceous silty CLAY with some chalk, flint and mudstone gravel. At 3.00m very closely ironstained fissures.	7.60	25.47
Compact silty fine SAND.	8.20	24.87
Stiff becoming very stiff dark grey fissured carbonaceous silty CLAY with some chalk, flint and mudstone gravel.	8.40	24.67
End of Borehole		

Drilling

Type	From	To	Size	Fluid
Cable Percussion	G.L.	8.40	0.15	-

Groundwater

Struck	Behaviour	Sealed	Date	Hole	Cased	Water
			11.2.88	G.L.	-	-
			11.2.88	8.40	1.50	Dry

Remarks

Borehole Record

exploration associates

Project
British Gas plc
Proposed Compressor Station Hatton

Contract E7593

Borehole 7 (1 of 1)

Sampling Depth	Type	Cu kPa	w%	SPT N	Strata Description	Depth	Level	Legend
					TOPSOIL.**	G.L.	34.14	
0.40	D					0.30	33.84	
0.50-0.95	U(20)				Soft to firm brown very sandy silty CLAY with clayey sand pockets.	0.80	33.34	
1.00	D				Firm to stiff grey and brown mottled fissured silty CLAY with some chalk and flint gravel.	1.70	32.44	
1.50-1.95	U(25)	84	20					
2.00	D				Stiff becoming very stiff grey and grey brown mottled fissured silty CLAY with some fine to medium chalk and flint gravel. At 3.00m ironstained fissures.	3.25	31.89	
2.50-2.95	U(45)							
3.00	D							
3.50	D				Stiff and very stiff dark grey fissured carbonaceous silty CLAY with some fine to medium chalk, flint and mudstone gravel.	7.00	27.14	
3.90-4.35	U(75)	146	16					
4.40	D							
5.00-5.45	U(60)							
5.50	D							
6.00	D							
6.50-7.00	U(75)							
6.50-7.00	B							
					End of Borehole			

Drilling

Type	From	To	Size	Fluid
Cable Percussion	G.L.	7.00	0.15	-

Groundwater

Struck	Behaviour	Sealed	Date	Hole	Cased	Water
			15.2.88	G.L.	-	-
			15.2.88	7.00	1.50	Dry

Remarks Cobble or boulder pushed 6.60m to 7.00m

Borehole Record

exploration associates

Project
British Gas plc
Proposed Compressor Station Hatton

Contract E7593

Borehole 8 (1 of 1)

Borehole Log

Soil Mechanics

Drilled DC Logged RDH Checked PH	Start 03/02/2009 End 03/02/2009	Equipment, Methods and Remarks Dando 3000 Cable percussion boring.	Depth from 0.00m to 10.00m Diameter 150mm Casing Depth 4.60m	Ground Level - Coordinates - National Grid - Chainage

Samples and Tests

Depth	Type & No	Records	Date Casing	Time Water
0.20	D 1	0.00-1.20 m Hand dug inspection pit.		
0.50-1.00	B 2			
1.20-1.65 1.20-1.65 1.20-1.65	SPT S D 3 B 4	N=10 (2,2/2,3,2,3)	1.20	dry
2.00-2.45	U 5	30 blows	1.20	dry
2.45-2.60	D 6			
3.00-3.45 3.00-3.45 3.00-3.45	SPT S D 7 B 8	N=23 (1,3/4,6,7,6)	2.90	dry
3.80-4.50	B 9			
5.00-5.45 5.00-5.45 5.00-5.45	SPT S D 10 B 11	N=27 (2,4/5,6,7,9)	4.60	dry
5.70-6.50	B 12			
7.00-7.19 7.00-7.25 7.00-7.45	SPT S D 13 B 14	50 (25 for 50mm/ 32,18 for 65mm)	4.60	dry
8.00-8.45	U 15	70 blows	4.60	dry
8.45-8.60	D 16			
9.00-9.45 9.00-9.45 9.00-9.45	SPT S D 17 B 18	N=34 (4,6/6,8,9,11)	4.60	dry
			03/02/2009 4.60	dry

Strata

Description	Depth, *Level* (Thickness)
Stiff greenish grey slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine and medium of various lithologies. (TOPSOIL)	0.20
Firm greyish brown slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of chalk and occasional flint. (GLACIAL TILL)	(2.30) 2.50
Stiff mottled grey and brown slightly sandy slightly gravelly CLAY. Gravel is subangular to well rounded fine to coarse of chalk. (GLACIAL TILL)	(0.50) 3.00
Stiff grey slightly gravelly becoming gravelly CLAY. Gravel is subangular to subrounded fine to coarse of predominately chalk, occasional flint and siltstone. (GLACIAL TILL) 7.00 m 1 No. subangular cobble of siltstone.	(5.20) 8.20
Very stiff fissured bluish grey silty CLAY with occasional fine and medium gravel sized marine shell fragments. (KIMMERIDGE EDGE)	(1.80)
EXPLORATORY HOLE ENDS AT 10.00 m	

Groundwater Entries
No. Struck (m) Post strike behaviour Depth sealed (m)
None observed (see Key Sheet)

Depth Related Remarks *
From to (m)

Chiselling
Depths (m) Time Tools used

Notes: For explanation of symbols and abbreviations see key sheet. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.

Scale 1:50

Project	HATTON COMPRESSOR STATION
Project No.	A8161
Carried out for	Land & Marine Project Engineering Ltd.

Borehole **BH1**

Borehole Log

Soil Mechanics

Drilled CR **Logged** RDH **Checked** PH	**Start** 03/02/2009 **End** 04/02/2009	**Equipment, Methods and Remarks** Dando 3000 Cable percussion boring	**Depth from** 0.00m **to** 10.00m **Diameter** 150mm **Casing Depth** 6.00m	**Ground Level** - **Coordinates** - **National Grid** - **Chainage**

Samples and Tests

Depth	Type & No	Records	Date Casing	Time Water
		0.00-1.20 m Hand dug inspection pit.		
0.60-1.00	B 1			
1.50-1.95	SPT S	N=19 (1,2/4,5,5,5)	1.00	dry
1.50-1.95	D 2			
1.50-1.95	B 3			
2.50-2.95	U 4	57 blows	2.50	dry
3.10	D 5			
4.00-4.45	SPT S	N=27 (2,4/4,6,8,9)	2.50	dry
4.00-4.45	D 6			
4.00-4.45	B 7			
6.00-6.45	SPT S	N=26 (2,3/5,6,7,8)	6.00	dry
6.00-6.45	D 8			
6.00-6.45	B 9		03/02/2009 6.00	dry
			04/02/2009 6.00	0800 dry
7.00-7.45	U 10	120 blows	6.00	dry
7.60	D 11			
8.10-8.55	SPT S	N=47 (5,6/9,11,12,15)	6.00	dry
8.10-8.55	D 12			
8.10-8.55	B 13			
			04/02/2009 6.00	dry

Strata

Description	Depth, *Level* (Thickness)
TOPSOIL	0.20
Firm becoming stiff mottled brown and grey slightly sandy CLAY.	(2.30) 2.50
Stiff grey slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine and medium of chalk and flint.	(4.70) 7.20
Very stiff fissured bluish grey silty CLAY with occasional fine and medium gravel sized marine shell fragments.	(2.80)
EXPLORATORY HOLE ENDS AT 10.00 m	

Groundwater Entries

No.	Struck (m)	Post strike behaviour	Depth sealed (m)

None observed (see Key Sheet)

Depth Related Remarks *

From to (m)

Chiselling

Depths (m) Time Tools used

Notes: For explanation of symbols and abbreviations see key sheet. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.

Scale 1:50

Project	HATTON COMPRESSOR STATION
Project No.	A8161
Carried out for	Land & Marine Project Engineering Ltd.

Borehole BH2

Borehole Log

Soil Mechanics

Drilled CR Logged RDH Checked PH	Start 04/02/2009 End 04/02/2009	Equipment, Methods and Remarks Dando 3000 Cable percussion boring	Depth from 0.00m	to 10.00m	Diameter 150mm	Casing Depth 6.00m	Ground Level - Coordinates - National Grid - Chainage

Samples and Tests

Depth	Type & No	Records	Date Casing	Time Water
		0.00-1.20 m Hand dug inspection pit		
1.50-1.95 1.50-1.95 1.50-1.95	SPT S D 1 B 2	N=23 (2,3/4,5,6,8)	1.00	dry
3.50-3.95 3.50-3.95 3.50-3.95	SPT S D 3 B 4	N=30 (2,4/4,5,7,14)	3.00	dry
5.50-5.95 5.60-6.05 5.60-6.05	SPT S D 5 B 6	N=36 (3,5/7,8,10,11)	5.50	dry
6.60-7.05	U 7	120 blows	6.00	dry
7.10-7.55 7.10-7.55 7.10-7.55 7.20	SPT S D 10 D 9 D 8	N=38 (4,5/6,9,11,12)	6.00	dry
9.10-9.55 9.10-9.55 9.10-9.55	SPT S D 11 B 12	N=41 (2,5/7,9,10,15)	6.00	dry
			04/02/2009 6.00	dry
Depth	Type & No	Records	Date Casing	Time Water

Strata

Description	Depth, *Level* (Thickness)	Legend	Backfill/ Instruments
TOPSOIL	0.20		
Firm becoming stiff mottled grey and brown slightly gravelly CLAY. Gravel is subangular to subrounded fine and medium of chalk.	(3.30) 3.50		
Stiff to very stiff dark grey slightly gravelly CLAY. Gravel is subangular to subrounded fine and medium of chalk.	(3.70) 7.20		
Very stiff fissured bluish grey silty CLAY with occasional fine and medium gravel sized marine shell fragments.	(2.80)		
EXPLORATORY HOLE ENDS AT 10.00 m			

Groundwater Entries

No.	Struck (m)	Post strike behaviour	Depth sealed (m)

None observed (see Key Sheet)

Depth Related Remarks *

From	to (m)

Chiselling

Depths (m)	Time	Tools used

Notes: For explanation of symbols and abbreviations see key sheet. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.

Scale 1:50

Project	HATTON COMPRESSOR STATION
Project No.	A8161
Carried out for	Land & Marine Project Engineering Ltd.

Borehole

BH3

Borehole Log

Soil Mechanics

Drilled CR Logged RDH Checked PH	Start 05/02/2009 End 05/02/2009	Equipment, Methods and Remarks Dando 3000 Cable percussion boring.	Depth from 0.00m to 10.00m Diameter 150mm Casing Depth 5.00m

Ground Level -
Coordinates -
National Grid -
Chainage

Samples and Tests / Strata

Depth	Type & No	Records	Date Casing	Time Water	Description	Depth, Level (Thickness)	Legend	Backfill/ Instruments
		0.00-1.20 m Hand dug inspection pit.			TOPSOIL	0.15		
					Firm becoming stiff mottled brown and grey slightly gravelly CLAY. Gravel is subangular to subrounded fine and medium of chalk.			
1.50-1.95 1.50-1.95 1.50-1.95	SPT S D 1 B 2	N=24 (2,4/4,5,7,8)	1.00	dry		(2.85)		
					Stiff to very stiff grey slightly gravelly CLAY. Gravel is subangular to subrounded fine and medium of chalk.	3.00		
3.50-3.95 3.50-3.95 3.50-3.95	SPT S D 3 B 4	N=34 (3,5/6,8,9,11)	2.50	dry				
						(3.00)		
5.50-5.95 5.50-5.95 5.50-5.95	SPT S D 5 B 6	N=37 (4,5/7,8,10,12)	4.00	dry				
					Very stiff fissured bluish grey silty CLAY with occasional fine and medium gravel sized marine shell fragments.	6.00		
7.50-7.95 7.50-7.95 7.50-7.95	SPT S D 7 B 8	N=42 (4,6/7,10,11,14)	5.00	dry				
						(4.00)		
9.00-9.45	U 9	120 blows	5.00	dry				
9.60	D 10							
			05/02/2009 5.00	dry				
Depth	Type & No	Records	Date Casing	Time Water	EXPLORATORY HOLE ENDS AT 10.00 m			

Groundwater Entries
No. Struck (m) Post strike behaviour Depth sealed (m)
None observed (see Key Sheet)

Depth Related Remarks *
From to (m)

Chiselling
Depths (m) Time Tools used

Notes: For explanation of symbols and abbreviations see key sheet. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.
Scale 1:50

Project HATTON COMPRESSOR STATION
Project No. A8161
Carried out for Land & Marine Project Engineering Ltd.

Borehole **BH4**

Borehole Log

Soil Mechanics

Drilled DC Logged RDH Checked PH	Start 03/02/2009 End 04/02/2009	Equipment, Methods and Remarks Dando 3000 Cable percussion boring.	Depth from 0.00m to 10.00m, Diameter 150mm, Casing Depth 3.00m	Ground Level - Coordinates - National Grid - Chainage

Samples and Tests / Strata

Depth	Type & No	Records	Date Casing	Time Water	Description	Depth, Level (Thickness)
		0.00-1.20 m Hand dug inspection pit.			Firm greyish brown slightly gravelly CLAY. Gravel is subangular to subrounded fine of chalk. (TOPSOIL)	0.20
0.20	D 1					
0.50-1.00	B 2				Firm mottled brown and grey slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine of chalk.	(2.80)
1.20-1.65	SPT S	N=8 (1,2/2,2,2,2)	1.20	dry		
1.20-1.65	D 3					
1.20-1.65	B 4					
2.00-2.50	B 5					
3.00-3.45	SPT S	N=24 (2,5/5,6,6,7)	3.00	dry	Stiff becoming very stiff slightly gravelly CLAY. Gravel is subangular to subrounded fine and medium of chalk.	3.00
3.00-3.45	D 6					
3.00-3.45	B 7					
4.00-4.45	U 8		3.00			
4.00-4.45	D 9					
4.00-4.45	U 8	45 blows		dry		
5.00-5.45	SPT S	N=25 (9,6/5,5,7,8)	3.00	dry	5.00 m 1 No. subrounded Chalk cobble.	
5.00-5.45	D 10					
5.00-5.45	B 11		03/02/2009 3.00	dry		
			04/02/2009 3.00	0800 dry		(5.30)
5.80-6.50	B 12					
7.00-7.45	SPT S	N=32 (3,5/8,7,8,9)	3.00	dry	7.00 m 1 No. subangular Sandstone cobble.	
7.00-7.45	D 13					
7.00-7.45	B 14					
7.80-8.30	B 15					
8.30	D 16				Very stiff fissured bluish grey silty CLAY with occasional fine and medium gravel sized marine shell fragments.	8.30
9.00-9.45	SPT S	N=34 (5,6/6,8,8,12)	3.00	dry		(1.70)
9.00-9.45	D 17					
9.00-9.45	B 18					
			04/02/2009 3.00	dry		
					EXPLORATORY HOLE ENDS AT 10.00 m	

Groundwater Entries
No. Struck (m) Post strike behaviour Depth sealed (m)
None observed (see Key Sheet)

Depth Related Remarks *
From to (m)

Chiselling
Depths (m) Time Tools used

Notes: For explanation of symbols and abbreviations see key sheet. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.
Scale 1:50

Project	HATTON COMPRESSOR STATION
Project No.	A8161
Carried out for	Land & Marine Project Engineering Ltd.

Borehole **BH5**

Sheet 1 of 1

Borehole Log

Soil Mechanics

Drilled DC Logged RDH Checked PH	Start 04/02/2009 End 04/02/2009	Equipment, Methods and Remarks Dando 3000 Cable percussion boring.	Depth from 0.00m, to 10.00m, Diameter 150mm, Casing Depth 1.60m	Ground Level - Coordinates - National Grid - Chainage

Samples and Tests / Strata

Depth	Type & No	Records	Date Casing	Time Water	Description	Depth, Level (Thickness)
0.20	D 1	0.00-1.20 m Hand dug inspection pit			Firm light brownish grey slightly sandy slightly gravelly CLAY. Gravel is angular fine and medium of various lithologies. (TOPSOIL)	0.20
0.50-1.00	B 2				Firm mottled grey and brown slightly gravelly CLAY. Gravel is subangular to subrounded fine and medium of chalk.	
1.20-1.65	SPT S	N=10 (1,2/2,2,3,3)	1.20	dry		
1.20-1.65	D 3					
1.20-1.65	B 4					(2.50)
2.00-2.50	B 5					
					2.50 m 1 No. subangular cobble of flint.	
2.70	D 6				Firm becoming stiff slightly gravelly to gravelly CLAY. Gravel is subangular to rounded fine and medium of chalk and occasional siltstone.	2.70
3.00-3.45	SPT S	N=17 (1,2/3,3,4,7)	1.60	dry		
3.00-3.45	D 7					
3.00-3.45	B 8					
4.00-4.45	U 9	55 blows	1.60	dry		
4.45-4.60	D 10					(3.30)
5.00-5.45	SPT S	N=26 (7,5/5,7,7,7)	1.60	dry		
5.00-5.45	D 11					
5.00-5.45	B 12					
6.00	D 13				Very stiff fissured bluish grey silty CLAY with occasional fine and medium gravel sized marine shell fragments.	6.00
6.00-6.50	B 14					
7.00-7.45	SPT S	N=34 (4,5/6,7,9,12)	1.60	dry		
7.00-7.45	D 15					
7.00-7.45	B 16					
7.80-8.50	B 17					(4.00)
9.00-9.45	SPT S	N=43 (3,4/7,9,12,15)	1.60	dry		
9.00-9.45	D 18					
9.00-9.45	B 19					
			04/02/2009 1.60	dry	EXPLORATORY HOLE ENDS AT 10.00 m	

Groundwater Entries

No. Struck (m) Post strike behaviour Depth sealed (m)

None observed (see Key Sheet)

Depth Related Remarks *

From to (m)

Chiselling

Depths (m) Time Tools used

Notes: For explanation of symbols and abbreviations see key sheet. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.

Scale 1:50

Project HATTON COMPRESSOR STATION

Project No. A8161

Carried out for Land & Marine Project Engineering Ltd.

Borehole **BH6**

Borehole Log

Soil Mechanics

Drilled DC Logged RDH Checked PH	Start 04/02/2009 End 04/02/2009	Equipment, Methods and Remarks Dando 3000 Cable percussion boring.	Depth from 0.00m to 10.00m Diameter 150mm Casing Depth 1.60m	Ground Level - Coordinates - National Grid - Chainage

Samples and Tests / Strata

Depth	Type & No	Records	Date Casing	Time Water	Description	Depth, Level (Thickness)
0.10	D 1	0.00-1.20 m Hand dug inspection pit			Firm greyish brown CLAY. (TOPSOIL)	0.10
0.50-1.00	B 2				Firm becoming stiff brown becoming mottled brown and grey slightly gravelly CLAY. Gravel is subangular fine to coarse of chalk.	
1.20-1.65 1.20-1.65 1.20-1.65	SPT S D 3 B 4	N=8 (1,1/1,2,2,3)	1.20	dry		(2.90)
2.00-2.45	U 5	25 blows	1.60	dry		
2.45-2.60	D 6					
3.00-3.45 3.00-3.45 3.00-3.45	SPT S D 7 B 8	N=17 (2,2/3,4,4,6)	1.60	dry	Stiff grey slightly gravelly to gravelly CLAY. Gravel is subangular to subrounded fine and medium, rarely coarse, of chalk.	3.00
3.80-4.50	B 9					(2.50)
5.00-5.45 5.00-5.45 5.00-5.45	SPT S D 10 B 11	N=21 (2,4/4,4,6,7)	1.60	dry		
5.50	D 12				Stiff to very stiff fissured bluish grey silty CLAY with occasional fine and medium gravel sized marine shell fragments.	5.50
6.00-6.45	U 13	35 blows	1.60	dry		
6.45-6.60	D 14					
7.00-7.45 7.00-7.45 7.00-7.45	SPT S D 15 B 16	N=26 (3,4/5,6,7,8)	1.60	dry		
7.80-8.50	B 17					(4.50)
9.00-9.45 9.00-9.45 9.00-9.45	SPT S D 18 B 19	N=33 (5,6/9,8,8,8)	1.60	dry		
			04/02/2009 1.60	dry		
Depth	Type & No	Records	Date Casing	Time Water	EXPLORATORY HOLE ENDS AT 10.00 m	

Legend | Backfill/Instruments

Groundwater Entries

No. Struck (m) Post strike behaviour Depth sealed (m)

None observed (see Key Sheet)

Depth Related Remarks *

From to (m)

Chiselling

Depths (m) Time Tools used

Notes: For explanation of symbols and abbreviations see key sheet. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.

Scale 1:50

Project	HATTON COMPRESSOR STATION
Project No.	A8161
Carried out for	Land & Marine Project Engineering Ltd.

Borehole **BH7**

Sheet 1 of 1

Norwest Holst Soil Engineering Ltd.

Borehole **1**

BOREHOLE LOG

Contract No. F4517
Location Hatton to Peterborough
Client British Gas
Method of Boring Percussion
Diameter of Borehole 150mm

Sheet 1 of 1
Chainage
Ground Level m.A.O.D
Date 6/5/80

Description of Strata	Legend	Depth Below G.L.(m)	O.D. Level (m)	Casing Depth	Sampling and Coring	"N"/ R.Q.D.%	Da Prog
TOPSOIL		0.30					
Brown sandy CLAY.		0.50			0.50	(60)	
Stiff olive green and grey becoming grey below 2.0m silty CLAY with much fine to coarse chalk gravel.				150mm to 1.50	1.50	(60)	
					2.50	(75)	
					4.00	(80)	
					5.50	(110)	
					7.50	(120)	
		8.00					

Type of Sample
S.P.T. Undisturbed
C.P.T. X Vane

Remarks (Observations of Ground Water etc.)
( ) blows to drive U samples
Borehole dry.

Norwest Holst Soil Engineering Ltd.

Borehole **2**

BOREHOLE LOG

Contract No. F4517
Location Hatton to Peterborough
Client British Gas
Method of Boring Percussion
Diameter of Borehole 150mm

Sheet 1 of 1
Chainage
Ground Level m.A.O.D
Date 6/5/80

Description of Strata	Legend	Depth Below G.L.(m)	O.D. Level (m)	Casing Depth	Sampling and Coring	"N"/ R.Q.D.%	Dai Prog
TOPSOIL		0.30					
Brown CLAY with occasional fine gravel.		0.50			0.50	(70)	
Stiff brown and grey mottled silty CLAY with occasional fine to coarse sub-rounded chalk gravel and occasional flints ..Below 4.0 becoming hard grey.				150mm to 2.00	1.50	(70)	
					2.50	(85)	
					4.00	(90)	
					5.50	(110)	
		8.00			7.50	(120)	

Remarks (Observations of Ground Water etc.)
( ) Blows to drive U samples.
Borehole dry during drilling.

Type of Sample
Is S.P.T. ■ Undisturbed
Ic. C.P.T. X Vane

Project: Hatton Compressor Station	Contractor: ADP	Borehole Number: **BH20-01**
Client: National Grid	Equipment: Commachio	Project Number: 415013-00011
	Method: Dynamic Sampling and Rotary Core	Surveyed Elevation: 34.13 m

Sample Type: Shelby Tube (ST), Core Sample, SPT Sample (SS), Grab Sample (GB), No Recovery, Bulk Sample

Well Details: Bentonite, Peltonite, Slough, Grout, Drill Cuttings, Sand

Columns: Depth (m) | Soil Symbol | SOIL DESCRIPTION | Sample Type | Sample Number | Plastic – MC – Liquid (10, 20, 30, 40) | Other Data/ Comments ■SPT Blow Counts per 75mm■ (20, 40, 60, 80) | Exploration | Elevation (m)

Soil Description	Sample Number	Plastic / MC / Liquid	SPT Blow Counts
Grass cover over firm brown slightly gravelly silty CLAY. Gravel is sub-angular fine to medium of chalk and flint. Clay is is of medium plasticity. No visual or olfactory evidence of contamination (TOPSOIL).	E, E, G		
MADE GROUND: Creamy brown slightly gravelly fine to medium, medium dense SAND with pockets of clay. Gravel is sub-rounded fine of flint. No visual or olfactory evidence of contamination.	G		20 (4-5-5-6)
MADE GROUND: Black plastic membrane.	G	17, PI=27	
Stiff grey mottled brown slightly gravelly CLAY. Gravel is sub-angular fine to medium of chalk and flint. No visual or olfactory evidence of contamination. Clay is dry of low plasticity (GLACIAL TILL).	G, E		27 (5-6-7-9)
2.8 % gravel, 12.8 % sand, 84.4 % fines Very stiff brown gravelly silty CLAY. Gravel is sub-angular fine to coarse chalk and flint. Clay is dry and of low to medium plasticity. No visual or olfactory evidence of contamination. (GLACIAL TILL).	G		30 (7-8-7-8)
Very stiff to hard brown grey slightly silty gravelly CLAY. Gravel is sub-angular fine to coarse chalk and flint. Clay is dry and of medium plasticity. No visual or olfactory evidence of contamination (GLACIAL TILL).	G		30 (6-6-8-10)
	G		36 (5-8-10-13)
	GE	17, PI=25	
	G		30 (7-7-8-8)

Depth (m): 1, 2, 3, 4, 5, 6, 7, 8, 9

Elevation (m): 34, 33, 32, 31, 30, 29, 28, 27, 26, 25

End of Hole at a depth of 7.50 m
No water encountered.
Hand dug to 1.20 m bgl.
Dynamic sampled to 2.00 m bgl, then rotary flushed to base due to stiffness of clay.
Hole backfilled upon completion with bentonite pellets.

Water Levels:
No Groundwater Observed

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Logged By: CL		Completion Depth: 7.50 m
Reviewed By: KM	Completed on: 20/10/2020	
Groundwater Depth:		Page 1 of 1

Project: Hatton Compressor Station	Contractor: ADP	Borehole Number: **BH20-01A**
Client: National Grid	Equipment: Hand Excavation	Project Number: 415013-00011
	Method: Hand Tools	Surveyed Elevation: 34.21 m

Sample Type: Shelby Tube (ST), Core Sample, SPT Sample (SS), Grab Sample (GB), No Recovery, Bulk Sample

Well Details: Bentonite, Peltonite, Slough, Grout, Drill Cuttings, Sand

Depth (m)	Soil Symbol	SOIL DESCRIPTION	Sample Type	Sample Number	Other Data/ Comments (Plastic 10 20 MC 30 Liquid 40)		Elevation (m)
		MADE GROUND: Grass cover over firm to stiff, brown, slightly gravelly, very silty CLAY. Low to medium plasticity. Gravel is subangular, fine to coarse flint and occasional wood. No visual or olfactory evidence of contamination.					34.0
0.5		End of Hole at a depth of 0.35 m Borehole terminated at 0.35 m bgl on a cobble or concrete layer (fairly flat surface). Pit relocated south to become BH20-01. Water Levels:					33.5

WP SPT/CORING HATTON GEOTECH LOGS.GPJ WORLEYPARSONS DATA.GDT 8/12/20

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Logged By: CL		Completion Depth: 0.35 m
Reviewed By: KM	Completed on: 19/10/2020	
Groundwater Depth:		Page 1 of 1

Project: Hatton Compressor Station	Contractor: ADP	Borehole Number: **BH20-02**
Client: National Grid	Equipment: Commachio	Project Number: 415013-00011
	Method: Dynamic Sampling and Rotary Core	Surveyed Elevation: 34.71 m

Sample Type: Shelby Tube (ST) | Core Sample | SPT Sample (SS) | Grab Sample (GB) | No Recovery | Bulk Sample

Well Details: Bentonite | Peltonite | Slough | Grout | Drill Cuttings | Sand

Depth (m)	SOIL DESCRIPTION	Sample Type	Sample Number	Plastic / MC / Liquid (10 20 30 40)	Other Data/ Comments (SPT Blow Counts per 75mm) (20 40 60 80)	Exploration	Elevation (m)
0.00–1.20	28.7 % gravel, 27.9 % sand, 43.4 % fines MADE GROUND: Grass cover over soft brown gravelly sandy CLAY. Sand is fine to medium. Gravel is sub-angular fine to coarse flint, sandstone and occasional concrete. Clay is of medium plasticity. No visual or olfactory evidence of contamination.		E E G	17 PI=27			34
1.20–2.90	9.7 % gravel, 13 % sand, 77.3 % fines Firm brown mottled grey gravelly very silty CLAY. Clay is low to medium plasticity. Gravel is sub-angular fine to medium of chalk and flint. No visual or olfactory evidence of contamination (GLACIAL TILL).		G		11 2-3-2-4		33
			E G	21 PI=27	24 4-5-6-9		32
2.90–7.50	4.5 % gravel, 5.7 % sand, 89.8 % fines Stiff to hard grey gravelly silty CLAY. Gravel is sub-angular fine to coarse of chalk and occasional flint. No visual or olfactory evidence of contamination (GLACIAL TILL).		G		28 4-6-9-9		31
			G		31 6-7-9-9		30, 29
			G	17 PI=16			28
			G		34 6-10-9-9		27

End of Hole at a depth of 7.50 m
No water encountered.
Hand dug to 1.20 m bgl.
Dynamic sampled to 2.50 m bgl, then rotary flushed to base due to stiffness of clay.
Unable to collect un-disturbed sample (U100) due to stiffness of clay.
Hole backfilled upon completion with bentonite pellets.

Water Levels:
No Groundwater Observed

Advisian
Worley Group

Logged By: CL		Completion Depth: 7.50 m
Reviewed By: KM	Completed on: 21/10/2020	
Groundwater Depth:		

Project: Hatton Compressor Station	Contractor: ADP	Borehole Number: **BH20-03**
Client: National Grid	Equipment: Commachio	Project Number: 415013-00011
	Method: Dynamic Sampling and Rotary Core	Surveyed Elevation: 34.69 m

Sample Type: Shelby Tube (ST) | Core Sample | SPT Sample (SS) | Grab Sample (GB) | No Recovery | Bulk Sample

Well Details: Bentonite | Peltonite | Slough | Grout | Drill Cuttings | Sand

Depth (m)	SOIL DESCRIPTION	Sample Number	Plastic / MC / Liquid	Other Data/ Comments (SPT Blow Counts per 75mm)
0	Grass cover over brown slightly gravelly fine SAND. Gravel is sub-angular fine of flint. No visual or olfactory evidence of contamination (TOPSOIL).	E		
	10.3 % gravel, 40.3 % sand, 49.3 % fines MADE GROUND: Firm orange brown slightly gravelly sandy CLAY. Clay is of medium plasticity. Sand is fine to medium. Gravel is sub-angular fine to coarse of flint. No visual or olfactory evidence of contamination.	G		13 (2-2-4-5)
	7.3 % gravel, 14.5 % sand, 39.2 % fines Firm grey mottled brown gravelly silty CLAY becoming stiff at 2.00 m bgl. Clay is of medium plasticity. Gravel is sub-angular fine to coarse of flint. No visual or olfactory evidence of contamination (GLACIAL TILL).	G	18, PI=25	22 (5-5-6-6)
	Stiff grey slightly gravelly silty CLAY. Gravel is sub-angular fine to coarse of flint and chalk. Clay is medium to low plastic. No visual or olfactory evidence of contamination (GLACIAL TILL).	E, G		22 (4-5-5-8)
5	Stiff to very stiff brownish grey slightly gravelly very silty CLAY. Gravel is sub-angular fine flint. Clay is low plastic. No visual or olfactory evidence of contamination (GLACIAL TILL).	E, G	18, PI=13	29 (5-6-8-10)
	Stiff to hard grey slightly gravelly silty CLAY. Gravel is sub-angular fine to coarse of flint and chalk. No visual or olfactory evidence of contamination (GLACIAL TILL).	G		35 (7-9-9-10)

End of Hole at a depth of 7.50 m
No water encountered.
Hand dug to 1.20 m bgl.
Dynamic sampled to 1.50 m bgl, then rotary flushed to base due to stiffness of clay.
Hole backfilled upon completion with bentonite pellets.

Water Levels:
No Groundwater Observed

Elevation (m): 34, 33, 32, 31, 30, 29, 28, 27, 26, 25

WP SPT/CORING HATTON GEOTECH LOGS.GPJ WORLEYPARSONS DATA.GDT 8/12/20

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Logged By: CL	Completion Depth: 7.50 m
Reviewed By: KM	Completed on: 21/10/2020
Groundwater Depth:	Page 1 of 1

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TRIAL PIT LOG

Pit No **TP20-01**

Project Name: Hatton Gas Compressor Station	Project No: 415013-00011	Level: 34.78m AOD	Date 22/10/2020
Location: Hatton		Dimensions: 3.00m × 0.75m; Depth 1.20m; Orientation: ° from North	Scale 1 : 23.81
Client: National Grid			Logged By CL; Checked By CL

Photo

Photo Description:

(m)	Water Levels	Samples & In Situ Testing Type	Depth (m)	Result	Legend	Depth (m) (thickness)	Elevation (m AOD)	Description
		ES	0.00-0.10	PID = 0ppmv		(0.45)		Grass cover over soft brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is sub-angular fine to coarse of flint with rare fragments of plastic. Clay is of medium plasticity. No visual or olfactory evidence of contamination (TOPSOIL). Penetrometer = 6.5 N/cm2
0.3		B	0.30-0.30					
0.45				PID = 0ppmv		0.45	34.33	Firm brown mottled grey gravelly silty CLAY. Gravel is sub-angular to rounded fine to coarse (including occasional cobbles) of flint. Clay is of medium plasticity. No visual or olfactory evidence of contamination (POSSIBLE REWORKED NATURAL).
0.7		ES	0.70			(0.75)		
1.0		B	1.00-1.00					...at 1.0 m, Fines = 66.8% (Clay = 35.8%, Silt = 31%); Sand = 14.7%; Gravel = 18.5%. MC = 15%, Liquid limit = 46%, Plastic limit = 21% Penetrometer = 3.6 N/cm2
1.15	1							
1.2				PID = 0ppmv		1.20	33.58	Trial pit completed at 1.20m

GENERAL REMARKS:
Perched water encountered at 1.15 m bgl around encountered drainage pipe.
Trial pit terminated at 1.20 m bgl due to encountering drainage pipe.

BURIED STRUCTURES:
0.1 m diameter blue plastic pipe encountered at 1.20 m. Pipe running parallel to the trial pit. National Grid confirmed it as a drainage pipe.

SHORING: N/A

STABILITY: N/A

TRIAL PIT LOG

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Pit No **TP20-02**
Sheet 1 of 1

Project Name:	Hatton Gas Compressor Station
Project No:	415013-00011
Level:	34.54m AOD
Date	22/10/2020
Location:	Hatton
Dimensions:	3.00m × 0.70m
Depth	2.10m
Orientation:	° from North
Scale	1 : 23.81
Client:	National Grid
Logged By	CL
Checked By	CL

Photo

Photo Description:

(m)	Water Levels	Samples & In Situ Testing: Type	Depth (m)	Result	Legend	Depth (m) (thickness)	Elevation (m AOD)	Description
		ES TP20-02	0.00-0.10	PID = 0ppmv		(0.90)		MADE GROUND: Grass cover over soft to firm brown slightly gravelly silty CLAY. Gravel is angular to sub-angular fine to coarse of flint and occasional pieces of concrete. Clay is of medium plasticity. No visual or olfactory evidence of contamination.
0.8		ES TP20-02	0.80-0.80	PID = 0ppmv		0.90	33.64	MC = 17%, Liquid limit = 38%, Plastic limit = 18% Penetrometer = 8.0 N/cm2
						(1.20)		Firm to stiff grey gravelly silty CLAY with frequent lenses of orange-brown fine to medium SAND. Gravel is sub-angular to sub-rounded fine to coarse of flint and occasional chalk. Clay is of medium plasticity. No visual or olfactory evidence of contamination (GLACIAL TILL).
1.9		B TP20-02	1.90	PID = 0ppmv		2.10	32.44	Penetrometer = 8.0 N/cm2
2.1								Trial pit completed at 2.10m

GENERAL REMARKS:
No water encountered.

BURIED STRUCTURES:

SHORING: N/A

STABILITY: N/A

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TRIAL PIT LOG

Pit No **TP20-03**
Sheet 1 of 1

Project Name:	Hatton Gas Compressor Station
Project No:	415013-00011
Level:	34.81m AOD
Date	22/10/2020
Location:	Hatton
Client:	National Grid
Dimensions:	2.50m x 0.70m
Depth	2.00m
Orientation:	° from North
Scale	1 : 23.81
Logged By	CL
Checked By	CL

Photo

Photo Description:

Depth (m)	Water Levels	Samples & In Situ Testing: Type	Depth (m)	Result	Legend	Depth (m) (thickness)	Elevation (m AOD)	Description
0.00				PID = 0ppmv				Grass cover over soft brown gravelly silty CLAY. Gravel is sub-angular fine to coarse of flint. Clay is of medium plasticity. No visual or olfactory evidence of contamination (TOPSOIL).
0.30						(0.60)		
0.55								Penetrometer = 5.0 N/cm2
0.60						0.60	34.21	Firm to stiff grey mottled brown slightly sandy gravelly silty CLAY. Gravel is sub-angular fine to coarse of flint and occasional chalk. Clay is of low plasticity. No visual or olfactory evidence of contamination (GLACIAL TILL).
1.30						(1.40)		
1.90		B TP20-03	1.90-1.90	PID = 0ppmv				Penetrometer = 6.5 N/cm2
2.00						2.00	32.81	Trial pit completed at 2.00m

GENERAL REMARKS:
Purpose of TP20-03 to investigate deeper as TP20-01 was determined due to encountering a pipe at 0.1 m .
No water encountered. Only bulk bags collected at base due to proximity to TP20-03.

BURIED STRUCTURES:

SHORING: N/A

STABILITY: N/A

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TRIAL PIT LOG

Pit No **TP20-04**

Project Name: Hatton Gas Compressor Station	Project No: 415013-00011	Level: 34.74m AOD	Date 22/10/2020
Location: Hatton		Dimensions: 3.40m × 0.65m; Depth 2.20m; Orientation: ° from North	Scale 1 : 23.81
Client: National Grid			Logged By CL; Checked By CL

Photo

Photo Description:

(m)	Water Levels	Type	Depth (m)	Result	Legend	Depth (m) (thickness)	Elevation (m AOD)	Description
0.0				PID = 0ppmv				MADE GROUND: Grass cover over soft brown gravelly sandy CLAY. Sand is fine. Gravel is sub-angular fine to coarse of flint. Clay is of medium plasticity. No visual or olfactory evidence of contamination.
0.2		ES TP20-04	0.20					
0.5						(0.90)		
0.6		ES TP20-04	0.60					Penetrometer = 6.5 N/cm2
0.9		B TP20-04	0.90	PID = 0ppmv		0.90	33.84	In south of trial pit: brown slightly sandy GRAVEL. Gravel is rounded medium of flint. Sand is fine to medium. Blue drainage pipe from TP20-01 encountered again.
1.0						1.00	33.74	Stiff grey gravelly silty CLAY. Gravel is sub-angular fine to coarse of flint and occasional chalk. Clay is low-medium plasticity. No visual or olfactory evidence of contamination (GLACIAL TILL).
1.6						(1.20)		
1.8		B TP20-04	1.80	PID = 0ppmv				...at 1.8 m, Fines = 64.3% (Clay = 35.3%, Silt = 29%); Sand = 17.1%; Gravel = 18.6% MC = 17%, Liquid limit = 45%, Plastic limit = 19% Penetrometer = 5.0 N/cm2
2.2						2.20	32.54	Trial pit completed at 2.20m

GENERAL REMARKS:
No water encountered.

BURIED STRUCTURES:

SHORING: N/A

STABILITY: N/A

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TRIAL PIT LOG

Pit No **TP20-05**
Sheet 1 of 1

Project Name: Hatton Gas Compressor Station	Project No: 415013-00011	Level: 34.70m AOD	Date 23/10/2020
Location: Hatton		Dimensions: 2.40m × 1.20m; Depth 1.90m; Orientation: ° from North	Scale 1 : 23.81
Client: National Grid			Logged By CL / Checked By CL

Photo

Photo Description:

(m)	Water Levels	Samples & In Situ Testing Type	Depth (m)	Result	Legend	Depth (m) (thickness)	Elevation (m AOD)	Description
0.0		ES TP20-05	0.00-0.10	PID = 0ppmv		(0.50)		Grass cover over stiff brown slightly gravelly clayey SILT. Gravel is sub-angular fine to medium flint. Moist (likely due to recent rainfall). No visual or olfactory evidence of contamination (TOPSOIL).
0.5				PID = 0ppmv		0.50 (0.50)	34.20	Firm to stiff brown gravelly very silty CLAY. Gravel is sub-angular fine to coarse flint. Material is dry and low plasticity (GLACIAL TILL). Penetrometer = 5.0 N/cm2
0.7		B TP20-05 ES TP20-05	0.70-0.70 0.70					
1.0				PID = 0ppmv		1.00 (0.90)	33.70	Firm to very stiff brown-grey gravelly silty CLAY. Gravel is sub-angular fine to coarse of flint (including cobbles) and occasional chalk. Material is very dry and of low to non plasticity (GLACIAL TILL).
1.8		B TP20-05 ES TP20-05	1.80-1.80 1.80					...at 1.8 m, Fines = 75.8% (Clay =32%, Silt = 43.6%); Sand = 16.2%; Gravel = 8.2% Penetrometer = 4.0 N/cm2
1.9						1.90	32.80	Trial pit completed at 1.90m

GENERAL REMARKS:
No water encountered.

BURIED STRUCTURES:
At 1.3 m in east of pit - blue plastic drainage pipe ~ 0.1 m diameter. Pipe damaged by JCB. No water in pipe, pipe dry.
National Grid were shown damage by Advisian Engineer, National Grid did not require the pipe to be repaired.

SHORING: N/A

STABILITY: N/A

TRIAL PIT LOG

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Pit No **TP20-06**

Project Name: Hatton Gas Compressor Station	Project No: 415013-00011	Level: 31.73m AOD	Date 23/10/2020
Location: Hatton		Dimensions: 2.40m × 1.20m; Depth 1.90m; Orientation: ° from North	Scale 1 : 23.81
Client: National Grid			Logged By CL; Checked By CL

Photo

Photo Description:

(m)	Water Levels	Type	Depth (m)	Result	Depth (m) (thickness)	Elevation (m AOD)	Description
		ES TP20-06	0.00-0.10	PID = 0ppmv	(0.30) 0.30	31.43	MADE GROUND: Grass cover over soft brown slightly gravelly very sandy CLAY. Sand is fine. Gravel is sub-angular medium of flint. Moisture in clay. Medium to high plasticity. No visual or olfactory evidence of contamination.
		B TP20-06	0.50-0.50	PID = 0ppmv			MADE GROUND: Firm brown gravelly silty CLAY. Gravel is sub-angular to sub-rounded fine to coarse flint with occasional concrete, red brick fragments and pieces of fabric. Medium to high plasticity. ...at 0.5 m, Fines = 44.4% (Clay =22.6%, Silt = 21.8%); Sand =25.1%; Gravel = 30.5%
		ES TP20-06	0.70		(1.35) 1.65	30.08	
		ES TP20-06	1.80		(0.25) 1.90	29.83	Firm brown gravelly silty CLAY. In the south of the trial pit, gravel and clay is stained black with a slight hydrocarbon odour (GLACIAL TILL).
		B TP20-06	1.90-1.90				Trial pit completed at 1.90m

GENERAL REMARKS:
Base of trial pit is slightly wet however there is no obvious ingress of water.

BURIED STRUCTURES:

SHORING: N/A

STABILITY: N/A

TRIAL PIT LOG

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Pit No **TP20-07**
Sheet 1 of 1

Project Name: Hatton Gas Compressor Station	Project No: 415013-00011	Level: 32.17m AOD	Date 23/10/2020
Location: Hatton		Dimensions: 2.90m × 0.65m; Depth 2.10m; Orientation: ° from North	Scale 1 : 23.81
Client: National Grid			Logged By CL; Checked By CL

Photo

Photo Description:

(m)	Water Levels	Samples & In Situ Testing: Type	Depth (m)	Result	Legend	Depth (m) (thickness)	Elevation (m AOD)	Description
		ES TP20-07	0.00-0.20	PID = 0ppmv		(0.50)		Grass cover over soft to firm brown gravelly sandy CLAY. Sand is fine to medium. Gravel is sub-angular fine to coarse of flint. Clay is slightly moist of medium plasticity. No visual or olfactory evidence of contamination (TOPSOIL). Penetrometer = 2.5 N/cm2
0.5				PID = 0ppmv		0.50	31.67	MADE GROUND: Firm to stiff brown gravelly sandy CLAY. Sand is fine to medium. Gravel is angular to sub-angular fine to coarse flint with occasional concrete, fabric and plastic. Clay is medium plastic. Occasional black staining throughout. No odour.
0.7		ES Sample C	0.70-0.70					
0.9		ES TP20-07 B TP20-07	0.90-0.90			(1.30)		...at 0.9 m, Fines = 41.1% (Clay = 23.3%, Silt = 17.8%); Sand = 36.5%; Gravel = 22.4% Penetrometer = 4.5 N/cm2 MC = 12%, Liquid limit = 44%, Plastic limit = 16%
1.8						1.80	30.37	MADE GROUND: Brown gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to sub-angular fine to coarse of flint and occasional concrete.
2.0		B TP20-07 ES TP20-07	2.00-2.00			(0.30)		...at 2 m, Fines = 39.6%; Sand = 24.6%; Gravel = 35.8% Penetrometer = 4.5 N/cm2
2.1						2.10	30.07	Trial pit completed at 2.10m

GENERAL REMARKS:
No water encountered.

BURIED STRUCTURES:

SHORING: N/A

STABILITY: N/A

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TRIAL PIT LOG

Pit No **TP20-08**
Sheet 1 of 1

Project Name: Hatton Gas Compressor Station	Project No: 415013-00011	Level: 32.22m AOD	Date 23/10/2020
Location: Hatton		Dimensions: 2.70m × 0.70m; Depth 1.90m; Orientation: ° from North	Scale 1 : 23.81
Client: National Grid			Logged By CL; Checked By CL

Photo

Photo Description:

Water Levels	Type	Depth (m)	Result	Depth (m) (thickness)	Elevation (m AOD)	Description
	ES TP20-08	0.00-0.10	PID = 0ppmv	(0.30) 0.30	31.92	MADE GROUND: Grass cover over soft brown slightly gravelly sandy CLAY. Sand is fine to medium. Gravel is sub-angular to sub-rounded fine to medium of flint. Clay is slightly moist of high plasticity. No visual or olfactory evidence of contamination. Penetrometer = 2.5 N/cm2
			PID = 0ppmv			
	ES TP20-08	0.60				
	B TP20-08	0.70		(0.50) 0.80	31.42	MADE GROUND: Firm brown gravelly silty CLAY. Gravel is sub-angular to sub-rounded fine to coarse flint with occasional concrete, brick, fabric and rare plastic. Clay is dry of medium plasticity. Penetrometer = 5.0 N/cm2
	ES TP20-08	1.00	PID = 0ppmv	(0.40) 1.20	31.02	Dark brown-black gravelly SAND. Sand is fine to coarse. Gravel is sub-angular of flint. No visual of olfactory evidence of contamination (GLACIAL TILL).
				1.30	30.92	Discontinuous orange-brown slightly clayey SAND. Sand is fine to medium (GLACIAL TILL).
	B TP20-08	1.50		(0.60) 1.90	30.32	Firm grey mottled brown slightly gravelly SILT. Gravel is sub-angular fine to medium of flint. No visual of olfactory evidence of contamination (GLACIAL TILL). Penetrometer = 4.0 N/cm2
						Trial pit completed at 1.90m

GENERAL REMARKS:
No water encountered.

BURIED STRUCTURES:
In SW corner of trial pit at 1.6 m bgl - a 5 cm grey pipe with blue rope inside was encountered. Excavator bucket made contact with pipe and water flowed from the pipe and started filling up the trial pit with water. National Grid identified this as an unused duct for a communication cable which was never installed.

SHORING: N/A

STABILITY: N/A

Project: Hatton Compressor Station	Contractor: ADP	Borehole Number: **HP20-01**
Client: National Grid	Equipment: Hand Excavation	Project Number: 415013-00011
	Method: Hand Tools	Surveyed Elevation:

Sample Type: Shelby Tube (ST) | Core Sample | SPT Sample (SS) | Grab Sample (GB) | No Recovery | Bulk Sample

Well Details: Bentonite | Peltonite | Slough | Grout | Drill Cuttings | Sand

Depth (m)	Soil Symbol	SOIL DESCRIPTION	Sample Type	Sample Number	Other Data/ Comments (Plastic, MC, Liquid: 10 20 30 40)
0.0		MADE GROUND: Soft brown silty CLAY with frequent plant rootlets.			
0.25		MADE GROUND: Soft brownish grey gravelly CLAY with frequent plant rootlets. Gravel is fine to coarse sub-angular chalk, chert and brick.	Grab Sample (GB)	HP20-01	
0.80		End of Hole at a depth of 0.80 m Refusal at 0.80 m bgl as ground too hard for the hand dig method. Water Levels: No Groundwater Observed			

Depth scale: 0.5, 1.0

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Worley Group

Logged By: RF		Completion Depth: 0.80 m
Reviewed By: KM	Completed on: 20/10/2020	
Groundwater Depth:		Page 1 of 1

WP SPT/CORING HATTON GEOTECH LOGS.GPJ WORLEYPARSONS DATA.GDT 8/12/20

Project: Hatton Compressor Station	Contractor: ADP	Borehole Number: **HP20-02**
Client: National Grid	Equipment: Hand Excavation	Project Number: 415013-00011
	Method: Hand Tools	Surveyed Elevation:

Sample Type: Shelby Tube (ST), Core Sample, SPT Sample (SS), Grab Sample (GB), No Recovery, Bulk Sample

Well Details: Bentonite, Peltonite, Slough, Grout, Drill Cuttings, Sand

Depth (m)	Soil Symbol	SOIL DESCRIPTION	Sample Type	Sample Number	Other Data/ Comments (Plastic, MC, Liquid: 10 20 30 40)
		Soft brown clayey SILT with frequent plant rootlets (TOPSOIL).			
0.5		5.4 % gravel, 18.7 % sand, 75.9 % fines Soft greyish brown gravelly CLAY with occasional plant rootlets. Gravel is fine to coarse sub-angular to rounded chalk, chert . Clay is medium plastic (GLACIAL TILL).	Grab Sample (GB)	HP20-02	15 PI=24
1.0		End of Hole at a depth of 0.90 m 0.00 - 0.15 m bgl advanced with hand held windowless sampling rig, 0.15 to 0.90 m bgl hand pitted. Refusal at 0.90 m bgl as ground too hard for the hand dig method. Water Levels: No Groundwater Observed			

WP SPT/CORING HATTON GEOTECH LOGS.GPJ WORLEYPARSONS DATA.GDT 8/12/20

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Worley Group

Logged By: RF		Completion Depth: 0.90 m
Reviewed By: KM	Completed on: 20/10/2020	
Groundwater Depth:		

Project: Hatton Compressor Station	Contractor: ADP	Borehole Number: **HP20-03**
Client: National Grid	Equipment: Hand Excavation	Project Number: 415013-00011
	Method: Hand Tools	Surveyed Elevation:

Sample Type: Shelby Tube (ST), Core Sample, SPT Sample (SS), Grab Sample (GB), No Recovery, Bulk Sample

Well Details: Bentonite, Peltonite, Slough, Grout, Drill Cuttings, Sand

Depth (m)	Soil Symbol	SOIL DESCRIPTION	Sample Type	Sample Number	Other Data/ Comments (Plastic, MC, Liquid; 10, 20, 30, 40)		
		MADE GROUND: Soft brown silty CLAY with abundant plant rootlets.					
0.5		MADE GROUND: Soft greyish brown gravelly CLAY with occasional plant rootlets. Gravel is fine to coarse sub-angular to rounded chalk, chert and occasional brick.	GB	HP20-03			
1.0		End of Hole at a depth of 0.90 m Hand pit terminated at 0.90 m bgl due to large gravel (chalk) pit, hand pit extended by still refused at 0.90 m bgl. Water Levels: No Groundwater Observed					

WP SPT/CORING HATTON GEOTECH LOGS.GPJ WORLEYPARSONS DATA.GDT 8/12/20

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Logged By: RF		Completion Depth: 0.90 m
Reviewed By: KM	Completed on: 20/10/2020	
Groundwater Depth:		Page 1 of 1

Project: Hatton Compressor Station	Contractor: ADP	Borehole Number: **HP20-04**
Client: National Grid	Equipment: Hand Excavation	Project Number: 415013-00011
	Method: Hand Tools	Surveyed Elevation:

Sample Type: Shelby Tube (ST), Core Sample, SPT Sample (SS), Grab Sample (GB), No Recovery, Bulk Sample

Well Details: Bentonite, Peltonite, Slough, Grout, Drill Cuttings, Sand

Depth (m)	Soil Symbol	SOIL DESCRIPTION	Sample Type	Sample Number	Other Data/ Comments (Plastic, MC, Liquid; 10 20 30 40)
		Soft brown clayey SILT with abundant plant rootlets (TOPSOIL).			
0.5		Soft greyish brown gravelly CLAY. Gravel is fine to coarse sub-angular to rounded chalk and occasional chert (GLACIAL TILL).	GB	HP20-04	
1.0		End of Hole at a depth of 0.92 m Refusal at 0.92 m bgl as ground too hard for the hand dig method. Water Levels: No Groundwater Observed			

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Logged By: RF		Completion Depth: 0.92 m
Reviewed By: KM	Completed on: 20/10/2020	
Groundwater Depth:		Page 1 of 1

Project: Hatton Compressor Station	Contractor: ADP	Borehole Number: **HP20-05**
Client: National Grid	Equipment: Hand Excavation	Project Number: 415013-00011
	Method: Hand Tools	Surveyed Elevation:

Sample Type: Shelby Tube (ST) | Core Sample | SPT Sample (SS) | Grab Sample (GB) | No Recovery | Bulk Sample

Well Details: Bentonite | Peltonite | Slough | Grout | Drill Cuttings | Sand

Depth (m)	Soil Symbol	SOIL DESCRIPTION	Sample Type	Sample Number	Other Data/ Comments (Plastic, MC, Liquid: 10, 20, 30, 40)
		MADE GROUND: Soft brown silty CLAY with abundant plant rootlets.			
0.5		MADE GROUND: Firm greyish brown gravelly CLAY with occasional plant rootlets. Gravel is fine to coarse sub angular to rounded chalk, chert and brick.	GB	HP20-05	
1.0		End of Hole at a depth of 0.85 m Refusal at 0.85 m bgl as ground too hard for the hand dig method. Water Levels: No Groundwater Observed			

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Logged By: RF		Completion Depth: 0.85 m
Reviewed By: KM	Completed on: 20/10/2020	
Groundwater Depth:		

Project: Hatton Compressor Station	Contractor: ADP	Borehole Number: **WS20-01**
Client: National Grid	Equipment: Hand Held Window Sampler	Project Number: 415013-00011
	Method: Window Sampler	Surveyed Elevation:

Sample Type	Shelby Tube (ST)	Core Sample	SPT Sample (SS)	Grab Sample (GB)	No Recovery	Bulk Sample
Well Details	Bentonite	Peltonite	Slough	Grout	Drill Cuttings	Sand

Depth (m)	Soil Symbol	SOIL DESCRIPTION	Sample Type	Sample Number	Other Data/ Comments (Plastic, MC, Liquid: 10 20 30 40)
		MADE GROUND: Firm dark brown fine CLAY			
		MADE GROUND: Firm greyish brown gravelly CLAY with frequent rootlets. Clay is low plasticity and very cohesive. Gravel is fine to coarse sub-angular to rounded of chalk, chert and brick.			
0.5				WS20-01	
				WS20-01	
1.0		End of Hole at a depth of 1.00 m Refusal at 1.00 m bgl as ground too hard for the hand held method. Water Levels: No Groundwater Observed			

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Logged By: RF		Completion Depth: 1.00 m
Reviewed By: KM	Completed on: 21/10/2020	
Groundwater Depth:		

Project: Hatton Compressor Station	Contractor: ADP	Borehole Number: **WS20-02**
Client: National Grid	Equipment: Hand Held Window Sampler	Project Number: 415013-00011
	Method: Window Sampler	Surveyed Elevation:

Sample Type	Shelby Tube (ST)	Core Sample	SPT Sample (SS)	Grab Sample (GB)	No Recovery	Bulk Sample
Well Details	Bentonite	Peltonite	Slough	Grout	Drill Cuttings	Sand

Depth (m)	Soil Symbol	SOIL DESCRIPTION	Sample Type	Sample Number	Other Data/ Comments (Plastic, MC, Liquid; 10 20 30 40)
		Firm dark brown fine SILT (TOPSOIL).			
		Greyish brown gravelly CLAY with occasional rootlets. Clay is low plasticity with no moisture. Gravel is fine to coarse rounded to sub-rounded chalk and flint (GLACIAL TILL).	GB	WS20-02	
0.5		End of Hole at a depth of 0.48 m Refusal at 0.48 m bgl as ground too hard for the hand held method. Water Levels: No Groundwater Observed			
1.0					

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Logged By: RF		Completion Depth: 0.48 m
Reviewed By: KM	Completed on: 20/10/2020	
Groundwater Depth:		

Project: Hatton Compressor Station	Contractor: ADP	Borehole Number: **WS20-03**
Client: National Grid	Equipment: Hand Held Window Sampler	Project Number: 415013-00011
	Method: Window Sampler	Surveyed Elevation:

Sample Type: Shelby Tube (ST), Core Sample, SPT Sample (SS), Grab Sample (GB), No Recovery, Bulk Sample

Well Details: Bentonite, Peltonite, Slough, Grout, Drill Cuttings, Sand

Depth (m)	Soil Symbol	SOIL DESCRIPTION	Sample Type	Sample Number	Other Data/ Comments (Plastic, MC, Liquid: 10 20 30 40)
		MADE GROUND: Firm dark brown CLAY with frequent rootlets.			
		3.5 % gravel, 22.3 % sand, 74.2 % fines MADE GROUND: Firm greyish brown gravelly CLAY with frequent rootlets. Clay has low to medium plasticity and is very cohesive. Gravel is fine to coarse sub-angular to rounded of chalk, chert and brick.			
0.5				WS20-03	
				WS20-03	16 PI=26
		End of Hole at a depth of 0.80 m Hand held windowless sampling from ground level to 0.20 m bgl, hand pitted from 0.20 - 0.80 m bgl. Refusal at 0.80 m bgl as ground too hard for the hand held method. Water Levels: No Groundwater Observed			
1.0					

WP SPT/CORING HATTON GEOTECH LOGS.GPJ WORLEYPARSONS DATA.GDT 8/12/20

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Logged By: RF		Completion Depth: 0.80 m
Reviewed By: KM	Completed on: 20/10/2020	
Groundwater Depth:		Page 1 of 1

Appendix 3 Laboratory Analysis results

Extracted from Advisian (Worley Group) (2021) Geo-Environmental Site Assessment, Hatton Gas Compressor Station, Hatton, Lincolnshire. Project Reference: 415013 - 00011

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Analytical Report Number : 20-36955

Replaces Analytical Report Number: 20-36955, issue no. 1
Client references/information amended.

Project / Site name:	Hatton	**Samples received on:**	21/10/2020
Your job number:		**Samples instructed on/ Analysis started on:**	21/10/2020
Your order number:	795301-57908 PCT GENERAL	**Analysis completed by:**	16/12/2020
Report Issue Number:	2	**Report issued on:**	16/12/2020
Samples Analysed:	5 leachate samples - 12 soil samples		

Signed: J. Wawrzeczko

Joanna Wawrzeczko
Technical Reviewer (Reporting Team)
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

- soils - 4 weeks from reporting
- leachates - 2 weeks from reporting
- waters - 2 weeks from reporting
- asbestos - 6 months from reporting

Excel copies of reports are only valid when accompanied by this PDF certificate.

Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement. Application of uncertainty of measurement would provide a range within which the true result lies.
An estimate of measurement uncertainty can be provided on request.

Analytical Report Number: 20-36955
Project / Site name: Hatton
Your Order No: 795301-57908 PCT GENERAL

Lab Sample Number				1658710	1658711	1658712	1658713	1658714
Sample Reference				BH20-01	BH20-02	BH20-01	BH20-01	Sample A
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.10-0.10	0.40-0.40	2.30-2.30	7.00-7.00	None Supplied
Date Sampled				19/10/2020	19/10/2020	20/10/2020	20/10/2020	20/10/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	-	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	0.01	NONE	-	7.3	11	11	11
Total mass of sample received	kg	0.001	NONE	-	1.3	1.4	1.3	1.2
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	-	-	-	-
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	-	8.6	8.2	8.1	7.9
Total Cyanide	mg/kg	1	MCERTS	-	< 1	< 1	< 1	< 1
Complex Cyanide	mg/kg	1	MCERTS	-	< 1	< 1	< 1	< 1
Free Cyanide	mg/kg	1	MCERTS	-	< 1	< 1	< 1	< 1
Thiocyanate as SCN	mg/kg	5	NONE	-	< 5.0	< 5.0	< 5.0	< 5.0
Water Soluble Sulphate as SO4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	-	95	3900	1100	1400
Water Soluble SO4 16hr extraction (2:1 Leachate Equivale	g/l	0.00125	MCERTS	-	0.048	1.9	0.55	0.72
Water Soluble SO4 16hr extraction (2:1 Leachate Equivale	mg/l	1.25	MCERTS	-	47.7	1930	551	721
Water Soluble Chloride (2:1)	mg/kg	1	MCERTS	-	5.1	11	82	94
Elemental Sulphur	mg/kg	5	MCERTS	-	< 5.0	< 5.0	< 5.0	< 5.0
Ammonium - Exchangeable as NH4	mg/kg	0.5	MCERTS	-	< 0.5	0.7	5.6	5.4
Organic Matter	%	0.1	MCERTS	-	-	2.1	-	-
Loss on Ignition @ 450oC	%	0.2	MCERTS	-	1.4	2.1	2.8	2.4
Phenols by HPLC								
Catechol	mg/kg	0.1	ISO 17025	-	< 0.10	< 0.10	< 0.10	< 0.10
Resorcinol	mg/kg	0.1	ISO 17025	-	< 0.10	< 0.10	< 0.10	< 0.10
Cresols (o-, m-, p-)	mg/kg	0.3	ISO 17025	-	< 0.30	< 0.30	< 0.30	< 0.30
Total Naphthols (sum of 1- and 2- Naphthol)	mg/kg	0.2	ISO 17025	-	< 0.20	< 0.20	< 0.20	< 0.20
2-Isopropylphenol	mg/kg	0.1	ISO 17025	-	< 0.10	< 0.10	< 0.10	< 0.10
Phenol	mg/kg	0.1	ISO 17025	-	< 0.10	< 0.10	< 0.10	< 0.10
Trimethylphenol (2,3,5-)	mg/kg	0.1	ISO 17025	-	< 0.10	< 0.10	< 0.10	< 0.10
Total Xylenols and Ethylphenols	mg/kg	0.3	ISO 17025	-	< 0.30	< 0.30	< 0.30	< 0.30
Total Phenols								
Total Phenols (HPLC)	mg/kg	1.3	ISO 17025	-	< 1.3	< 1.3	< 1.3	< 1.3
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	< 0.05
Anthracene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	< 0.05
Pyrene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(a)anthracene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	< 0.05
Chrysene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	< 0.05

Analytical Report Number: 20-36955
Project / Site name: Hatton
Your Order No: 795301-57908 PCT GENERAL

Lab Sample Number				1658710	1658711	1658712	1658713	1658714
Sample Reference				BH20-01	BH20-02	BH20-01	BH20-01	Sample A
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.10-0.10	0.40-0.40	2.30-2.30	7.00-7.00	None Supplied
Date Sampled				19/10/2020	19/10/2020	20/10/2020	20/10/2020	20/10/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	-	< 0.80	< 0.80	< 0.80	< 0.80
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	-	9.4	13	16	14
Boron (water soluble)	mg/kg	0.2	MCERTS	-	0.5	2.4	5	9
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	-	< 0.2	< 0.2	< 0.2	< 0.2
Chromium (hexavalent)	mg/kg	4	MCERTS	-	< 4.0	< 4.0	< 4.0	< 4.0
Chromium (III)	mg/kg	1	NONE	-	14	20	19	18
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	-	14	20	19	18
Copper (aqua regia extractable)	mg/kg	1	MCERTS	-	6.4	17	20	19
Lead (aqua regia extractable)	mg/kg	1	MCERTS	-	21	13	14	13
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	-	< 0.3	< 0.3	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	-	12	28	28	27
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	-	< 1.0	< 1.0	< 1.0	< 1.0
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	-	34	57	73	56
Monoaromatics & Oxygenates								
Benzene	mg/kg	0.001	MCERTS	-	< 0.001	< 0.001	< 0.001	< 0.001
Toluene	mg/kg	0.001	MCERTS	-	< 0.001	< 0.001	< 0.001	< 0.001
Ethylbenzene	mg/kg	0.001	MCERTS	-	< 0.001	< 0.001	< 0.001	< 0.001
p & m-xylene	mg/kg	0.001	MCERTS	-	< 0.001	< 0.001	< 0.001	< 0.001
o-xylene	mg/kg	0.001	MCERTS	-	< 0.001	< 0.001	< 0.001	< 0.001
MTBE (Methyl Tertiary Butyl Ether)	mg/kg	0.001	MCERTS	-	< 0.001	< 0.001	< 0.001	< 0.001
Petroleum Hydrocarbons								
TPH C10 - C40	mg/kg	10	MCERTS	-	< 10	< 10	160	< 10
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	-	-	-	-	-
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	-	-	-	-	-
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	-	-	-	-
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	-	-	-	-	-
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	-	-	-	-	-
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	-	-	-	-	-
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	-	-	-	-	-
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	-	-	-	-	-
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	-	-	-	-	-
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	-	-	-	-	-
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	-	-	-	-
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	-	-	-	-	-
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	-	-	-	-	-
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	-	-	-	-	-
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	-	-	-	-	-
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	-	-	-	-	-

U/S = Unsuitable Sample   I/S = Insufficient Sample

Analytical Report Number: 20-36955
Project / Site name: Hatton
Your Order No: 795301-57908 PCT GENERAL

Lab Sample Number				1658715	1658716	1658717	1658718	1658719
Sample Reference				BH20-02	BH20-02	BH20-01	BH20-02	WS20-03
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.20-0.20	0.30-0.30	0.40-0.60	0.10-0.40	0.50-0.80
Date Sampled				20/10/2020	20/10/2020	19/10/2020	20/10/2020	20/10/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	-	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	0.01	NONE	-	10	8.1	9.3	9.2
Total mass of sample received	kg	0.001	NONE	-	0.3	1	1.2	1
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	-	Not-detected	Not-detected	Not-detected
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	-	8.2	8.1	8.5	8
Total Cyanide	mg/kg	1	MCERTS	-	< 1	< 1	< 1	< 1
Complex Cyanide	mg/kg	1	MCERTS	-	< 1	< 1	< 1	< 1
Free Cyanide	mg/kg	1	MCERTS	-	< 1	< 1	< 1	< 1
Thiocyanate as SCN	mg/kg	5	NONE	-	< 5.0	< 5.0	< 5.0	< 5.0
Water Soluble Sulphate as SO4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	-	470	1100	150	3000
Water Soluble SO4 16hr extraction (2:1 Leachate Equivale	g/l	0.00125	MCERTS	-	0.24	0.55	0.073	1.5
Water Soluble SO4 16hr extraction (2:1 Leachate Equivale	mg/l	1.25	MCERTS	-	236	548	73.1	1520
Water Soluble Chloride (2:1)	mg/kg	1	MCERTS	-	9	3.6	6.3	7.8
Elemental Sulphur	mg/kg	5	MCERTS	-	< 5.0	< 5.0	< 5.0	< 5.0
Ammonium - Exchangeable as NH4	mg/kg	0.5	MCERTS	-	< 0.5	< 0.5	< 0.5	< 0.5
Organic Matter	%	0.1	MCERTS	-	-	-	1.4	-
Loss on Ignition @ 450oC	%	0.2	MCERTS	-	1.9	1.8	1.8	2.3
Phenols by HPLC								
Catechol	mg/kg	0.1	ISO 17025	-	< 0.10	< 0.10	< 0.10	< 0.10
Resorcinol	mg/kg	0.1	ISO 17025	-	< 0.10	< 0.10	< 0.10	< 0.10
Cresols (o-, m-, p-)	mg/kg	0.3	ISO 17025	-	< 0.30	< 0.30	< 0.30	< 0.30
Total Naphthols (sum of 1- and 2- Naphthol)	mg/kg	0.2	ISO 17025	-	< 0.20	< 0.20	< 0.20	< 0.20
2-Isopropylphenol	mg/kg	0.1	ISO 17025	-	< 0.10	< 0.10	< 0.10	< 0.10
Phenol	mg/kg	0.1	ISO 17025	-	< 0.10	< 0.10	< 0.10	< 0.10
Trimethylphenol (2,3,5-)	mg/kg	0.1	ISO 17025	-	< 0.10	< 0.10	< 0.10	< 0.10
Total Xylenols and Ethylphenols	mg/kg	0.3	ISO 17025	-	< 0.30	< 0.30	< 0.30	< 0.30
Total Phenols								
Total Phenols (HPLC)	mg/kg	1.3	ISO 17025	-	< 1.3	< 1.3	< 1.3	< 1.3
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	-	0.29	< 0.05	< 0.05	< 0.05
Anthracene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	-	0.34	< 0.05	< 0.05	< 0.05
Pyrene	mg/kg	0.05	MCERTS	-	0.33	< 0.05	< 0.05	< 0.05
Benzo(a)anthracene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	< 0.05
Chrysene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	< 0.05

Analytical Report Number: 20-36955
Project / Site name: Hatton
Your Order No: 795301-57908 PCT GENERAL

Lab Sample Number				1658715	1658716	1658717	1658718	1658719
Sample Reference				BH20-02	BH20-02	BH20-01	BH20-02	WS20-03
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.20-0.20	0.30-0.30	0.40-0.60	0.10-0.40	0.50-0.80
Date Sampled				20/10/2020	20/10/2020	19/10/2020	20/10/2020	20/10/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	-	0.96	< 0.80	< 0.80	< 0.80
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	-	14	17	14	15
Boron (water soluble)	mg/kg	0.2	MCERTS	-	1.2	0.7	0.5	0.5
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	-	< 0.2	< 0.2	< 0.2	< 0.2
Chromium (hexavalent)	mg/kg	4	MCERTS	-	< 4.0	< 4.0	< 4.0	< 4.0
Chromium (III)	mg/kg	1	NONE	-	19	18	22	24
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	-	19	18	22	25
Copper (aqua regia extractable)	mg/kg	1	MCERTS	-	13	13	16	18
Lead (aqua regia extractable)	mg/kg	1	MCERTS	-	16	11	13	14
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	-	< 0.3	< 0.3	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	-	17	21	25	30
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	-	< 1.0	< 1.0	< 1.0	< 1.0
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	-	52	55	53	53
Monoaromatics & Oxygenates								
Benzene	mg/kg	0.001	MCERTS	-	< 0.001	< 0.001	< 0.001	< 0.001
Toluene	mg/kg	0.001	MCERTS	-	< 0.001	< 0.001	< 0.001	< 0.001
Ethylbenzene	mg/kg	0.001	MCERTS	-	< 0.001	< 0.001	< 0.001	< 0.001
p & m-xylene	mg/kg	0.001	MCERTS	-	< 0.001	< 0.001	< 0.001	< 0.001
o-xylene	mg/kg	0.001	MCERTS	-	< 0.001	< 0.001	< 0.001	< 0.001
MTBE (Methyl Tertiary Butyl Ether)	mg/kg	0.001	MCERTS	-	< 0.001	< 0.001	< 0.001	< 0.001
Petroleum Hydrocarbons								
TPH C10 - C40	mg/kg	10	MCERTS	-	< 10	< 10	< 10	< 10
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	-	-	< 0.001	-	-
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	-	-	< 0.001	-	-
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	-	< 0.001	-	-
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	-	-	< 1.0	-	-
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	-	-	< 2.0	-	-
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	-	-	< 8.0	-	-
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	-	-	< 8.0	-	-
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	-	-	< 10	-	-
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	-	-	< 0.001	-	-
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	-	-	< 0.001	-	-
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	-	< 0.001	-	-
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	-	-	< 1.0	-	-
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	-	-	< 2.0	-	-
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	-	-	< 10	-	-
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	-	-	< 10	-	-
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	-	-	< 10	-	-

U/S = Unsuitable Sample   I/S = Insufficient Sample

Analytical Report Number: 20-36955
Project / Site name: Hatton
Your Order No: 795301-57908 PCT GENERAL

Lab Sample Number				1658720	1658721
Sample Reference				HP20-01	HP20-02
Sample Number				None Supplied	None Supplied
Depth (m)				0.70-0.80	0.80-0.90
Date Sampled				20/10/2020	20/10/2020
Time Taken				None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**		
Stone Content	%	0.1	NONE	< 0.1	< 0.1
Moisture Content	%	0.01	NONE	8.5	11
Total mass of sample received	kg	0.001	NONE	1	1
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected
General Inorganics					
pH - Automated	pH Units	N/A	MCERTS	7.9	7.9
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1
Complex Cyanide	mg/kg	1	MCERTS	< 1	< 1
Free Cyanide	mg/kg	1	MCERTS	< 1	< 1
Thiocyanate as SCN	mg/kg	5	NONE	< 5.0	< 5.0
Water Soluble Sulphate as SO4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	3100	1200
Water Soluble SO4 16hr extraction (2:1 Leachate Equivale	g/l	0.00125	MCERTS	1.6	0.62
Water Soluble SO4 16hr extraction (2:1 Leachate Equivale	mg/l	1.25	MCERTS	1570	616
Water Soluble Chloride (2:1)	mg/kg	1	MCERTS	14	14
Elemental Sulphur	mg/kg	5	MCERTS	< 5.0	< 5.0
Ammonium - Exchangeable as NH4	mg/kg	0.5	MCERTS	< 0.5	< 0.5
Organic Matter	%	0.1	MCERTS	-	1.6
Loss on Ignition @ 450oC	%	0.2	MCERTS	2.6	2.2
Phenols by HPLC					
Catechol	mg/kg	0.1	ISO 17025	< 0.10	< 0.10
Resorcinol	mg/kg	0.1	ISO 17025	< 0.10	< 0.10
Cresols (o-, m-, p-)	mg/kg	0.3	ISO 17025	< 0.30	< 0.30
Total Naphthols (sum of 1- and 2- Naphthol)	mg/kg	0.2	ISO 17025	< 0.20	< 0.20
2-Isopropylphenol	mg/kg	0.1	ISO 17025	< 0.10	< 0.10
Phenol	mg/kg	0.1	ISO 17025	< 0.10	< 0.10
Trimethylphenol (2,3,5-)	mg/kg	0.1	ISO 17025	< 0.10	< 0.10
Total Xylenols and Ethylphenols	mg/kg	0.3	ISO 17025	< 0.30	< 0.30
Total Phenols					
Total Phenols (HPLC)	mg/kg	1.3	ISO 17025	< 1.3	< 1.3
Speciated PAHs					
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Chrysene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05

Analytical Report Number: 20-36955
Project / Site name: Hatton
Your Order No: 795301-57908 PCT GENERAL

Lab Sample Number				1658720	1658721
Sample Reference				HP20-01	HP20-02
Sample Number				None Supplied	None Supplied
Depth (m)				0.70-0.80	0.80-0.90
Date Sampled				20/10/2020	20/10/2020
Time Taken				None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**		
Total PAH					
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	< 0.80	< 0.80
Heavy Metals / Metalloids					
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	14	15
Boron (water soluble)	mg/kg	0.2	MCERTS	1.8	1.1
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0
Chromium (III)	mg/kg	1	NONE	22	24
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	22	24
Copper (aqua regia extractable)	mg/kg	1	MCERTS	18	16
Lead (aqua regia extractable)	mg/kg	1	MCERTS	15	15
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	25	27
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	59	55
Monoaromatics & Oxygenates					
Benzene	mg/kg	0.001	MCERTS	< 0.001	< 0.001
Toluene	mg/kg	0.001	MCERTS	< 0.001	< 0.001
Ethylbenzene	mg/kg	0.001	MCERTS	< 0.001	< 0.001
p & m-xylene	mg/kg	0.001	MCERTS	< 0.001	< 0.001
o-xylene	mg/kg	0.001	MCERTS	< 0.001	< 0.001
MTBE (Methyl Tertiary Butyl Ether)	mg/kg	0.001	MCERTS	< 0.001	< 0.001
Petroleum Hydrocarbons					
TPH C10 - C40	mg/kg	10	MCERTS	< 10	15
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001	-
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001	-
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	-
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	-
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	-
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	< 8.0	-
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	< 8.0	-
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	< 10	-
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001	-
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001	-
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	-
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	-
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	-
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	< 10	-
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	< 10	-
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	< 10	-

U/S = Unsuitable Sample   I/S = Insufficient Sample

Analytical Report Number: 20-36955
Project / Site name: Hatton

Your Order No: 795301-57908 PCT GENERAL

Lab Sample Number				1658722	1658723	1658724	1658725	1658726
Sample Reference				BH20-01	BH20-02	WS20-03	HP20-01	HP20-02
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.40-0.40	0.20-0.20	0.50-0.80	0.70-0.80	0.80-0.90
Date Sampled				19/10/2020	19/10/2020	19/10/2020	19/10/2020	19/10/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Leachate Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
General Inorganics								
pH	pH Units	N/A	ISO 17025	8.5	8.1	7.6	7.9	8.2
Electrical Conductivity	µS/cm	10	ISO 17025	79	150	780	410	180
Total Cyanide	mg/l	0.01	ISO 17025	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Complex Cyanide	mg/l	0.01	ISO 17025	< 0.0100	< 0.0100	< 0.0100	< 0.0100	< 0.0100
Free Cyanide	mg/l	0.01	ISO 17025	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Thiocyanate as SCN	mg/l	0.2	NONE	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Sulphate as SO4	mg/l	0.1	ISO 17025	2.8	30.6	474	204	1.3
Total Sulphur	mg/l	0.015	NONE	0.936	10.2	158	67.8	0.427
Sulphide	mg/l	0.005	NONE	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Chloride	mg/l	4	NONE	< 4.0	4.7	< 4.0	< 4.0	< 4.0
Ammonium as NH4	mg/l	0.015	NONE	< 0.015	< 0.015	< 0.015	< 0.015	< 0.015
Dissolved Organic Carbon (DOC)	mg/l	0.1	NONE	4.26	5.06	4.19	2.72	3.18
Phenols by HPLC								
Catechol	mg/l	0.0005	NONE	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Resorcinol	mg/l	0.0005	NONE	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Ethylphenol & Dimethylphenol	mg/l	0.0005	NONE	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Cresols	mg/l	0.0005	NONE	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Naphthols	mg/l	0.0005	NONE	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Isopropylphenol	mg/l	0.0005	NONE	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Phenol	mg/l	0.0005	NONE	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Trimethylphenol	mg/l	0.0005	NONE	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Total Phenols								
Total Phenols (HPLC)	mg/l	0.0035	NONE	< 0.0035	< 0.0035	< 0.0035	< 0.0035	< 0.0035
Speciated PAHs								
Naphthalene	mg/l	0.00001	ISO 17025	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Acenaphthylene	mg/l	0.00001	ISO 17025	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Acenaphthene	mg/l	0.00001	ISO 17025	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Fluorene	mg/l	0.00001	ISO 17025	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Phenanthrene	mg/l	0.00001	ISO 17025	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Anthracene	mg/l	0.00001	ISO 17025	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Fluoranthene	mg/l	0.00001	ISO 17025	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Pyrene	mg/l	0.00001	ISO 17025	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Benzo(a)anthracene	mg/l	0.00001	ISO 17025	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Chrysene	mg/l	0.00001	ISO 17025	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Benzo(b)fluoranthene	mg/l	0.00001	ISO 17025	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Benzo(k)fluoranthene	mg/l	0.00001	ISO 17025	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Benzo(a)pyrene	mg/l	0.00001	ISO 17025	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Indeno(1,2,3-cd)pyrene	mg/l	0.00001	NONE	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Dibenz(a,h)anthracene	mg/l	0.00001	NONE	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Benzo(ghi)perylene	mg/l	0.00001	NONE	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001

UKAS TESTING 4041

Analytical Environmental Science

Analytical Report Number: 20-36955
Project / Site name: Hatton

Your Order No: 795301-57908 PCT GENERAL

Lab Sample Number				1658722	1658723	1658724	1658725	1658726
Sample Reference				BH20-01	BH20-02	WS20-03	HP20-01	HP20-02
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.40-0.40	0.20-0.20	0.50-0.80	0.70-0.80	0.80-0.90
Date Sampled				19/10/2020	19/10/2020	19/10/2020	19/10/2020	19/10/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Leachate Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Total PAH								
Total EPA-16 PAHs	mg/l	0.0002	NONE	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Heavy Metals / Metalloids								
Arsenic (dissolved)	mg/l	0.001	ISO 17025	< 0.001	0.004	< 0.001	< 0.001	< 0.001
Cadmium (dissolved)	mg/l	0.0001	ISO 17025	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Chromium (dissolved)	mg/l	0.0004	ISO 17025	0.0007	0.0031	< 0.0004	0.0009	0.0011
Copper (dissolved)	mg/l	0.0003	ISO 17025	0.0045	0.0071	0.0034	0.0015	0.0033
Iron (dissolved)	mg/l	0.004	ISO 17025	0.028	1.9	0.046	0.32	0.3
Lead (dissolved)	mg/l	0.001	ISO 17025	0.002	0.007	0.003	0.002	0.005
Mercury (dissolved)	mg/l	0.0005	ISO 17025	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Nickel (dissolved)	mg/l	0.0003	ISO 17025	0.0025	0.0049	0.0026	0.0019	0.0029
Selenium (dissolved)	mg/l	0.004	ISO 17025	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Zinc (dissolved)	mg/l	0.0004	ISO 17025	0.0084	0.0224	0.0078	0.0063	0.0114
Monoaromatics & Oxygenates								
Benzene	mg/l	0.001	ISO 17025	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Toluene	mg/l	0.001	ISO 17025	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Ethylbenzene	mg/l	0.001	ISO 17025	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
p & m-xylene	mg/l	0.001	ISO 17025	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
o-xylene	mg/l	0.001	ISO 17025	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
MTBE (Methyl Tertiary Butyl Ether)	mg/l	0.01	NONE	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Petroleum Hydrocarbons								
TPH1 (C10 - C40)	µg/l	10	NONE	< 10	< 10	< 10	< 10	< 10
TPH1 (C10 - C40)	mg/l	0.01	NONE	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

U/S = Unsuitable Sample   I/S = Insufficient Sample

Analytical Report Number : 20-36955
Project / Site name: Hatton

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
1658711	BH20-02	None Supplied	0.40-0.40	Brown loam and clay with gravel and vegetation.
1658712	BH20-01	None Supplied	2.30-2.30	Brown clay with gravel.
1658713	BH20-01	None Supplied	7.00-7.00	Grey clay with gravel.
1658714	Sample A	None Supplied	None Supplied	Grey clay with gravel.
1658716	BH20-02	None Supplied	0.30-0.30	Brown clay and loam with gravel and vegetation.
1658717	BH20-01	None Supplied	0.40-0.60	Brown clay with gravel and chalk.
1658718	BH20-02	None Supplied	0.10-0.40	Brown clay with gravel and vegetation.
1658719	WS20-03	None Supplied	0.50-0.80	Brown clay with gravel and vegetation.
1658720	HP20-01	None Supplied	0.70-0.80	Brown clay with gravel and vegetation.
1658721	HP20-02	None Supplied	0.80-0.90	Brown clay with gravel and vegetation.

Analytical Report Number : 20-36955
Project / Site name: Hatton

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In house method.	L038-PL	D	MCERTS
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
NRA Leachate Prep	10:1 extract with de-ionised water shaken for 24 hours then filtered.	In-house method based on National Rivers Authority	L020-PL	W	NONE
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Phenols, speciated, in soil, by HPLC	Determination of speciated phenols by HPLC.	In house method based on Blue Book Method.	L030-PL	W	ISO 17025
Boron, water soluble, in soil	Determination of water soluble boron in soil by hot water extract followed by ICP-OES.	In-house method based on Second Site Properties version 3	L038-PL	D	MCERTS
Complex Cyanide in soil	Determination of complex cyanide by calculation.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Chloride in leachate	Determination of chloride in leachate by titration against silver nitrate.	In house based on MEWAM Method ISBN 0117516260.	L024-PL	W	NONE
Chloride, water soluble, in soil	Determination of Chloride colorimetrically by discrete analyser.	In house method.	L082-PL	D	MCERTS
Hexavalent chromium in soil	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method	L080-PL	W	MCERTS
Electrical conductivity at 20oC of leachate	Determination of electrical conductivity in leachate by electrometric measurement.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L031-PL	W	ISO 17025
Elemental sulphur in soil	Determination of elemental sulphur in soil by extraction in acetonitrile followed by HPLC.	In-house method based on Secondsite Property Holdings Guidance for Assessing and Managing Potential	L021-PL	D	MCERTS
Free cyanide in leachate	Determination of free cyanide by distillation followed by colorimetry.	In-house method	L080-PL	W	ISO 17025
Free cyanide in soil	Determination of free cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Metals by ICP-OES in leachate	Determination of metals in leachate by acidification followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L039-PL	W	ISO 17025
Loss on ignition of soil @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace.	In house method.	L047-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically. (30 oC)	In house method.	L019-UK/PL	W	NONE

Analytical Report Number : 20-36955
Project / Site name: Hatton

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Organic matter (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	In house method.	L009-PL	D	MCERTS
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In house method.	L099-PL	D	MCERTS
pH at 20oC in leachate	Determination of pH in leachate by electrometric measurement.	In house method.	L005-PL	W	ISO 17025
Thiocyanate in soil	Determination of thiocyanate in soil by extraction in water followed by acidification followed by addition of ferric nitrate followed by discrete analyser (spectrophotometer).	In-house method	L082-PL	D	NONE
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
TPH1 (Leachates)	Determination of dichloromethane extractable hydrocarbons in leachate by GC-MS.	In-house method	L070-PL	W	NONE
Total cyanide in leachate	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	ISO 17025
Total cyanide in soil	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Dissolved Organic Carbon in leachate	Determination of dissolved organic carbon in leachate by the measurement on a non-dispersive infrared analyser of carbon dioxide released by acidification.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L023-PL	W	NONE
Exchangeable Ammonium as NH4 in soil	Determination of Ammonium/Ammonia/ Ammoniacal Nitrogen by the colorimetric salicylate/nitroprusside method, 10:1 water extraction.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L082-PL	W	MCERTS
Complex cyanide in leachate	Determination of complex cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L040-PL	W	ISO 17025
Thiocyanate in leachate	Determination of thiocyanate in water by discreet analyser (colorimetry).	In house method based on SMWW 4500-CN-M.	L082-PL	W	NONE
Sulphide in leachate	Determination of sulphide in leachate by ion selective electrode.	In-house method	L010-PL	W	NONE
Phenols, speciated, in leachate, by HPLC	Determination of speciated phenols by HPLC.	In house method based on Blue Book Method.	L030-PL	W	NONE
Speciated EPA-16 PAHs in leachate	Determination of PAH compounds in leachate by extraction in dichloromethane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L102B-PL	W	ISO 17025
BTEX and MTBE in leachates (Monoaromatics)	Determination of BTEX and MTBE in leachates by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	NONE

Analytical Report Number : 20-36955
Project / Site name: Hatton

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Total Sulphur in leachates	Determination of total sulphur in leachates by acidification followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L039-PL	W	NONE
Cr (III) in soil	In-house method by calculation from total Cr and Cr VI.	In-house method by calculation	L080-PL	W	NONE
TPHCWG (Soil)	Determination of hexane extractable hydrocarbons in soil by GC-MS/GC-FID.	In-house method with silica gel split/clean up.	L088/76-PL	W	MCERTS
TPH Banding in Soil by FID	Determination of hexane extractable hydrocarbons in soil by GC-FID.	In-house method, TPH with carbon banding and silica gel split/cleanup.	L076-PL	W	MCERTS
BTEX in leachates	Determination of BTEX in leachates by headspace GC-MS.	In-house method based on USEPA8260	L017-PL	W	ISO 17025
Ammonium as NH4 in leachate	Determination of ammonium in leachate by addition of buffer solution followed by ion selective electrode.	In-house method	L035-PL	W	NONE
Sulphate in leachates	Determination of sulphate in leachate by acidification followed by ICP-OES.	In-house method based on MEWAM 1986 Methods for the Determination of Metals in Soil""	L039-PL	W	ISO 17025
BTEX and MTBE in soil (Monoaromatics)	Determination of BTEX in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS
Sulphate, water soluble, in soil	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In house method.	L038-PL	D	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

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Analytical Report Number : 20-37285

Replaces Analytical Report Number: 20-37285, issue no. 1
Client references/information amended.

Project / Site name:	Hatton	**Samples received on:**	21/10/2020
Your job number:		**Samples instructed on/ Analysis started on:**	23/10/2020
Your order number:	795301-57408 PCT GENERAL	**Analysis completed by:**	16/12/2020
Report Issue Number:	2	**Report issued on:**	16/12/2020
Samples Analysed:	3 leachate samples - 8 soil samples		

Signed: I. Wawrzeczko

Joanna Wawrzeczko
Technical Reviewer (Reporting Team)
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :
soils - 4 weeks from reporting
leachates - 2 weeks from reporting
waters - 2 weeks from reporting
asbestos - 6 months from reporting

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Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement.
Application of uncertainty of measurement would provide a range within which the true result lies.
An estimate of measurement uncertainty can be provided on request.

Analytical Report Number: 20-37285
Project / Site name: Hatton
Your Order No: 795301-57408 PCT GENERAL

Lab Sample Number				1660711	1660712	1660713	1660714	1660715
Sample Reference				HP20-03	HP20-04	HP20-05	BH20-02	BH20-02
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.70-0.90	0.70-0.90	0.60-0.85	2.40-2.40	6.50-6.50
Date Sampled				21/10/2020	21/10/2020	21/10/2020	21/10/2020	21/10/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	0.01	NONE	8.1	8.6	8.6	13	11
Total mass of sample received	kg	0.001	NONE	1.2	1.2	1.2	0.4	0.4
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected	-	-
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	8.1	8.2	8	8.1	8.5
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1	< 1
Complex Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1	< 1
Free Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1	< 1
Thiocyanate as SCN	mg/kg	5	NONE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Water Soluble Sulphate as SO4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	3400	1500	5000	6600	1000
Water Soluble SO4 16hr extraction (2:1 Leachate Equivale	g/l	0.00125	MCERTS	1.7	0.73	2.5	3.3	0.52
Water Soluble SO4 16hr extraction (2:1 Leachate Equivale	mg/l	1.25	MCERTS	1690	734	2520	3310	517
Water Soluble Chloride (2:1)	mg/kg	1	MCERTS	11	10	24	7.7	49
Elemental Sulphur	mg/kg	5	MCERTS	< 5.0	11	< 5.0	< 5.0	< 5.0
Ammonium - Exchangeable as NH4	mg/kg	0.5	MCERTS	< 0.5	< 0.5	< 0.5	< 0.5	3.9
Organic Matter	%	0.1	MCERTS	-	1.1	-	1.3	-
Loss on Ignition @ 450oC	%	0.2	MCERTS	2.2	1.9	4.9	2.2	1.8
Phenols by HPLC								
Catechol	mg/kg	0.1	ISO 17025	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Resorcinol	mg/kg	0.1	ISO 17025	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Cresols (o-, m-, p-)	mg/kg	0.3	ISO 17025	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30
Total Naphthols (sum of 1- and 2- Naphthol)	mg/kg	0.2	ISO 17025	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
2-Isopropylphenol	mg/kg	0.1	ISO 17025	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Phenol	mg/kg	0.1	ISO 17025	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Trimethylphenol (2,3,5-)	mg/kg	0.1	ISO 17025	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Total Xylenols and Ethylphenols	mg/kg	0.3	ISO 17025	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30
Total Phenols								
Total Phenols (HPLC)	mg/kg	1.3	ISO 17025	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Chrysene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05

Total PAH

Analytical Report Number: 20-37285
Project / Site name: Hatton
Your Order No: 795301-57408 PCT GENERAL

Lab Sample Number				1660711	1660712	1660713	1660714	1660715
Sample Reference				HP20-03	HP20-04	HP20-05	BH20-02	BH20-02
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.70-0.90	0.70-0.90	0.60-0.85	2.40-2.40	6.50-6.50
Date Sampled				21/10/2020	21/10/2020	21/10/2020	21/10/2020	21/10/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	< 0.80	< 0.80	< 0.80	< 0.80	< 0.80
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	16	16	31	13	16
Boron (water soluble)	mg/kg	0.2	MCERTS	1.4	0.6	1.2	1	2.4
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0
Chromium (III)	mg/kg	1	NONE	23	24	25	20	14
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	23	24	25	20	14
Copper (aqua regia extractable)	mg/kg	1	MCERTS	16	16	15	14	15
Lead (aqua regia extractable)	mg/kg	1	MCERTS	16	13	16	11	9.5
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	24	27	28	25	21
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	67	58	55	52	55
Monoaromatics & Oxygenates								
Benzene	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Toluene	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Ethylbenzene	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
p & m-xylene	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
o-xylene	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
MTBE (Methyl Tertiary Butyl Ether)	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Petroleum Hydrocarbons								
TPH C10 - C40	mg/kg	10	MCERTS	< 10	< 10	< 10	< 10	< 10
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	-	< 0.001	-	-	-
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	-	< 0.001	-	-	-
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	< 0.001	-	-	-
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	-	< 1.0	-	-	-
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	-	< 2.0	-	-	-
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	-	< 8.0	-	-	-
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	-	< 8.0	-	-	-
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	-	< 10	-	-	-
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	-	< 0.001	-	-	-
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	-	< 0.001	-	-	-
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	< 0.001	-	-	-
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	-	< 1.0	-	-	-
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	-	< 2.0	-	-	-
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	-	< 10	-	-	-
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	-	< 10	-	-	-
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	-	< 10	-	-	-

U/S = Unsuitable Sample   I/S = Insufficient Sample

Analytical Report Number: 20-37285
Project / Site name: Hatton
Your Order No: 795301-57408 PCT GENERAL

Lab Sample Number				1660716	1660717	1660718
Sample Reference				BH20-03	BH20-03	BH20-03
Sample Number				None Supplied	None Supplied	None Supplied
Depth (m)				0.30-0.30	3.00-3.00	5.10-5.10
Date Sampled				21/10/2020	21/10/2020	21/10/2020
Time Taken				None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**			
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1
Moisture Content	%	0.01	NONE	15	13	12
Total mass of sample received	kg	0.001	NONE	1.2	0.4	0.4
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	-	-
General Inorganics						
pH - Automated	pH Units	N/A	MCERTS	8.1	7.8	7.9
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1
Complex Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1
Free Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1
Thiocyanate as SCN	mg/kg	5	NONE	< 5.0	< 5.0	< 5.0
Water Soluble Sulphate as SO4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	840	1600	1100
Water Soluble SO4 16hr extraction (2:1 Leachate Equivale	g/l	0.00125	MCERTS	0.42	0.78	0.54
Water Soluble SO4 16hr extraction (2:1 Leachate Equivale	mg/l	1.25	MCERTS	422	777	544
Water Soluble Chloride (2:1)	mg/kg	1	MCERTS	18	39	39
Elemental Sulphur	mg/kg	5	MCERTS	< 5.0	< 5.0	< 5.0
Ammonium - Exchangeable as NH4	mg/kg	0.5	MCERTS	< 0.5	1.7	1.9
Organic Matter	%	0.1	MCERTS	1.7	-	-
Loss on Ignition @ 450oC	%	0.2	MCERTS	1.8	2	0.7
Phenols by HPLC						
Catechol	mg/kg	0.1	ISO 17025	< 0.10	< 0.10	< 0.10
Resorcinol	mg/kg	0.1	ISO 17025	< 0.10	< 0.10	< 0.10
Cresols (o-, m-, p-)	mg/kg	0.3	ISO 17025	< 0.30	< 0.30	< 0.30
Total Naphthols (sum of 1- and 2- Naphthol)	mg/kg	0.2	ISO 17025	< 0.20	< 0.20	< 0.20
2-Isopropylphenol	mg/kg	0.1	ISO 17025	< 0.10	< 0.10	< 0.10
Phenol	mg/kg	0.1	ISO 17025	< 0.10	< 0.10	< 0.10
Trimethylphenol (2,3,5-)	mg/kg	0.1	ISO 17025	< 0.10	< 0.10	< 0.10
Total Xylenols and Ethylphenols	mg/kg	0.3	ISO 17025	< 0.30	< 0.30	< 0.30
Total Phenols						
Total Phenols (HPLC)	mg/kg	1.3	ISO 17025	< 1.3	< 1.3	< 1.3
Speciated PAHs						
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05
Anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05
Pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05
Chrysene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05

Total PAH

Analytical Report Number: 20-37285
Project / Site name: Hatton
Your Order No: 795301-57408 PCT GENERAL

Lab Sample Number				1660716	1660717	1660718
Sample Reference				BH20-03	BH20-03	BH20-03
Sample Number				None Supplied	None Supplied	None Supplied
Depth (m)				0.30-0.30	3.00-3.00	5.10-5.10
Date Sampled				21/10/2020	21/10/2020	21/10/2020
Time Taken				None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**			
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	< 0.80	< 0.80	< 0.80
Heavy Metals / Metalloids						
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	13	14	10
Boron (water soluble)	mg/kg	0.2	MCERTS	1.8	2	0.6
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	0.3	0.3	< 0.2
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0
Chromium (III)	mg/kg	1	NONE	17	19	12
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	17	19	12
Copper (aqua regia extractable)	mg/kg	1	MCERTS	15	17	11
Lead (aqua regia extractable)	mg/kg	1	MCERTS	11	11	7.4
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	25	25	15
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	1.5	< 1.0	< 1.0
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	47	54	35
Monoaromatics & Oxygenates						
Benzene	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001
Toluene	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001
Ethylbenzene	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001
p & m-xylene	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001
o-xylene	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001
MTBE (Methyl Tertiary Butyl Ether)	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001
Petroleum Hydrocarbons						
TPH C10 - C40	mg/kg	10	MCERTS	< 10	< 10	< 10
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	-	-	-
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	-	-	-
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	-	-
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	-	-	-
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	-	-	-
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	-	-	-
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	-	-	-
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	-	-	-
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	-	-	-
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	-	-	-
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	-	-
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	-	-	-
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	-	-	-
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	-	-	-
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	-	-	-
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	-	-	-

U/S = Unsuitable Sample   I/S = Insufficient Sample

Analytical Report Number: 20-37285
Project / Site name: Hatton

Your Order No: 795301-57408 PCT GENERAL

Lab Sample Number				1660719	1660720	1660721
Sample Reference				HP20-04	HP20-05	BH20-03
Sample Number				None Supplied	None Supplied	None Supplied
Depth (m)				0.70-0.90	0.60-0.85	3.00-3.00
Date Sampled				21/10/2020	21/10/2020	21/10/2020
Time Taken				None Supplied	None Supplied	None Supplied
Analytical Parameter (Leachate Analysis)	**Units**	**Limit of detection**	**Accreditation Status**			
General Inorganics						
pH	pH Units	N/A	ISO 17025	8.2	7.8	7.9
Electrical Conductivity	µS/cm	10	ISO 17025	210	290	85
Total Cyanide	mg/l	0.01	ISO 17025	< 0.010	< 0.010	< 0.010
Complex Cyanide	mg/l	0.01	ISO 17025	< 0.0100	< 0.0100	< 0.0100
Free Cyanide	mg/l	0.01	ISO 17025	< 0.010	< 0.010	< 0.010
Thiocyanate as SCN	mg/l	0.2	NONE	< 0.2	< 0.2	< 0.2
Sulphate as SO4	mg/l	0.1	ISO 17025	75.1	128	11.9
Total Sulphur	mg/l	0.015	NONE	25	42.8	3.97
Sulphide	mg/l	0.005	NONE	< 0.005	< 0.005	< 0.005
Chloride	mg/l	4	NONE	< 4.0	< 4.0	< 4.0
Ammonium as NH4	mg/l	0.015	NONE	< 0.015	< 0.015	< 0.015
Dissolved Organic Carbon (DOC)	mg/l	0.1	NONE	3.57	3.82	4.95
Phenols by HPLC						
Catechol	mg/l	0.0005	NONE	< 0.0005	< 0.0005	< 0.0005
Resorcinol	mg/l	0.0005	NONE	< 0.0005	< 0.0005	< 0.0005
Ethylphenol & Dimethylphenol	mg/l	0.0005	NONE	< 0.0005	< 0.0005	< 0.0005
Cresols	mg/l	0.0005	NONE	< 0.0005	< 0.0005	< 0.0005
Naphthols	mg/l	0.0005	NONE	< 0.0005	< 0.0005	< 0.0005
Isopropylphenol	mg/l	0.0005	NONE	< 0.0005	< 0.0005	< 0.0005
Phenol	mg/l	0.0005	NONE	< 0.0005	< 0.0005	< 0.0005
Trimethylphenol	mg/l	0.0005	NONE	< 0.0005	< 0.0005	< 0.0005
Total Phenols						
Total Phenols (HPLC)	mg/l	0.0035	NONE	< 0.0035	< 0.0035	< 0.0035
Speciated PAHs						
Naphthalene	mg/l	0.00001	ISO 17025	< 0.0000	< 0.0000	< 0.0000
Acenaphthylene	mg/l	0.00001	ISO 17025	< 0.0000	< 0.0000	< 0.0000
Acenaphthene	mg/l	0.00001	ISO 17025	< 0.0000	< 0.0000	< 0.0000
Fluorene	mg/l	0.00001	ISO 17025	< 0.0000	< 0.0000	< 0.0000
Phenanthrene	mg/l	0.00001	ISO 17025	< 0.0000	< 0.0000	< 0.0000
Anthracene	mg/l	0.00001	ISO 17025	< 0.0000	< 0.0000	< 0.0000
Fluoranthene	mg/l	0.00001	ISO 17025	< 0.0000	< 0.0000	< 0.0000
Pyrene	mg/l	0.00001	ISO 17025	< 0.0000	< 0.0000	< 0.0000
Benzo(a)anthracene	mg/l	0.00001	ISO 17025	< 0.0000	< 0.0000	< 0.0000
Chrysene	mg/l	0.00001	ISO 17025	< 0.0000	< 0.0000	< 0.0000
Benzo(b)fluoranthene	mg/l	0.00001	ISO 17025	< 0.0000	< 0.0000	< 0.0000
Benzo(k)fluoranthene	mg/l	0.00001	ISO 17025	< 0.0000	< 0.0000	< 0.0000
Benzo(a)pyrene	mg/l	0.00001	ISO 17025	< 0.0000	< 0.0000	< 0.0000
Indeno(1,2,3-cd)pyrene	mg/l	0.00001	NONE	< 0.0000	< 0.0000	< 0.0000
Dibenz(a,h)anthracene	mg/l	0.00001	NONE	< 0.0000	< 0.0000	< 0.0000
Benzo(ghi)perylene	mg/l	0.00001	NONE	< 0.0000	< 0.0000	< 0.0000
Total PAH						
Total EPA-16 PAHs	mg/l	0.0002	NONE	< 0.0002	< 0.0002	< 0.0002
Heavy Metals / Metalloids						
Arsenic (dissolved)	mg/l	0.001	ISO 17025	0.008	< 0.001	0.003
Cadmium (dissolved)	mg/l	0.0001	ISO 17025	< 0.0001	< 0.0001	< 0.0001
Chromium (dissolved)	mg/l	0.0004	ISO 17025	< 0.0004	0.0005	0.001

Analytical Report Number: 20-37285
Project / Site name: Hatton

Your Order No: 795301-57408 PCT GENERAL

Lab Sample Number				1660719	1660720	1660721
Sample Reference				HP20-04	HP20-05	BH20-03
Sample Number				None Supplied	None Supplied	None Supplied
Depth (m)				0.70-0.90	0.60-0.85	3.00-3.00
Date Sampled				21/10/2020	21/10/2020	21/10/2020
Time Taken				None Supplied	None Supplied	None Supplied
Analytical Parameter (Leachate Analysis)	**Units**	**Limit of detection**	**Accreditation Status**			
Copper (dissolved)	mg/l	0.0003	ISO 17025	0.0024	0.0033	0.0021
Iron (dissolved)	mg/l	0.004	ISO 17025	0.02	0.066	1
Lead (dissolved)	mg/l	0.001	ISO 17025	< 0.001	0.002	0.003
Mercury (dissolved)	mg/l	0.0005	ISO 17025	< 0.0005	< 0.0005	< 0.0005
Nickel (dissolved)	mg/l	0.0003	ISO 17025	0.0015	0.0019	0.0024
Selenium (dissolved)	mg/l	0.004	ISO 17025	< 0.004	< 0.004	< 0.004
Zinc (dissolved)	mg/l	0.0004	ISO 17025	0.0047	0.0089	0.0032

Monoaromatics & Oxygenates

Benzene	mg/l	0.001	ISO 17025	< 0.001	< 0.001	< 0.001
Toluene	mg/l	0.001	ISO 17025	< 0.001	< 0.001	< 0.001
Ethylbenzene	mg/l	0.001	ISO 17025	< 0.001	< 0.001	< 0.001
p & m-xylene	mg/l	0.001	ISO 17025	< 0.001	< 0.001	< 0.001
o-xylene	mg/l	0.001	ISO 17025	< 0.001	< 0.001	< 0.001
MTBE (Methyl Tertiary Butyl Ether)	mg/l	0.01	NONE	< 0.010	< 0.010	< 0.010

Petroleum Hydrocarbons

TPH1 (C10 - C40)	µg/l	10	NONE	< 10	< 10	< 10
TPH1 (C10 - C40)	mg/l	0.01	NONE	< 0.01	< 0.01	< 0.01

U/S = Unsuitable Sample   I/S = Insufficient Sample

Analytical Report Number : 20-37285
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* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
1660711	HP20-03	None Supplied	0.70-0.90	Light grey clay and sand with chalk.
1660712	HP20-04	None Supplied	0.70-0.90	Light grey clay and sand with chalk.
1660713	HP20-05	None Supplied	0.60-0.85	2.4.8.17
1660714	BH20-02	None Supplied	2.40-2.40	Brown clay with chalk and gravel
1660715	BH20-02	None Supplied	6.50-6.50	Grey clay with gravel.
1660716	BH20-03	None Supplied	0.30-0.30	Brown clay with gravel.
1660717	BH20-03	None Supplied	3.00-3.00	Grey clay with gravel.
1660718	BH20-03	None Supplied	5.10-5.10	Light grey clay with gravel.

Analytical Report Number : 20-37285
Project / Site name: Hatton

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In house method.	L038-PL	D	MCERTS
NRA Leachate Prep	10:1 extract with de-ionised water shaken for 24 hours then filtered.	In-house method based on National Rivers Authority	L020-PL	W	NONE
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Phenols, speciated, in soil, by HPLC	Determination of speciated phenols by HPLC.	In house method based on Blue Book Method.	L030-PL	W	ISO 17025
Boron, water soluble, in soil	Determination of water soluble boron in soil by hot water extract followed by ICP-OES.	In-house method based on Second Site Properties version 3	L038-PL	D	MCERTS
Complex Cyanide in soil	Determination of complex cyanide by calculation.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Chloride in leachate	Determination of chloride in leachate by titration against silver nitrate.	In house based on MEWAM Method ISBN 0117516260.	L024-PL	W	NONE
Chloride, water soluble, in soil	Determination of Chloride colorimetrically by discrete analyser.	In house method.	L082-PL	D	MCERTS
Hexavalent chromium in soil	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method	L080-PL	W	MCERTS
Electrical conductivity at 20oC of leachate	Determination of electrical conductivity in leachate by electrometric measurement.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L031-PL	W	ISO 17025
Elemental sulphur in soil	Determination of elemental sulphur in soil by extraction in acetonitrile followed by HPLC.	In-house method based on Secondsite Property Holdings Guidance for Assessing and Managing Potential	L021-PL	D	MCERTS
Free cyanide in leachate	Determination of free cyanide by distillation followed by colorimetry.	In-house method	L080-PL	W	ISO 17025
Free cyanide in soil	Determination of free cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Metals by ICP-OES in leachate	Determination of metals in leachate by acidification followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L039-PL	W	ISO 17025
Loss on ignition of soil @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace.	In house method.	L047-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically. (30 oC)	In house method.	L019-UK/PL	W	NONE

Analytical Report Number : 20-37285
Project / Site name: Hatton

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Organic matter (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	In house method.	L009-PL	D	MCERTS
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In house method.	L099-PL	D	MCERTS
pH at 20oC in leachate	Determination of pH in leachate by electrometric measurement.	In house method.	L005-PL	W	ISO 17025
Thiocyanate in soil	Determination of thiocyanate in soil by extraction in water followed by acidification followed by addition of ferric nitrate followed by discrete analyser (spectrophotometer).	In-house method	L082-PL	D	NONE
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
TPH1 (Leachates)	Determination of dichloromethane extractable hydrocarbons in leachate by GC-MS.	In-house method	L070-PL	W	NONE
Total cyanide in leachate	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	ISO 17025
Total cyanide in soil	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Dissolved Organic Carbon in leachate	Determination of dissolved organic carbon in leachate by the measurement on a non-dispersive infrared analyser of carbon dioxide released by acidification.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L023-PL	W	NONE
Exchangeable Ammonium as NH4 in soil	Determination of Ammonium/Ammonia/ Ammoniacal Nitrogen by the colorimetric salicylate/nitroprusside method, 10:1 water extraction.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L082-PL	W	MCERTS
Complex cyanide in leachate	Determination of complex cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L040-PL	W	ISO 17025
Thiocyanate in leachate	Determination of thiocyanate in water by discreet analyser (colorimetry).	In house method based on SMWW 4500-CN-M.	L082-PL	W	NONE
Sulphide in leachate	Determination of sulphide in leachate by ion selective electrode.	In-house method	L010-PL	W	NONE
Phenols, speciated, in leachate, by HPLC	Determination of speciated phenols by HPLC.	In house method based on Blue Book Method.	L030-PL	W	NONE
Speciated EPA-16 PAHs in leachate	Determination of PAH compounds in leachate by extraction in dichloromethane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L102B-PL	W	ISO 17025
BTEX and MTBE in leachates (Monoaromatics)	Determination of BTEX and MTBE in leachates by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	NONE

Analytical Report Number : 20-37285
Project / Site name: Hatton

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Total Sulphur in leachates	Determination of total sulphur in leachates by acidification followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L039-PL	W	NONE
Cr (III) in soil	In-house method by calculation from total Cr and Cr VI.	In-house method by calculation	L080-PL	W	NONE
TPHCWG (Soil)	Determination of hexane extractable hydrocarbons in soil by GC-MS/GC-FID.	In-house method with silica gel split/clean up.	L088/76-PL	W	MCERTS
TPH Banding in Soil by FID	Determination of hexane extractable hydrocarbons in soil by GC-FID.	In-house method, TPH with carbon banding and silica gel split/cleanup.	L076-PL	W	MCERTS
BTEX in leachates	Determination of BTEX in leachates by headspace GC-MS.	In-house method based on USEPA8260	L017-PL	W	ISO 17025
Ammonium as NH4 in leachate	Determination of ammonium in leachate by addition of buffer solution followed by ion selective electrode.	In-house method	L035-PL	W	NONE
Sulphate in leachates	Determination of sulphate in leachate by acidification followed by ICP-OES.	In-house method based on MEWAM 1986 Methods for the Determination of Metals in Soil""	L039-PL	W	ISO 17025
BTEX and MTBE in soil (Monoaromatics)	Determination of BTEX in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS
Sulphate, water soluble, in soil	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In house method.	L038-PL	D	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

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Analytical Report Number : 20-37429

Project / Site name:	Halton	**Samples received on:**	23/10/2020
Your job number:		**Samples instructed on/ Analysis started on:**	23/10/2020
Your order number:	795301-52908	**Analysis completed by:**	02/11/2020
Report Issue Number:	1	**Report issued on:**	02/11/2020
Samples Analysed:	1 leachate sample - 6 soil samples		

Signed: Karolina Marek

Karolina Marek
PL Head of Reporting Team
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils - 4 weeks from reporting
leachates - 2 weeks from reporting
waters - 2 weeks from reporting
asbestos - 6 months from reporting

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Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement.
Application of uncertainty of measurement would provide a range within which the true result lies.
An estimate of measurement uncertainty can be provided on request.

Analytical Report Number: 20-37429
Project / Site name: Halton

Your Order No: 795301-52908

Lab Sample Number				1661367
Sample Reference				TP20-02
Sample Number				None Supplied
Depth (m)				0.80-0.80
Date Sampled				22/10/2020
Time Taken				None Supplied
Analytical Parameter (Leachate Analysis)	**Units**	**Limit of detection**	**Accreditation Status**	

General Inorganics

pH	pH Units	N/A	ISO 17025	8.1
Electrical Conductivity	µS/cm	10	ISO 17025	140
Total Cyanide	mg/l	0.01	ISO 17025	< 0.010
Complex Cyanide	mg/l	0.01	ISO 17025	< 0.0100
Free Cyanide	mg/l	0.01	ISO 17025	< 0.010
Thiocyanate as SCN	mg/l	0.2	NONE	< 0.2
Sulphate as SO4	mg/l	0.1	ISO 17025	25.1
Total Sulphur	mg/l	0.015	NONE	8.35
Sulphide	mg/l	0.005	NONE	< 0.005
Chloride	mg/l	4	NONE	< 4.0
Ammonium as NH4	mg/l	0.015	NONE	0.018
Dissolved Organic Carbon (DOC)	mg/l	0.1	NONE	4.36

Phenols by HPLC

Catechol	mg/l	0.0005	NONE	< 0.0005
Resorcinol	mg/l	0.0005	NONE	< 0.0005
Ethylphenol & Dimethylphenol	mg/l	0.0005	NONE	< 0.0005
Cresols	mg/l	0.0005	NONE	< 0.0005
Naphthols	mg/l	0.0005	NONE	< 0.0005
Isopropylphenol	mg/l	0.0005	NONE	< 0.0005
Phenol	mg/l	0.0005	NONE	< 0.0005
Trimethylphenol	mg/l	0.0005	NONE	< 0.0005

Total Phenols

Total Phenols (HPLC)	mg/l	0.0035	NONE	< 0.0035

Speciated PAHs

Naphthalene	mg/l	0.00001	ISO 17025	< 0.00001
Acenaphthylene	mg/l	0.00001	ISO 17025	< 0.00001
Acenaphthene	mg/l	0.00001	ISO 17025	< 0.00001
Fluorene	mg/l	0.00001	ISO 17025	< 0.00001
Phenanthrene	mg/l	0.00001	ISO 17025	< 0.00001
Anthracene	mg/l	0.00001	ISO 17025	< 0.00001
Fluoranthene	mg/l	0.00001	ISO 17025	< 0.00001
Pyrene	mg/l	0.00001	ISO 17025	< 0.00001
Benzo(a)anthracene	mg/l	0.00001	ISO 17025	< 0.00001
Chrysene	mg/l	0.00001	ISO 17025	< 0.00001
Benzo(b)fluoranthene	mg/l	0.00001	ISO 17025	< 0.00001
Benzo(k)fluoranthene	mg/l	0.00001	ISO 17025	< 0.00001
Benzo(a)pyrene	mg/l	0.00001	ISO 17025	< 0.00001
Indeno(1,2,3-cd)pyrene	mg/l	0.00001	NONE	< 0.00001
Dibenz(a,h)anthracene	mg/l	0.00001	NONE	< 0.00001
Benzo(ghi)perylene	mg/l	0.00001	NONE	< 0.00001

Total PAH

Total EPA-16 PAHs	mg/l	0.0002	NONE	< 0.0002

Analytical Report Number: 20-37429
Project / Site name: Halton

Your Order No: 795301-52908

Lab Sample Number				1661367
Sample Reference				TP20-02
Sample Number				None Supplied
Depth (m)				0.80-0.80
Date Sampled				22/10/2020
Time Taken				None Supplied
Analytical Parameter (Leachate Analysis)	**Units**	**Limit of detection**	**Accreditation Status**	
Heavy Metals / Metalloids				
Arsenic (dissolved)	mg/l	0.001	ISO 17025	0.003
Cadmium (dissolved)	mg/l	0.0001	ISO 17025	< 0.0001
Chromium (dissolved)	mg/l	0.0004	ISO 17025	0.0008
Copper (dissolved)	mg/l	0.0003	ISO 17025	0.0146
Iron (dissolved)	mg/l	0.004	ISO 17025	0.075
Lead (dissolved)	mg/l	0.001	ISO 17025	0.006
Mercury (dissolved)	mg/l	0.0005	ISO 17025	< 0.0005
Nickel (dissolved)	mg/l	0.0003	ISO 17025	0.002
Selenium (dissolved)	mg/l	0.004	ISO 17025	< 0.004
Zinc (dissolved)	mg/l	0.0004	ISO 17025	0.0103
Monoaromatics & Oxygenates				
Benzene	mg/l	0.001	ISO 17025	< 0.001
Toluene	mg/l	0.001	ISO 17025	< 0.001
Ethylbenzene	mg/l	0.001	ISO 17025	< 0.001
p & m-xylene	mg/l	0.001	ISO 17025	< 0.001
o-xylene	mg/l	0.001	ISO 17025	< 0.001
MTBE (Methyl Tertiary Butyl Ether)	mg/l	0.01	NONE	< 0.010
Petroleum Hydrocarbons				
TPH1 (C10 - C40)	mg/l	0.01	NONE	< 0.01

U/S = Unsuitable Sample   I/S = Insufficient Sample

Analytical Report Number: 20-37429
Project / Site name: Halton
Your Order No: 795301-52908

Lab Sample Number				1661361	1661362	1661363	1661364
Sample Reference				TP20-01	TP20-01	TP20-02	TP20-02
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.10-0.10	0.20-0.20	0.10-0.10	0.80-0.80
Date Sampled				22/10/2020	22/10/2020	22/10/2020	22/10/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**				
Stone Content	%	0.1	NONE	< 0.1	< 0.1	-	< 0.1
Moisture Content	%	N/A	NONE	15	13	-	10
Total mass of sample received	kg	0.001	NONE	0.7	1.2	-	1.2
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	-	Not-detected	-
General Inorganics							
pH - Automated	pH Units	N/A	MCERTS	8.3	8.1	-	8.2
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1	-	< 1
Complex Cyanide	mg/kg	1	MCERTS	< 1	< 1	-	< 1
Free Cyanide	mg/kg	1	MCERTS	< 1	< 1	-	< 1
Thiocyanate as SCN	mg/kg	5	NONE	< 5.0	< 5.0	-	< 5.0
Water Soluble Sulphate as SO4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	49	360	-	730
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.024	0.18	-	0.36
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	24.4	178	-	363
Water Soluble Chloride (2:1)	mg/kg	1	MCERTS	4.7	6.1	-	44
Elemental Sulphur	mg/kg	5	MCERTS	< 5.0	< 5.0	-	< 5.0
Ammonium - Exchangeable as NH4	mg/kg	0.5	MCERTS	< 0.5	< 0.5	-	< 0.5
Loss on Ignition @ 450oC	%	0.2	MCERTS	3.3	1.8	-	2.9
Phenols by HPLC							
Catechol	mg/kg	0.1	ISO 17025	< 0.10	< 0.10	-	< 0.10
Resorcinol	mg/kg	0.1	ISO 17025	< 0.10	< 0.10	-	< 0.10
Cresols (o-, m-, p-)	mg/kg	0.3	ISO 17025	< 0.30	< 0.30	-	< 0.30
Total Naphthols (sum of 1- and 2- Naphthol)	mg/kg	0.2	ISO 17025	< 0.20	< 0.20	-	< 0.20
2-Isopropylphenol	mg/kg	0.1	ISO 17025	< 0.10	< 0.10	-	< 0.10
Phenol	mg/kg	0.1	ISO 17025	< 0.10	< 0.10	-	< 0.10
Trimethylphenol (2,3,5-)	mg/kg	0.1	ISO 17025	< 0.10	< 0.10	-	< 0.10
Total Xylenols and Ethylphenols	mg/kg	0.3	ISO 17025	< 0.30	< 0.30	-	< 0.30
Total Phenols							
Total Phenols (HPLC)	mg/kg	1.3	ISO 17025	< 1.3	< 1.3	-	< 1.3

Analytical Report Number: 20-37429
Project / Site name: Halton
Your Order No: 795301-52908

Lab Sample Number				1661361	1661362	1661363	1661364
Sample Reference				TP20-01	TP20-01	TP20-02	TP20-02
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.10-0.10	0.20-0.20	0.10-0.10	0.80-0.80
Date Sampled				22/10/2020	22/10/2020	22/10/2020	22/10/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**				
Speciated PAHs							
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05
Anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	0.66
Pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	0.67
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	0.36
Chrysene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	0.38
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05
Total PAH							
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	< 0.80	< 0.80	-	2.07
Heavy Metals / Metalloids							
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	13	11	-	12
Boron (water soluble)	mg/kg	0.2	MCERTS	1.7	0.8	-	0.6
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	-	0.6
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0	-	< 4.0
Chromium (III)	mg/kg	1	NONE	25	21	-	20
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	26	21	-	20
Copper (aqua regia extractable)	mg/kg	1	MCERTS	18	9.9	-	10
Lead (aqua regia extractable)	mg/kg	1	MCERTS	22	10	-	19
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	-	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	19	20	-	16
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	76	33	-	46
Monoaromatics & Oxygenates							
Benzene	mg/kg	0.001	MCERTS	< 0.001	< 0.001	-	< 0.001
Toluene	mg/kg	0.001	MCERTS	< 0.001	< 0.001	-	< 0.001
Ethylbenzene	mg/kg	0.001	MCERTS	< 0.001	< 0.001	-	< 0.001
p & m-xylene	mg/kg	0.001	MCERTS	< 0.001	< 0.001	-	< 0.001
o-xylene	mg/kg	0.001	MCERTS	< 0.001	< 0.001	-	< 0.001
MTBE (Methyl Tertiary Butyl Ether)	mg/kg	0.001	MCERTS	< 0.001	< 0.001	-	< 0.001
Petroleum Hydrocarbons							
TPH C10 - C40	mg/kg	10	MCERTS	< 10	< 10	-	< 10

U/S = Unsuitable Sample   I/S = Insufficient Sample

Analytical Report Number: 20-37429
Project / Site name: Halton
Your Order No: 795301-52908

Lab Sample Number				1661365	1661366
Sample Reference				TP20-04	TP20-04
Sample Number				None Supplied	None Supplied
Depth (m)				0.20-0.20	0.60-0.60
Date Sampled				22/10/2020	22/10/2020
Time Taken				None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**		
Stone Content	%	0.1	NONE	-	< 0.1
Moisture Content	%	N/A	NONE	-	15
Total mass of sample received	kg	0.001	NONE	-	1.2
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	-
General Inorganics					
pH - Automated	pH Units	N/A	MCERTS	-	7.9
Total Cyanide	mg/kg	1	MCERTS	-	< 1
Complex Cyanide	mg/kg	1	MCERTS	-	< 1
Free Cyanide	mg/kg	1	MCERTS	-	< 1
Thiocyanate as SCN	mg/kg	5	NONE	-	< 5.0
Water Soluble Sulphate as SO4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	-	1600
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	-	0.8
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	-	802
Water Soluble Chloride (2:1)	mg/kg	1	MCERTS	-	5
Elemental Sulphur	mg/kg	5	MCERTS	-	< 5.0
Ammonium - Exchangeable as NH4	mg/kg	0.5	MCERTS	-	< 0.5
Loss on Ignition @ 450oC	%	0.2	MCERTS	-	2.9
Phenols by HPLC					
Catechol	mg/kg	0.1	ISO 17025	-	< 0.10
Resorcinol	mg/kg	0.1	ISO 17025	-	< 0.10
Cresols (o-, m-, p-)	mg/kg	0.3	ISO 17025	-	< 0.30
Total Naphthols (sum of 1- and 2- Naphthol)	mg/kg	0.2	ISO 17025	-	< 0.20
2-Isopropylphenol	mg/kg	0.1	ISO 17025	-	< 0.10
Phenol	mg/kg	0.1	ISO 17025	-	< 0.10
Trimethylphenol (2,3,5-)	mg/kg	0.1	ISO 17025	-	< 0.10
Total Xylenols and Ethylphenols	mg/kg	0.3	ISO 17025	-	< 0.30
Total Phenols					
Total Phenols (HPLC)	mg/kg	1.3	ISO 17025	-	< 1.3

Analytical Report Number: 20-37429
Project / Site name: Halton
Your Order No: 795301-52908

Lab Sample Number				1661365	1661366
Sample Reference				TP20-04	TP20-04
Sample Number				None Supplied	None Supplied
Depth (m)				0.20-0.20	0.60-0.60
Date Sampled				22/10/2020	22/10/2020
Time Taken				None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**		
Speciated PAHs					
Naphthalene	mg/kg	0.05	MCERTS	-	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	-	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	-	< 0.05
Fluorene	mg/kg	0.05	MCERTS	-	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	-	< 0.05
Anthracene	mg/kg	0.05	MCERTS	-	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	-	< 0.05
Pyrene	mg/kg	0.05	MCERTS	-	< 0.05
Benzo(a)anthracene	mg/kg	0.05	MCERTS	-	< 0.05
Chrysene	mg/kg	0.05	MCERTS	-	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	-	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	-	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	-	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	-	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	-	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	-	< 0.05
Total PAH					
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	-	< 0.80
Heavy Metals / Metalloids					
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	-	16
Boron (water soluble)	mg/kg	0.2	MCERTS	-	1.2
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	-	< 0.2
Chromium (hexavalent)	mg/kg	4	MCERTS	-	< 4.0
Chromium (III)	mg/kg	1	NONE	-	27
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	-	27
Copper (aqua regia extractable)	mg/kg	1	MCERTS	-	16
Lead (aqua regia extractable)	mg/kg	1	MCERTS	-	18
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	-	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	-	24
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	-	< 1.0
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	-	58
Monoaromatics & Oxygenates					
Benzene	mg/kg	0.001	MCERTS	-	< 0.001
Toluene	mg/kg	0.001	MCERTS	-	< 0.001
Ethylbenzene	mg/kg	0.001	MCERTS	-	< 0.001
p & m-xylene	mg/kg	0.001	MCERTS	-	< 0.001
o-xylene	mg/kg	0.001	MCERTS	-	< 0.001
MTBE (Methyl Tertiary Butyl Ether)	mg/kg	0.001	MCERTS	-	< 0.001
Petroleum Hydrocarbons					
TPH C10 - C40	mg/kg	10	MCERTS	-	< 10

U/S = Unsuitable Sample   I/S = Insufficient Sample

Analytical Report Number : 20-37429
Project / Site name: Halton

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
1661361	TP20-01	None Supplied	0.10-0.10	Brown clay and loam with gravel.
1661362	TP20-01	None Supplied	0.20-0.20	Brown clay and loam with gravel.
1661364	TP20-02	None Supplied	0.80-0.80	Brown clay and loam with gravel.
1661366	TP20-04	None Supplied	0.60-0.60	Brown clay and loam with gravel.

Analytical Report Number : 20-37429
Project / Site name: Halton

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In house method.	L038-PL	D	MCERTS
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
NRA Leachate Prep	10:1 extract with de-ionised water shaken for 24 hours then filtered.	In-house method based on National Rivers Authority	L020-PL	W	NONE
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Phenols, speciated, in soil, by HPLC	Determination of speciated phenols by HPLC.	In house method based on Blue Book Method.	L030-PL	W	ISO 17025
Boron, water soluble, in soil	Determination of water soluble boron in soil by hot water extract followed by ICP-OES.	In-house method based on Second Site Properties version 3	L038-PL	D	MCERTS
Complex Cyanide in soil	Determination of complex cyanide by calculation.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Chloride in leachate	Determination of chloride in leachate by titration against silver nitrate.	In house based on MEWAM Method ISBN 0117516260.	L024-PL	W	NONE
Chloride, water soluble, in soil	Determination of Chloride colorimetrically by discrete analyser.	In house method.	L082-PL	D	MCERTS
Hexavalent chromium in soil	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method	L080-PL	W	MCERTS
Electrical conductivity at 20oC of leachate	Determination of electrical conductivity in leachate by electrometric measurement.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L031-PL	W	ISO 17025
Elemental sulphur in soil	Determination of elemental sulphur in soil by extraction in acetonitrile followed by HPLC.	In-house method based on Secondsite Property Holdings Guidance for Assessing and Managing Potential	L021-PL	D	MCERTS
Free cyanide in leachate	Determination of free cyanide by distillation followed by colorimetry.	In-house method	L080-PL	W	ISO 17025
Free cyanide in soil	Determination of free cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Metals by ICP-OES in leachate	Determination of metals in leachate by acidification followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L039-PL	W	ISO 17025
Loss on ignition of soil @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace.	In house method.	L047-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically. (30 oC)	In house method.	L019-UK/PL	W	NONE

Analytical Report Number : 20-37429
Project / Site name: Halton

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In house method.	L099-PL	D	MCERTS
pH at 20oC in leachate	Determination of pH in leachate by electrometric measurement.	In house method.	L005-PL	W	ISO 17025
Thiocyanate in soil	Determination of thiocyanate in soil by extraction in water followed by acidification followed by addition of ferric nitrate followed by discrete analyser (spectrophotometer).	In-house method	L082-PL	D	NONE
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
TPH1 (Leachates)	Determination of dichloromethane extractable hydrocarbons in leachate by GC-MS.	In-house method	L070-PL	W	NONE
Total cyanide in leachate	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	ISO 17025
Total cyanide in soil	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Dissolved Organic Carbon in leachate	Determination of dissolved organic carbon in leachate by the measurement on a non-dispersive infrared analyser of carbon dioxide released by acidification.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L023-PL	W	NONE
Exchangeable Ammonium as NH4 in soil	Determination of Ammonium/Ammonia/ Ammoniacal Nitrogen by the colorimetric salicylate/nitroprusside method, 10:1 water extraction.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L082-PL	W	MCERTS
Complex cyanide in leachate	Determination of complex cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L040-PL	W	ISO 17025
Thiocyanate in leachate	Determination of thiocyanate in water by discreet analyser (colorimetry).	In house method based on SMWW 4500-CN-M.	L082-PL	W	NONE
Sulphide in leachate	Determination of sulphide in leachate by ion selective electrode.	In-house method	L010-PL	W	NONE
Phenols, speciated, in leachate, by HPLC	Determination of speciated phenols by HPLC.	In house method based on Blue Book Method.	L030-PL	W	NONE
Speciated EPA-16 PAHs in leachate	Determination of PAH compounds in leachate by extraction in dichloromethane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L102B-PL	W	ISO 17025
BTEX and MTBE in leachates (Monoaromatics)	Determination of BTEX and MTBE in leachates by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	NONE
Total Sulphur in leachates	Determination of total sulphur in leachates by acidification followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L039-PL	W	NONE

Analytical Report Number : 20-37429
Project / Site name: Halton

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Cr (III) in soil	In-house method by calculation from total Cr and Cr VI.	In-house method by calculation	L080-PL	W	NONE
TPH Banding in Soil by FID	Determination of hexane extractable hydrocarbons in soil by GC-FID.	In-house method, TPH with carbon banding and silica gel split/cleanup.	L076-PL	W	MCERTS
BTEX in leachates	Determination of BTEX in leachates by headspace GC-MS.	In-house method based on USEPA8260	L017-PL	W	ISO 17025
Ammonium as NH4 in leachate	Determination of ammonium in leachate by addition of buffer solution followed by ion selective electrode.	In-house method	L035-PL	W	NONE
Sulphate in leachates	Determination of sulphate in leachate by acidification followed by ICP-OES.	In-house method based on MEWAM 1986 Methods for the Determination of Metals in Soil""	L039-PL	W	ISO 17025
BTEX and MTBE in soil (Monoaromatics)	Determination of BTEX in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS
Sulphate, water soluble, in soil	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In house method.	L038-PL	D	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

Sample Deviation Report

Analytical Report Number : 20-37429
Project / Site name: Halton

Sample ID	Other ID	Sample Type	Lab Sample Number	Sample Deviation	Test Name	Test Ref	Test Deviation
TP20-01	None Supplied	S	1661361	b	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	b
TP20-01	None Supplied	S	1661361	b	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	b
TP20-01	None Supplied	S	1661361	b	Phenols, speciated, in soil, by HPLC	L030-PL	b
TP20-01	None Supplied	S	1661361	b	Speciated EPA-16 PAHs in soil	L064-PL	b

Key: **a** - No sampling date **b** - Incorrect container
c - Holding time **d** - Headspace **e** - Temperature

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Analytical Report Number : 20-37829

Project / Site name:	Halton	**Samples received on:**	26/10/2020
Your job number:		**Samples instructed on/ Analysis started on:**	26/10/2020
Your order number:	795301-51908 PCT GENERAL	**Analysis completed by:**	02/11/2020
Report Issue Number:	1	**Report issued on:**	02/11/2020
Samples Analysed:	2 leachate samples - 14 soil samples		

Signed:

Joanna Wawrzeczko
Technical Reviewer (Reporting Team)
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils - 4 weeks from reporting
leachates - 2 weeks from reporting
waters - 2 weeks from reporting
asbestos - 6 months from reporting

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Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement.
Application of uncertainty of measurement would provide a range within which the true result lies.
An estimate of measurement uncertainty can be provided on request.

UKAS TESTING 4041

Analytical Environmental Science

Analytical Report Number: 20-37829
Project / Site name: Halton

Your Order No: 795301-51908 PCT GENERAL

Lab Sample Number				1663870	1663871
Sample Reference				TP20-05	TP20-08
Sample Number				None Supplied	None Supplied
Depth (m)				1.80-1.80	0.60-0.60
Date Sampled				23/10/2020	23/10/2020
Time Taken				None Supplied	None Supplied
Analytical Parameter (Leachate Analysis)	**Units**	**Limit of detection**	**Accreditation Status**		
General Inorganics					
pH	pH Units	N/A	ISO 17025	7.8	8
Electrical Conductivity	µS/cm	10	ISO 17025	1100	110
Total Cyanide	mg/l	0.01	ISO 17025	< 0.010	< 0.010
Complex Cyanide	mg/l	0.01	ISO 17025	< 0.0100	< 0.0100
Free Cyanide	mg/l	0.01	ISO 17025	< 0.010	< 0.010
Thiocyanate as SCN	mg/l	0.2	NONE	< 0.2	< 0.2
Sulphate as SO4	mg/l	0.1	ISO 17025	677	11.1
Total Sulphur	mg/l	0.015	NONE	226	3.69
Sulphide	mg/l	0.005	NONE	< 0.005	< 0.005
Chloride	mg/l	4	NONE	< 4.0	6.8
Ammonium as NH4	mg/l	0.015	NONE	< 0.015	0.056
Dissolved Organic Carbon (DOC)	mg/l	0.1	NONE	2.27	3.84
Phenols by HPLC					
Catechol	mg/l	0.0005	NONE	< 0.0005	< 0.0005
Resorcinol	mg/l	0.0005	NONE	< 0.0005	< 0.0005
Ethylphenol & Dimethylphenol	mg/l	0.0005	NONE	< 0.0005	< 0.0005
Cresols	mg/l	0.0005	NONE	< 0.0005	< 0.0005
Naphthols	mg/l	0.0005	NONE	< 0.0005	< 0.0005
Isopropylphenol	mg/l	0.0005	NONE	< 0.0005	< 0.0005
Phenol	mg/l	0.0005	NONE	< 0.0005	< 0.0005
Trimethylphenol	mg/l	0.0005	NONE	< 0.0005	< 0.0005
Total Phenols					
Total Phenols (HPLC)	mg/l	0.0035	NONE	< 0.0035	< 0.0035
Speciated PAHs					
Naphthalene	mg/l	0.00001	ISO 17025	< 0.00001	< 0.00001
Acenaphthylene	mg/l	0.00001	ISO 17025	< 0.00001	< 0.00001
Acenaphthene	mg/l	0.00001	ISO 17025	< 0.00001	< 0.00001
Fluorene	mg/l	0.00001	ISO 17025	< 0.00001	< 0.00001
Phenanthrene	mg/l	0.00001	ISO 17025	< 0.00001	< 0.00001
Anthracene	mg/l	0.00001	ISO 17025	< 0.00001	< 0.00001
Fluoranthene	mg/l	0.00001	ISO 17025	< 0.00001	< 0.00001
Pyrene	mg/l	0.00001	ISO 17025	< 0.00001	< 0.00001
Benzo(a)anthracene	mg/l	0.00001	ISO 17025	< 0.00001	< 0.00001
Chrysene	mg/l	0.00001	ISO 17025	< 0.00001	< 0.00001
Benzo(b)fluoranthene	mg/l	0.00001	ISO 17025	< 0.00001	< 0.00001
Benzo(k)fluoranthene	mg/l	0.00001	ISO 17025	< 0.00001	< 0.00001
Benzo(a)pyrene	mg/l	0.00001	ISO 17025	< 0.00001	< 0.00001
Indeno(1,2,3-cd)pyrene	mg/l	0.00001	NONE	< 0.00001	< 0.00001
Dibenz(a,h)anthracene	mg/l	0.00001	NONE	< 0.00001	< 0.00001
Benzo(ghi)perylene	mg/l	0.00001	NONE	< 0.00001	< 0.00001
Total PAH					
Total EPA-16 PAHs	mg/l	0.0002	NONE	< 0.0002	< 0.0002

UKAS TESTING 4041

Environmental Science

Analytical Report Number: 20-37829
Project / Site name: Halton

Your Order No: 795301-51908 PCT GENERAL

Lab Sample Number				1663870	1663871
Sample Reference				TP20-05	TP20-08
Sample Number				None Supplied	None Supplied
Depth (m)				1.80-1.80	0.60-0.60
Date Sampled				23/10/2020	23/10/2020
Time Taken				None Supplied	None Supplied
Analytical Parameter (Leachate Analysis)	**Units**	**Limit of detection**	**Accreditation Status**		
Heavy Metals / Metalloids					
Arsenic (dissolved)	mg/l	0.001	ISO 17025	< 0.001	0.007
Cadmium (dissolved)	mg/l	0.0001	ISO 17025	< 0.0001	< 0.0001
Chromium (dissolved)	mg/l	0.0004	ISO 17025	< 0.0004	0.0033
Copper (dissolved)	mg/l	0.0003	ISO 17025	0.0086	0.0049
Iron (dissolved)	mg/l	0.004	ISO 17025	0.048	1.9
Lead (dissolved)	mg/l	0.001	ISO 17025	0.002	0.005
Mercury (dissolved)	mg/l	0.0005	ISO 17025	< 0.0005	< 0.0005
Nickel (dissolved)	mg/l	0.0003	ISO 17025	0.0019	0.0045
Selenium (dissolved)	mg/l	0.004	ISO 17025	< 0.004	< 0.004
Zinc (dissolved)	mg/l	0.0004	ISO 17025	0.0058	0.0092
Monoaromatics & Oxygenates					
Benzene	mg/l	0.001	ISO 17025	< 0.001	< 0.001
Toluene	mg/l	0.001	ISO 17025	< 0.001	< 0.001
Ethylbenzene	mg/l	0.001	ISO 17025	< 0.001	< 0.001
p & m-xylene	mg/l	0.001	ISO 17025	< 0.001	< 0.001
o-xylene	mg/l	0.001	ISO 17025	< 0.001	< 0.001
MTBE (Methyl Tertiary Butyl Ether)	mg/l	0.01	NONE	< 0.010	< 0.010
Petroleum Hydrocarbons					
TPH1 (C10 - C40)	µg/l	10	NONE	< 10	< 10
TPH1 (C10 - C40)	mg/l	0.01	NONE	< 0.01	< 0.01

U/S = Unsuitable Sample   I/S = Insufficient Sample

Analytical Report Number: 20-37829
Project / Site name: Halton
Your Order No: 795301-51908 PCT GENERAL

Lab Sample Number				1663856	1663857	1663858	1663859
Sample Reference				TP20-05	TP20-05	TP20-05	TP20-06
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.10-0.10	0.70-0.70	1.80-1.80	0.10-0.10
Date Sampled				23/10/2020	23/10/2020	23/10/2020	23/10/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**				
Stone Content	%	0.1	NONE	-	< 0.1	< 0.1	-
Moisture Content	%	N/A	NONE	-	12	10	-
Total mass of sample received	kg	0.001	NONE	-	1.5	0.3	-

Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	-	-	Not-detected

General Inorganics

pH - Automated	pH Units	N/A	MCERTS	-	7.6	7	-
Total Cyanide	mg/kg	1	MCERTS	-	< 1	< 1	-
Complex Cyanide	mg/kg	1	MCERTS	-	< 1	< 1	-
Free Cyanide	mg/kg	1	MCERTS	-	< 1	< 1	-
Thiocyanate as SCN	mg/kg	5	NONE	-	< 5.0	< 5.0	-
Water Soluble Sulphate as SO4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	-	170	6800	-
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	-	0.086	3.4	-
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	-	86.4	3380	-
Water Soluble Chloride (2:1)	mg/kg	1	MCERTS	-	8.4	28	-
Elemental Sulphur	mg/kg	5	MCERTS	-	< 5.0	28	-
Ammonium - Exchangeable as NH4	mg/kg	0.5	MCERTS	-	< 0.5	< 0.5	-
Organic Matter	%	0.1	MCERTS	-	-	1.2	-
Loss on Ignition @ 450oC	%	0.2	MCERTS	-	3.7	3.7	-

Phenols by HPLC

Catechol	mg/kg	0.1	ISO 17025	-	< 0.10	< 0.10	-
Resorcinol	mg/kg	0.1	ISO 17025	-	< 0.10	< 0.10	-
Cresols (o-, m-, p-)	mg/kg	0.3	ISO 17025	-	< 0.30	< 0.30	-
Total Naphthols (sum of 1- and 2- Naphthol)	mg/kg	0.2	ISO 17025	-	< 0.20	< 0.20	-
2-Isopropylphenol	mg/kg	0.1	ISO 17025	-	< 0.10	< 0.10	-
Phenol	mg/kg	0.1	ISO 17025	-	< 0.10	< 0.10	-
Trimethylphenol (2,3,5-)	mg/kg	0.1	ISO 17025	-	< 0.10	< 0.10	-
Total Xylenols and Ethylphenols	mg/kg	0.3	ISO 17025	-	< 0.30	< 0.30	-

Total Phenols

Total Phenols (HPLC)	mg/kg	1.3	ISO 17025	-	< 1.3	< 1.3	-

Speciated PAHs

Naphthalene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	-
Acenaphthylene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	-
Acenaphthene	mg/kg	0.05	MCERTS	-	< 0.05	1.6	-
Fluorene	mg/kg	0.05	MCERTS	-	< 0.05	1.2	-
Phenanthrene	mg/kg	0.05	MCERTS	-	< 0.05	6.9	-
Anthracene	mg/kg	0.05	MCERTS	-	< 0.05	2.6	-
Fluoranthene	mg/kg	0.05	MCERTS	-	0.45	9.9	-
Pyrene	mg/kg	0.05	MCERTS	-	0.4	7.9	-
Benzo(a)anthracene	mg/kg	0.05	MCERTS	-	< 0.05	4.5	-
Chrysene	mg/kg	0.05	MCERTS	-	< 0.05	3.8	-
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	-	< 0.05	4	-
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	-	< 0.05	3.9	-
Benzo(a)pyrene	mg/kg	0.05	MCERTS	-	< 0.05	3.9	-
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	-	< 0.05	1.6	-
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	-	< 0.05	0.38	-
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	-	< 0.05	1.7	-

Analytical Report Number: 20-37829
Project / Site name: Halton
Your Order No: 795301-51908 PCT GENERAL

Lab Sample Number				1663856	1663857	1663858	1663859
Sample Reference				TP20-05	TP20-05	TP20-05	TP20-06
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.10-0.10	0.70-0.70	1.80-1.80	0.10-0.10
Date Sampled				23/10/2020	23/10/2020	23/10/2020	23/10/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**				
Total PAH							
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	-	0.85	53.7	-
Heavy Metals / Metalloids							
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	-	20	12	-
Boron (water soluble)	mg/kg	0.2	MCERTS	-	0.9	1.4	-
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	-	< 0.2	< 0.2	-
Chromium (hexavalent)	mg/kg	4	MCERTS	-	< 4.0	< 4.0	-
Chromium (III)	mg/kg	1	NONE	-	27	16	-
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	-	27	16	-
Copper (aqua regia extractable)	mg/kg	1	MCERTS	-	35	13	-
Lead (aqua regia extractable)	mg/kg	1	MCERTS	-	21	10	-
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	-	< 0.3	< 0.3	-
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	-	26	22	-
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	-	< 1.0	< 1.0	-
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	-	69	47	-
Monoaromatics & Oxygenates							
Benzene	mg/kg	0.001	MCERTS	-	< 0.001	< 0.001	-
Toluene	mg/kg	0.001	MCERTS	-	< 0.001	< 0.001	-
Ethylbenzene	mg/kg	0.001	MCERTS	-	< 0.001	< 0.001	-
p & m-xylene	mg/kg	0.001	MCERTS	-	< 0.001	< 0.001	-
o-xylene	mg/kg	0.001	MCERTS	-	< 0.001	< 0.001	-
MTBE (Methyl Tertiary Butyl Ether)	mg/kg	0.001	MCERTS	-	< 0.001	< 0.001	-
Petroleum Hydrocarbons							
TPH C10 - C40	mg/kg	10	MCERTS	-	< 10	150	-
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	-	-	-	-
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	-	-	-	-
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	-	-	-
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	-	-	-	-
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	-	-	-	-
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	-	-	-	-
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	-	-	-	-
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	-	-	-	-
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	-	-	-	-
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	-	-	-	-
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	-	-	-
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	-	-	-	-
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	-	-	-	-
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	-	-	-	-
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	-	-	-	-
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	-	-	-	-

U/S = Unsuitable Sample   I/S = Insufficient Sample

Analytical Report Number: 20-37829
Project / Site name: Halton
Your Order No: 795301-51908 PCT GENERAL

Lab Sample Number				1663860	1663861	1663862	1663863
Sample Reference				TP20-06	TP20-06	TP20-07	TP20-07
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				1.80-1.80	0.70-0.70	0.20-0.20	0.70-0.70
Date Sampled				23/10/2020	23/10/2020	23/10/2020	23/10/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**				
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	7.6	13	14	13
Total mass of sample received	kg	0.001	NONE	1.5	1.5	1.5	1.7

Asbestos in Soil	Type	N/A	ISO 17025	-	-	Not-detected	-

General Inorganics

pH - Automated	pH Units	N/A	MCERTS	7.6	8.1	-	7.8
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1	-	< 1
Complex Cyanide	mg/kg	1	MCERTS	< 1	< 1	-	< 1
Free Cyanide	mg/kg	1	MCERTS	< 1	< 1	-	< 1
Thiocyanate as SCN	mg/kg	5	NONE	< 5.0	< 5.0	-	< 5.0
Water Soluble Sulphate as SO4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	480	340	-	3200
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.24	0.17	-	1.6
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	240	173	-	1610
Water Soluble Chloride (2:1)	mg/kg	1	MCERTS	71	5.5	-	45
Elemental Sulphur	mg/kg	5	MCERTS	160	< 5.0	-	14
Ammonium - Exchangeable as NH4	mg/kg	0.5	MCERTS	5.2	5.6	-	< 0.5
Organic Matter	%	0.1	MCERTS	-	1.8	2	-
Loss on Ignition @ 450oC	%	0.2	MCERTS	4.5	3.5	-	2.6

Phenols by HPLC

Catechol	mg/kg	0.1	ISO 17025	< 0.10	< 0.10	-	< 0.10
Resorcinol	mg/kg	0.1	ISO 17025	< 0.10	< 0.10	-	< 0.10
Cresols (o-, m-, p-)	mg/kg	0.3	ISO 17025	< 0.30	< 0.30	-	< 0.30
Total Naphthols (sum of 1- and 2- Naphthol)	mg/kg	0.2	ISO 17025	< 0.20	< 0.20	-	< 0.20
2-Isopropylphenol	mg/kg	0.1	ISO 17025	< 0.10	< 0.10	-	< 0.10
Phenol	mg/kg	0.1	ISO 17025	< 0.10	< 0.10	-	< 0.10
Trimethylphenol (2,3,5-)	mg/kg	0.1	ISO 17025	< 0.10	< 0.10	-	< 0.10
Total Xylenols and Ethylphenols	mg/kg	0.3	ISO 17025	< 0.30	< 0.30	-	< 0.30

Total Phenols

Total Phenols (HPLC)	mg/kg	1.3	ISO 17025	< 1.3	< 1.3	-	< 1.3

Speciated PAHs

Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	1.5	< 0.05	-	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	6.7	< 0.05	-	< 0.05
Fluorene	mg/kg	0.05	MCERTS	6.2	< 0.05	-	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	42	< 0.05	-	< 0.05
Anthracene	mg/kg	0.05	MCERTS	16	< 0.05	-	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	77	< 0.05	-	0.4
Pyrene	mg/kg	0.05	MCERTS	64	< 0.05	-	0.41
Benzo(a)anthracene	mg/kg	0.05	MCERTS	45	< 0.05	-	< 0.05
Chrysene	mg/kg	0.05	MCERTS	35	< 0.05	-	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	45	< 0.05	-	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	26	< 0.05	-	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	47	< 0.05	-	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	17	< 0.05	-	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	5.6	< 0.05	-	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	18	< 0.05	-	< 0.05

Analytical Report Number: 20-37829
Project / Site name: Halton
Your Order No: 795301-51908 PCT GENERAL

Lab Sample Number				1663860	1663861	1663862	1663863
Sample Reference				TP20-06	TP20-06	TP20-07	TP20-07
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				1.80-1.80	0.70-0.70	0.20-0.20	0.70-0.70
Date Sampled				23/10/2020	23/10/2020	23/10/2020	23/10/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**				
Total PAH							
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	453	< 0.80	-	0.81
Heavy Metals / Metalloids							
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	9.6	13	-	14
Boron (water soluble)	mg/kg	0.2	MCERTS	0.8	0.8	-	0.8
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	0.5	< 0.2	-	< 0.2
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0	-	< 4.0
Chromium (III)	mg/kg	1	NONE	18	22	-	18
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	18	22	-	18
Copper (aqua regia extractable)	mg/kg	1	MCERTS	13	13	-	19
Lead (aqua regia extractable)	mg/kg	1	MCERTS	22	18	-	16
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	-	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	13	20	-	21
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	57	55	-	61
Monoaromatics & Oxygenates							
Benzene	mg/kg	0.001	MCERTS	< 0.001	< 0.001	-	< 0.001
Toluene	mg/kg	0.001	MCERTS	< 0.001	< 0.001	-	< 0.001
Ethylbenzene	mg/kg	0.001	MCERTS	< 0.001	< 0.001	-	< 0.001
p & m-xylene	mg/kg	0.001	MCERTS	< 0.001	< 0.001	-	< 0.001
o-xylene	mg/kg	0.001	MCERTS	< 0.001	< 0.001	-	< 0.001
MTBE (Methyl Tertiary Butyl Ether)	mg/kg	0.001	MCERTS	< 0.001	< 0.001	-	< 0.001
Petroleum Hydrocarbons							
TPH C10 - C40	mg/kg	10	MCERTS	1400	< 10	-	< 10
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001	-	-	-
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001	-	-	-
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	-	-	-
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	-	-	-
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	7.3	-	-	-
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	18	-	-	-
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	190	-	-	-
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	220	-	-	-
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001	-	-	-
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001	-	-	-
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	-	-	-
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	8.9	-	-	-
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	19	-	-	-
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	250	-	-	-
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	440	-	-	-
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	730	-	-	-

U/S = Unsuitable Sample   I/S = Insufficient Sample

Analytical Report Number: 20-37829
Project / Site name: Halton
Your Order No: 795301-51908 PCT GENERAL

Lab Sample Number				1663864	1663865	1663866	1663867
Sample Reference				TP20-07	TP20-08	TP20-08	TP20-08
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				2.00-2.00	0.10-0.10	0.60-0.60	1.00-1.00
Date Sampled				23/10/2020	23/10/2020	23/10/2020	23/10/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**				
Stone Content	%	0.1	NONE	< 0.1	-	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	7	-	11	14
Total mass of sample received	kg	0.001	NONE	1.7	-	1.5	1.7
Asbestos in Soil	Type	N/A	ISO 17025	-	Not-detected	-	-
General Inorganics							
pH - Automated	pH Units	N/A	MCERTS	8.4	-	8.8	8
Total Cyanide	mg/kg	1	MCERTS	< 1	-	< 1	< 1
Complex Cyanide	mg/kg	1	MCERTS	< 1	-	< 1	< 1
Free Cyanide	mg/kg	1	MCERTS	< 1	-	< 1	< 1
Thiocyanate as SCN	mg/kg	5	NONE	< 5.0	-	< 5.0	< 5.0
Water Soluble Sulphate as SO4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	440	-	210	1500
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.22	-	0.1	0.74
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	221	-	105	741
Water Soluble Chloride (2:1)	mg/kg	1	MCERTS	14	-	68	340
Elemental Sulphur	mg/kg	5	MCERTS	7.9	-	5.5	560
Ammonium - Exchangeable as NH4	mg/kg	0.5	MCERTS	< 0.5	-	< 0.5	11
Organic Matter	%	0.1	MCERTS	-	-	0.4	-
Loss on Ignition @ 450oC	%	0.2	MCERTS	2.3	-	2.2	4.2
Phenols by HPLC							
Catechol	mg/kg	0.1	ISO 17025	< 0.10	-	< 0.10	< 0.10
Resorcinol	mg/kg	0.1	ISO 17025	< 0.10	-	< 0.10	< 0.10
Cresols (o-, m-, p-)	mg/kg	0.3	ISO 17025	< 0.30	-	< 0.30	< 0.30
Total Naphthols (sum of 1- and 2- Naphthol)	mg/kg	0.2	ISO 17025	< 0.20	-	< 0.20	< 0.20
2-Isopropylphenol	mg/kg	0.1	ISO 17025	< 0.10	-	< 0.10	< 0.10
Phenol	mg/kg	0.1	ISO 17025	< 0.10	-	< 0.10	< 0.10
Trimethylphenol (2,3,5-)	mg/kg	0.1	ISO 17025	< 0.10	-	< 0.10	< 0.10
Total Xylenols and Ethylphenols	mg/kg	0.3	ISO 17025	< 0.30	-	< 0.30	< 0.30
Total Phenols							
Total Phenols (HPLC)	mg/kg	1.3	ISO 17025	< 1.3	-	< 1.3	< 1.3
Speciated PAHs							
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	0.33	-	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	0.45	-	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	0.48	-	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	4.1	-	< 0.05	< 0.05
Anthracene	mg/kg	0.05	MCERTS	1.7	-	< 0.05	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	8.4	-	< 0.05	0.68
Pyrene	mg/kg	0.05	MCERTS	7.7	-	< 0.05	0.68
Benzo(a)anthracene	mg/kg	0.05	MCERTS	4.3	-	< 0.05	0.41
Chrysene	mg/kg	0.05	MCERTS	3.7	-	< 0.05	0.31
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	4.6	-	< 0.05	0.37
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	3.5	-	< 0.05	0.24
Benzo(a)pyrene	mg/kg	0.05	MCERTS	5.7	-	< 0.05	0.38
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	2.1	-	< 0.05	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	0.59	-	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	2.4	-	< 0.05	< 0.05

Analytical Report Number: 20-37829
Project / Site name: Halton
Your Order No: 795301-51908 PCT GENERAL

Lab Sample Number				1663864	1663865	1663866	1663867
Sample Reference				TP20-07	TP20-08	TP20-08	TP20-08
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				2.00-2.00	0.10-0.10	0.60-0.60	1.00-1.00
Date Sampled				23/10/2020	23/10/2020	23/10/2020	23/10/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**				
Total PAH							
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	50.1	-	< 0.80	3.07
Heavy Metals / Metalloids							
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	8.6	-	16	14
Boron (water soluble)	mg/kg	0.2	MCERTS	0.6	-	0.4	0.7
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	0.3	-	< 0.2	0.4
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	-	< 4.0	< 4.0
Chromium (III)	mg/kg	1	NONE	11	-	21	21
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	11	-	21	21
Copper (aqua regia extractable)	mg/kg	1	MCERTS	9.5	-	14	22
Lead (aqua regia extractable)	mg/kg	1	MCERTS	12	-	11	19
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	-	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	9.2	-	28	19
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	-	< 1.0	< 1.0
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	30	-	44	69
Monoaromatics & Oxygenates							
Benzene	mg/kg	0.001	MCERTS	< 0.001	-	< 0.001	< 0.001
Toluene	mg/kg	0.001	MCERTS	< 0.001	-	< 0.001	< 0.001
Ethylbenzene	mg/kg	0.001	MCERTS	< 0.001	-	< 0.001	< 0.001
p & m-xylene	mg/kg	0.001	MCERTS	< 0.001	-	< 0.001	< 0.001
o-xylene	mg/kg	0.001	MCERTS	< 0.001	-	< 0.001	< 0.001
MTBE (Methyl Tertiary Butyl Ether)	mg/kg	0.001	MCERTS	< 0.001	-	< 0.001	< 0.001
Petroleum Hydrocarbons							
TPH C10 - C40	mg/kg	10	MCERTS	660	-	< 10	< 10
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	-	-	-	-
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	-	-	-	-
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	-	-	-
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	-	-	-	-
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	-	-	-	-
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	-	-	-	-
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	-	-	-	-
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	-	-	-	-
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	-	-	-	-
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	-	-	-	-
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	-	-	-
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	-	-	-	-
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	-	-	-	-
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	-	-	-	-
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	-	-	-	-
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	-	-	-	-

U/S = Unsuitable Sample I/S = Insufficient Sample

Analytical Report Number: 20-37829
Project / Site name: Halton
Your Order No: 795301-51908 PCT GENERAL

Lab Sample Number				1663868	1663869
Sample Reference				Sample B	Sample C
Sample Number				None Supplied	None Supplied
Depth (m)				None Supplied	None Supplied
Date Sampled				23/10/2020	23/10/2020
Time Taken				None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**		
Stone Content	%	0.1	NONE	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	10	13
Total mass of sample received	kg	0.001	NONE	0.3	0.3

Asbestos in Soil	Type	N/A	ISO 17025	-	-

General Inorganics

pH - Automated	pH Units	N/A	MCERTS	7.4	7.5
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1
Complex Cyanide	mg/kg	1	MCERTS	< 1	< 1
Free Cyanide	mg/kg	1	MCERTS	< 1	< 1
Thiocyanate as SCN	mg/kg	5	NONE	< 5.0	< 5.0
Water Soluble Sulphate as SO4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	8300	2800
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	4.1	1.4
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	4130	1400
Water Soluble Chloride (2:1)	mg/kg	1	MCERTS	24	42
Elemental Sulphur	mg/kg	5	MCERTS	< 5.0	35
Ammonium - Exchangeable as NH4	mg/kg	0.5	MCERTS	< 0.5	< 0.5
Organic Matter	%	0.1	MCERTS	-	-
Loss on Ignition @ 450oC	%	0.2	MCERTS	3.4	3

Phenols by HPLC

Catechol	mg/kg	0.1	ISO 17025	< 0.10	< 0.10
Resorcinol	mg/kg	0.1	ISO 17025	< 0.10	< 0.10
Cresols (o-, m-, p-)	mg/kg	0.3	ISO 17025	< 0.30	< 0.30
Total Naphthols (sum of 1- and 2- Naphthol)	mg/kg	0.2	ISO 17025	< 0.20	< 0.20
2-Isopropylphenol	mg/kg	0.1	ISO 17025	< 0.10	< 0.10
Phenol	mg/kg	0.1	ISO 17025	< 0.10	< 0.10
Trimethylphenol (2,3,5-)	mg/kg	0.1	ISO 17025	< 0.10	< 0.10
Total Xylenols and Ethylphenols	mg/kg	0.3	ISO 17025	< 0.30	< 0.30

Total Phenols

Total Phenols (HPLC)	mg/kg	1.3	ISO 17025	< 1.3	< 1.3

Speciated PAHs

Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05	0.51
Pyrene	mg/kg	0.05	MCERTS	< 0.05	0.5
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05	0.35
Chrysene	mg/kg	0.05	MCERTS	< 0.05	0.34
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	0.29
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	0.23
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	0.4
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05

Analytical Report Number: 20-37829
Project / Site name: Halton
Your Order No: 795301-51908 PCT GENERAL

Lab Sample Number				1663868	1663869
Sample Reference				Sample B	Sample C
Sample Number				None Supplied	None Supplied
Depth (m)				None Supplied	None Supplied
Date Sampled				23/10/2020	23/10/2020
Time Taken				None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**		
Total PAH					
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	< 0.80	2.62

Heavy Metals / Metalloids

Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	12	13
Boron (water soluble)	mg/kg	0.2	MCERTS	0.8	0.9
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	1	0.3
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0
Chromium (III)	mg/kg	1	NONE	17	18
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	17	18
Copper (aqua regia extractable)	mg/kg	1	MCERTS	18	15
Lead (aqua regia extractable)	mg/kg	1	MCERTS	16	14
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	23	18
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	89	56

Monoaromatics & Oxygenates

Benzene	mg/kg	0.001	MCERTS	< 0.001	< 0.001
Toluene	mg/kg	0.001	MCERTS	< 0.001	< 0.001
Ethylbenzene	mg/kg	0.001	MCERTS	< 0.001	< 0.001
p & m-xylene	mg/kg	0.001	MCERTS	< 0.001	< 0.001
o-xylene	mg/kg	0.001	MCERTS	< 0.001	< 0.001
MTBE (Methyl Tertiary Butyl Ether)	mg/kg	0.001	MCERTS	< 0.001	< 0.001

Petroleum Hydrocarbons

TPH C10 - C40	mg/kg	10	MCERTS	< 10	< 10

TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	-	-
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	-	-
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	-
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	-	-
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	-	-
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	-	-
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	-	-
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	-	-

TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	-	-
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	-	-
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	-
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	-	-
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	-	-
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	-	-
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	-	-
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	-	-

U/S = Unsuitable Sample   I/S = Insufficient Sample

Analytical Report Number : 20-37829
Project / Site name: Halton

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
1663857	TP20-05	None Supplied	0.70-0.70	Brown clay and loam with gravel and vegetation.
1663858	TP20-05	None Supplied	1.80-1.80	Brown clay and loam with gravel and chalk.
1663860	TP20-06	None Supplied	1.80-1.80	Brown clay and loam with gravel.
1663861	TP20-06	None Supplied	0.70-0.70	Brown clay and loam with gravel and vegetation.
1663862	TP20-07	None Supplied	0.20-0.20	Brown clay and loam with gravel and vegetation.
1663863	TP20-07	None Supplied	0.70-0.70	Brown clay and loam with gravel and vegetation.
1663864	TP20-07	None Supplied	2.00-2.00	Brown clay and sand with gravel and vegetation.
1663866	TP20-08	None Supplied	0.60-0.60	Brown clay and sand with gravel.
1663867	TP20-08	None Supplied	1.00-1.00	Brown clay and sand with gravel and vegetation.
1663868	Sample B	None Supplied	None Supplied	Brown clay and loam with gravel and chalk.
1663869	Sample C	None Supplied	None Supplied	Brown clay and loam with gravel.

Analytical Report Number : 20-37829
Project / Site name: Halton

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In house method.	L038-PL	D	MCERTS
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
NRA Leachate Prep	10:1 extract with de-ionised water shaken for 24 hours then filtered.	In-house method based on National Rivers Authority	L020-PL	W	NONE
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Phenols, speciated, in soil, by HPLC	Determination of speciated phenols by HPLC.	In house method based on Blue Book Method.	L030-PL	W	ISO 17025
Boron, water soluble, in soil	Determination of water soluble boron in soil by hot water extract followed by ICP-OES.	In-house method based on Second Site Properties version 3	L038-PL	D	MCERTS
Complex Cyanide in soil	Determination of complex cyanide by calculation.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Chloride in leachate	Determination of chloride in leachate by titration against silver nitrate.	In house based on MEWAM Method ISBN 0117516260.	L024-PL	W	NONE
Chloride, water soluble, in soil	Determination of Chloride colorimetrically by discrete analyser.	In house method.	L082-PL	D	MCERTS
Hexavalent chromium in soil	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method	L080-PL	W	MCERTS
Electrical conductivity at 20oC of leachate	Determination of electrical conductivity in leachate by electrometric measurement.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L031-PL	W	ISO 17025
Elemental sulphur in soil	Determination of elemental sulphur in soil by extraction in acetonitrile followed by HPLC.	In-house method based on Secondsite Property Holdings Guidance for Assessing and Managing Potential	L021-PL	D	MCERTS
Free cyanide in leachate	Determination of free cyanide by distillation followed by colorimetry.	In-house method	L080-PL	W	ISO 17025
Free cyanide in soil	Determination of free cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Metals by ICP-OES in leachate	Determination of metals in leachate by acidification followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L039-PL	W	ISO 17025
Loss on ignition of soil @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace.	In house method.	L047-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically. (30 oC)	In house method.	L019-UK/PL	W	NONE

Analytical Report Number : 20-37829
Project / Site name: Halton

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Organic matter (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	In house method.	L009-PL	D	MCERTS
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In house method.	L099-PL	D	MCERTS
pH at 20oC in leachate	Determination of pH in leachate by electrometric measurement.	In house method.	L005-PL	W	ISO 17025
Thiocyanate in soil	Determination of thiocyanate in soil by extraction in water followed by acidification followed by addition of ferric nitrate followed by discrete analyser (spectrophotometer).	In-house method	L082-PL	D	NONE
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
TPH1 (Leachates)	Determination of dichloromethane extractable hydrocarbons in leachate by GC-MS.	In-house method	L070-PL	W	NONE
Total cyanide in leachate	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	ISO 17025
Total cyanide in soil	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Dissolved Organic Carbon in leachate	Determination of dissolved organic carbon in leachate by the measurement on a non-dispersive infrared analyser of carbon dioxide released by acidification.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L023-PL	W	NONE
Exchangeable Ammonium as NH4 in soil	Determination of Ammonium/Ammonia/ Ammoniacal Nitrogen by the colorimetric salicylate/nitroprusside method, 10:1 water extraction.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L082-PL	W	MCERTS
Complex cyanide in leachate	Determination of complex cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L040-PL	W	ISO 17025
Thiocyanate in leachate	Determination of thiocyanate in water by discreet analyser (colorimetry).	In house method based on SMWW 4500-CN-M.	L082-PL	W	NONE
Sulphide in leachate	Determination of sulphide in leachate by ion selective electrode.	In-house method	L010-PL	W	NONE
Phenols, speciated, in leachate, by HPLC	Determination of speciated phenols by HPLC.	In house method based on Blue Book Method.	L030-PL	W	NONE
Speciated EPA-16 PAHs in leachate	Determination of PAH compounds in leachate by extraction in dichloromethane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L102B-PL	W	ISO 17025
BTEX and MTBE in leachates (Monoaromatics)	Determination of BTEX and MTBE in leachates by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	NONE

Analytical Report Number : 20-37829
Project / Site name: Halton

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Total Sulphur in leachates	Determination of total sulphur in leachates by acidification followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L039-PL	W	NONE
Cr (III) in soil	In-house method by calculation from total Cr and Cr VI.	In-house method by calculation	L080-PL	W	NONE
TPHCWG (Soil)	Determination of hexane extractable hydrocarbons in soil by GC-MS/GC-FID.	In-house method with silica gel split/clean up.	L088/76-PL	W	MCERTS
TPH Banding in Soil by FID	Determination of hexane extractable hydrocarbons in soil by GC-FID.	In-house method, TPH with carbon banding and silica gel split/cleanup.	L076-PL	W	MCERTS
BTEX in leachates	Determination of BTEX in leachates by headspace GC-MS.	In-house method based on USEPA8260	L017-PL	W	ISO 17025
Ammonium as NH4 in leachate	Determination of ammonium in leachate by addition of buffer solution followed by ion selective electrode.	In-house method	L035-PL	W	NONE
Sulphate in leachates	Determination of sulphate in leachate by acidification followed by ICP-OES.	In-house method based on MEWAM 1986 Methods for the Determination of Metals in Soil""	L039-PL	W	ISO 17025
BTEX and MTBE in soil (Monoaromatics)	Determination of BTEX in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS
Sulphate, water soluble, in soil	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In house method.	L038-PL	D	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

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Analytical Report Number : 20-37848

Project / Site name:	Halton	**Samples received on:**	23/10/2020
Your job number:		**Samples instructed on/ Analysis started on:**	23/10/2020
Your order number:	795301-52908 PCT GENERAL	**Analysis completed by:**	30/10/2020
Report Issue Number:	1	**Report issued on:**	30/10/2020
Samples Analysed:	2 soil samples		

Signed: Karolina Marek

Karolina Marek
PL Head of Reporting Team
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils - 4 weeks from reporting
leachates - 2 weeks from reporting
waters - 2 weeks from reporting
asbestos - 6 months from reporting

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Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement.
Application of uncertainty of measurement would provide a range within which the true result lies.
An estimate of measurement uncertainty can be provided on request.

Analytical Report Number: 20-37848
Project / Site name: Halton
Your Order No: 795301-52908 PCT GENERAL

Lab Sample Number				1663957	1663958
Sample Reference				TP20-02	TP20-04
Sample Number				None Supplied	None Supplied
Depth (m)				2.00-2.00	1.80-1.80
Date Sampled				22/10/2020	22/10/2020
Time Taken				None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**		
Stone Content	%	0.1	NONE	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	14	14
Total mass of sample received	kg	0.001	NONE	1.5	1.5
General Inorganics					
pH - Automated	pH Units	N/A	MCERTS	8.4	8.5
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1
Complex Cyanide	mg/kg	1	MCERTS	< 1	< 1
Free Cyanide	mg/kg	1	MCERTS	< 1	< 1
Thiocyanate as SCN	mg/kg	5	NONE	< 5.0	< 5.0
Water Soluble Sulphate as SO4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	530	750
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.26	0.38
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	263	375
Water Soluble Chloride (2:1)	mg/kg	1	MCERTS	39	18
Elemental Sulphur	mg/kg	5	MCERTS	< 5.0	< 5.0
Ammonium - Exchangeable as NH4	mg/kg	0.5	MCERTS	< 0.5	< 0.5
Loss on Ignition @ 450oC	%	0.2	MCERTS	2.4	2.4
Phenols by HPLC					
Catechol	mg/kg	0.1	ISO 17025	< 0.10	< 0.10
Resorcinol	mg/kg	0.1	ISO 17025	< 0.10	< 0.10
Cresols (o-, m-, p-)	mg/kg	0.3	ISO 17025	< 0.30	< 0.30
Total Naphthols (sum of 1- and 2- Naphthol)	mg/kg	0.2	ISO 17025	< 0.20	< 0.20
2-Isopropylphenol	mg/kg	0.1	ISO 17025	< 0.10	< 0.10
Phenol	mg/kg	0.1	ISO 17025	< 0.10	< 0.10
Trimethylphenol (2,3,5-)	mg/kg	0.1	ISO 17025	< 0.10	< 0.10
Total Xylenols and Ethylphenols	mg/kg	0.3	ISO 17025	< 0.30	< 0.30
Total Phenols					
Total Phenols (HPLC)	mg/kg	1.3	ISO 17025	< 1.3	< 1.3
Speciated PAHs					
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05	0.43
Pyrene	mg/kg	0.05	MCERTS	< 0.05	0.41
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Chrysene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Total PAH					
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	< 0.80	0.84

Analytical Report Number: 20-37848
Project / Site name: Halton
Your Order No: 795301-52908 PCT GENERAL

Lab Sample Number				1663957	1663958
Sample Reference				TP20-02	TP20-04
Sample Number				None Supplied	None Supplied
Depth (m)				2.00-2.00	1.80-1.80
Date Sampled				22/10/2020	22/10/2020
Time Taken				None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**		
Heavy Metals / Metalloids					
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	16	15
Boron (water soluble)	mg/kg	0.2	MCERTS	1.3	1
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0
Chromium (III)	mg/kg	1	NONE	26	22
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	26	22
Copper (aqua regia extractable)	mg/kg	1	MCERTS	29	15
Lead (aqua regia extractable)	mg/kg	1	MCERTS	23	15
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	31	25
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	65	50
Monoaromatics & Oxygenates					
Benzene	mg/kg	0.001	MCERTS	< 0.001	< 0.001
Toluene	mg/kg	0.001	MCERTS	< 0.001	< 0.001
Ethylbenzene	mg/kg	0.001	MCERTS	< 0.001	< 0.001
p & m-xylene	mg/kg	0.001	MCERTS	< 0.001	< 0.001
o-xylene	mg/kg	0.001	MCERTS	< 0.001	< 0.001
MTBE (Methyl Tertiary Butyl Ether)	mg/kg	0.001	MCERTS	< 0.001	< 0.001
Petroleum Hydrocarbons					
TPH C10 - C40	mg/kg	10	MCERTS	< 10	< 10

U/S = Unsuitable Sample   I/S = Insufficient Sample

Analytical Report Number : 20-37848
Project / Site name: Halton

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation.
The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
1663957	TP20-02	None Supplied	2.00-2.00	Brown loam and clay with gravel.
1663958	TP20-04	None Supplied	1.80-1.80	Brown loam and clay with gravel.

Analytical Report Number : 20-37848
Project / Site name: Halton

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In house method.	L038-PL	D	MCERTS
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Phenols, speciated, in soil, by HPLC	Determination of speciated phenols by HPLC.	In house method based on Blue Book Method.	L030-PL	W	ISO 17025
Boron, water soluble, in soil	Determination of water soluble boron in soil by hot water extract followed by ICP-OES.	In-house method based on Second Site Properties version 3	L038-PL	D	MCERTS
Complex Cyanide in soil	Determination of complex cyanide by calculation.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Chloride, water soluble, in soil	Determination of Chloride colorimetrically by discrete analyser.	In house method.	L082-PL	D	MCERTS
Hexavalent chromium in soil	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method	L080-PL	W	MCERTS
Elemental sulphur in soil	Determination of elemental sulphur in soil by extraction in acetonitrile followed by HPLC.	In-house method based on Secondsite Property Holdings Guidance for Assessing and Managing Potential	L021-PL	D	MCERTS
Free cyanide in soil	Determination of free cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Loss on ignition of soil @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace.	In house method.	L047-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically. (30 oC)	In house method.	L019-UK/PL	W	NONE
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In house method.	L099-PL	D	MCERTS
Thiocyanate in soil	Determination of thiocyanate in soil by extraction in water followed by acidification followed by addition of ferric nitrate followed by discrete analyser (spectrophotometer).	In-house method	L082-PL	D	NONE
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Total cyanide in soil	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Exchangeable Ammonium as NH4 in soil	Determination of Ammonium/Ammonia/ Ammoniacal Nitrogen by the colorimetric salicylate/nitroprusside method, 10:1 water extraction.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L082-PL	W	MCERTS

Analytical Report Number : 20-37848
Project / Site name: Halton

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Cr (III) in soil	In-house method by calculation from total Cr and Cr VI.	In-house method by calculation	L080-PL	W	NONE
TPH Banding in Soil by FID	Determination of hexane extractable hydrocarbons in soil by GC-FID.	In-house method, TPH with carbon banding and silica gel split/cleanup.	L076-PL	W	MCERTS
BTEX and MTBE in soil (Monoaromatics)	Determination of BTEX in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS
Sulphate, water soluble, in soil	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In house method.	L038-PL	D	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

Appendix 3: Noise impact assessment

Noise Impact Assessment

Document no: B2500014/N/1 | A
Revision no: 1

National Gas Transmission Permit EPR/UP3333LL

Hatton Gas Compressor Station Upgrade
25 April 2023

Noise Impact Assessment

Client name:	National Gas Transmission Permit EPR/UP3333LL		
Project name:	Hatton Gas Compressor Station Upgrade		
Document no:	B2500014/N/1 | A	**Project no:**	B2600014
Revision no:	1	**Project manager:**	Carl Hughes
Date:	25 April 2023	**Prepared by:**	Humphrey Roberts-Powell
Doc status:	Draft for client review	**File name:**	Hatton Gas Compressor Station Noise Impact Assessment.docx

Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
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Appendices

1. Introduction

1.1 Background

National Gas Transmission PLC (National Gas Transmission) is responsible for the safe and efficient delivery of natural gas from the coastal reception terminals to the point of use. It operates twenty-four compressor stations as part of the National Transmission System (NTS). This is a network of high pressure, buried pipelines over 7,600 kilometres in length that enables natural gas from terminals and entry points to be transported to customers (which include the gas Distribution Network Operators) across the country. Within this system, compressor stations are used to compress the gas being transported to maintain flow and safe system operating pressures.

Hatton Compressor Station (hereafter referred to as ‘the station’) is in the east of the UK and has a pivotal role in the operation of the NTS. With nine connecting pipelines, Hatton is used across a wide range of scenarios. The station is used to facilitate gas flows from terminals to the north, to support the operation of storage sites in the North West, to provide demand support in the south east and to support the interconnector flows between the UK and continental Europe at Bacton.

The station is a regulated installation which currently operates under conditions set out in Environmental Permit EPR/UP3333LL under the Environmental Permitting (England & Wales) Regulations 2016 (as amended).

The operation of gas fired compressor units results in the emission of air pollutants, such as oxides of nitrogen and carbon monoxide. National Gas Transmission is obliged under law to control and manage the release of these air pollutants, via operation under an EPR permit, which in the case of Hatton implements emission limits set for large combustion plant in the Industrial Emissions Directive.

In response to these obligations, and following a detailed analysis of all options available at Hatton compressor station and interacting stations, Ofgem has approved the need for a single new, low emission gas turbine (jet engine) driven natural gas compressor unit at the station to replace two older legacy compressor units at the site.

This noise assessment, which supports the application to vary the existing Environmental Permit, considers the operation of the new compressor and related infrastructure.

The noise output from the site depends on the national gas supply and demand patterns, at any given time. The site typically has lower utilisation during the summer months, with maximum noise output occurring on the coldest days of the year. Based on historical patterns of site usage and national gas demand, it is expected that there would be no compressor operation (and therefore negligible noise output) for the majority of the year. At this site, and comparable compressor stations around the network, compressor operations may occur for approximately 1%-30% of a typical year, although this is inherently variable as legal gas transmission obligations must be met, these often being influenced by external factors such as weather and geopolitical events.

Periods of highest noise output would generally be expected to occur when residents are least likely to be sleeping with open windows. During the summer, when people are more likely to sleep with open windows, the operation of the compressors is much less frequent.

Hatton gas compressor station has operated for over 30 years, during which time there has been no complaint of noise relating to gas compression activity. The proposed new gas compressor would not change the type of activity undertaken at the site, and is not expected to change the character of the noise, or the patterns of national gas demand that dictate when gas compression is required.

This report sets out this noise assessment; it defines a study area, identifies assessment locations, determines baseline sound levels, details the noise modelling techniques used to predict noise emissions from the new equipment, and assesses the significance of the noise levels at the assessment locations. The report follows the advice and structure set out in the Environment Agency’s online guidance on noise and vibration management for environmental permits[1]. A summary of relevant environmental noise terminology is provided in Appendix A.

1.2 Planning background

A noise assessment report was submitted to East Lindsey District Council (ELDC) in June 2021 in support of the planning application for the new compressor unit, ancillary buildings and equipment (Application ref: S/079/01298/21). Planning consent was granted in September 2021 subject to the following noise conditions:

12. No part of the development shall be brought into use until a noise management plan has been submitted to and approved in writing by the Local Planning Authority. The site shall be used only in accordance with the approved noise management plan. The management plan shall include but not be limited to, measures to control noise from activities and operations at the site (including the operation of any equipment, plant, building services, noise from vehicles and deliveries), noise complaint procedures, emergencies and exceptional events.

13. The acoustic screen to the Lube Oil Cooler as shown on drawing no. 415013-00011-EN-DAL-00013 Rev. 1 received by the Local Planning Authority on 11th June 2021 shall be erected prior to the compressor hereby permitted being operational.

14. At any residential dwelling where tonality is present, the rating level of noise emitted from the site shall not exceed 46dB LAr,1 hour between 07:00 and 23:00; and 46dB LAr,15 minutes at any other time, other than during emergencies and exceptional events defined in the agreed noise management plan. At any residential dwelling where tonality is not present the rating level of noise emitted from the site shall not exceed 40dB LAr,1 hour between 07:00 and 23:00; and 40dB LAr, 15 minutes any other time. The rating level of noise shall be determined according to BS4142:2014+A1:2019 and/or its subsequent amendments.

15. The rating level of noise emitted from the site outside of operation of the gas compressor units shall not exceed 40dB LAr,1 hour between 07:00 and 23:00; and 40dB LAr,15 minutes at any other time, other than during emergencies and exceptional events defined in the agreed noise management plan. The rating level of noise shall be determined at any residential dwelling according to BS4142:2014+A1:2019 and/or its subsequent amendments.

[1] https://www.gov.uk/government/publications/noise-and-vibration-management-environmental-permits/noise-and-vibration-management-environmental-permits. Accessed 24th November 2022.

2. Assessment location

2.1 General

Hatton Compressor Station is located off the A158 at Hatton, Lincolnshire, and is shown on the site location plan on Figure 1 in Appendix B. The postcode for the site is LN8 5QE.

The area around the site is rural and the surrounding land use is predominantly low-lying arable farming. The A158 passes to the south and west of the site, approximately [redacted] away at its closest point. Minor local roads are immediately to the west and to the north of the site.

2.2 Closest Noise Sensitive Receptors

The closest existing residential properties to Hatton Compressor site are as follows:

- The village of Hatton which is approximately [redacted] to the north east. The closest properties in the village to Hatton Compressor Station are Strawberry Cottage and Meadow Farm;
- A cluster of houses including Thorney Lodge and The Forge at the crossroads of the A158 and Buttergate Hill road, near Cross Roads Farm, approximately [redacted] to the west;
- Walkers Farm, which is approximately [redacted] to the south east; and
- A cluster of houses including Budec and Welgrove House, approximately [redacted] to the south.

The adopted representative assessment locations are as follows; the 'AL' nomenclature is used in this report to provide consistency with historic environmental assessments that have been undertaken at the site. Their location is shown on Figure 1 in Appendix B.

- AL1 - Thorney Lodge
- AL2 - Meadow Farm / Strawberry Cottage
- AL3 – Walkers Farm
- AL4 - Welgrove House / Budec

2.3 Complaint History

The known complaints received by National Gas Transmission regarding noise from the Hatton Compressor Station are as follows:

- Historic complaints regarding construction noise associated with earlier phases of site development;
- A complaint in 2015 regarding buzzers on security fencing;
- A complaint in 2021 regarding the operation of temporary mobile plant brought to site to remove and recompress gas in certain pipework sections requiring maintenance; and
- A complaint in April 2023 relating to an emergency unit shutdown and vent which occurred during the night, in relation to the existing VSD unit D.

There is no known history of complaints in relation to the operation of the compressor units.

2.4 Existing site equipment

Hatton compressor station is currently equipped with three Rolls Royce RB211-24 gas turbine driven compressor units (Units A, B and C) and an additional 35 MW electrically powered Variable Speed Drive (VSD) unit (Unit D) that was commissioned in 2016. Unit D is the station lead unit, the other three units can be operated either individually or in parallel; only two machines of any type can be operated concurrently to provide compression duty.

Hatton Units A, B and C are all impacted by the Industrial Emissions Directive. Unit A is under Emergency Use Derogation (EUD), which limits running to 500 hours per year in perpetuity. Units B and C are operated under the Limited Life Derogation (LLD) which allows for a maximum of 17,500 hours operation per unit or until the 31st December 2023 (whichever comes first) after which the units must be taken out of operation.

Various other equipment is installed and operated at the site relating to the transportation of gas and providing ancillary support to the gas compressor units. This includes above ground gas pipework, valves, vent systems and gas separators (or ‘scrubbers’, to remove any trace dust or liquids present in the gas stream).

2.5 Future site equipment

The main design parameters relating to the installation of one new gas turbine driven compressor have been confirmed. This will be located within the existing land ownership boundary, with ancillary plant and infrastructure on land adjacent to the three gas compressors to the east and the Above Ground Installation (AGI) to the west. The new compressor unit necessitates an extension to the permitted installation boundary.

3. Equipment and meteorology

3.1 Meteorological measurement equipment

Meteorological conditions, including wind speed, wind direction and rainfall rate, were monitored during the survey using the Vaisala WXT536 weather station that is installed at the on-site measurement position shown on Figure 1 in Appendix B.

3.2 Noise measurement equipment

The equipment used to measure sound pressure levels complies with the requirements of Class 1 of British Standard EN 61672-1:2003: "Electroacoustics - Sound level meters - Part 1: Specifications". The measurement equipment was calibrated in the preceding two years by a competent calibration laboratory that can demonstrate that its measurements are traceable to national standards. The calibration certificates are presented in Appendix D. Precautions were taken to minimise the influence of wind by using outdoor windshields.

The following broadband statistical noise parameters were logged every 15 minutes during the survey: LAeq, LA10, LA90, LAF,Max. All measured data was processed and analysed using Microsoft Excel.

The following information is provided on the measurement sheets in Appendix C:

- description of measurement location;
- measurement conditions and height;
- British National Grid coordinates;
- measurement start and end dates / times;
- photographs of sound level meter in situ;
- subjective field notes made by engineer during equipment setup/retrieval;
- manufacturer, type, serial number, lab calibration date for sound level meter, preamplifier, microphone and calibrator;
- field calibration records, including offset and draft;
- time history of measured sound levels and weather data;
- histograms showing statistical distribution of rounded $l_{a90,15min}$ values during weekday and weekend day and night periods;
- graphs showing average values measured during each hour of the day/night;
- identification of the typical la90,15min value for each period and the reason for the selection; and
- identification of logarithmically averaged laeq,15min values for each period.

4. Methodologies

4.1 Noise survey methodology

4.1.1 Survey standards, approach and personnel

A baseline sound level survey was undertaken between 14th - 21st April 2021, in accordance with the requirements of:

- British Standard 4142:2014+A1:2019 “Methods for rating and assessing industrial and commercial sound”
- British Standard 7445-1: 2003 "Description and measurement of environmental noise – Part 1: Guide to quantities and procedures”.
- National Gas Transmission Specification for Environmental Noise Assessment for Compressor Projects T/SP/ENV/26, March 2013

During the survey period, the existing compressor units at the site operated for a cumulative total of 1.5 hours, and these measurements were excluded from the analysis. The personnel that installed and calibrated the equipment, and took site notes and photographs, were Mohammed Aloyared and Emma Tynan MIOA of Jacobs.

4.1.2 Measurement locations

Noise monitoring equipment was installed for one week at three locations considered to be acoustically representative of nearby sensitive receptors for the purpose of establishing the typical local background sound levels (L_{A90}) in the absence of noise generating activity on site. The measurement locations are shown on Figure 1 in Appendix B.

4.1.3 Consultation with Environment Agency

The Environment Agency was consulted prior to the commencement of the noise survey regarding the methodology for the survey. In their Report ID: UP3333LL/0388646, dated 17/03/2021 the following feedback was received “*The proposed methodology within the report is acceptable to the Environment Agency as it appears to be in line with the relevant standards and guidance.”.* Further advice was provided in relation to standard references and time periods.

4.2 Methodology for the derivation of typical background levels

The time histories in Appendix C present a summary of the typical measured daytime and night-time baseline sound levels during weekdays and weekends. The datasets have then been filtered to remove any contribution from:

- periods during operation of the existing compressor station;
- periods with wind speeds above 5m/s; and
- periods during and immediately after rainfall.

The statistical distribution of the this filtered dataset is presented on histograms in Appendix C. These distributions have been analysed to determine a representative background noise level. In all cases, the statistical mode has been selected to represent the typical background level for each period.

4.3 Noise propagation modelling methodology

Noise modelling software provides a way of constructing a three-dimensional computer model of terrain, ground characteristics and noise sources, which enables the prediction of noise at any point within the modelled area. To compute the environmental noise emission level from plant items and operations at the representative noise sensitive receptors, noise emission modelling has been undertaken using Cadna/A, a commercial noise prediction software package.

The software was configured to use the noise prediction method set out in ISO9613-2, which is suitable for the prediction of noise levels in the community from sources of known sound emission. The noise prediction method described ISO9613-2 is general, and is suitable for a wide range of engineering applications where the noise level outdoors is of interest. The noise source(s) may be moving or stationary and the method considers the following major mechanisms of noise attenuation:

- geometrical divergence (also known as distance loss or geometric damping);
- atmospheric absorption;
- ground effect;
- reflection from surfaces; and
- screening by obstacles.

The method predicts noise levels under meteorological conditions favourable to noise propagation from the sound source to the receiver, such as downwind propagation, or propagation under a moderate ground based temperature inversion as commonly occurs at night. Porous ground has been selected to represent the grassed landscaping at the site and farmland between the source and receptor locations.

The physical dimensions and heights of noise sources are taken from the relevant 3D CAD models of the installation. Other physical features outside the installation are based on the Ordnance Survey MasterMap® Topographic layer product, which provides detailed building outlines and areas of differing ground cover, surveyed to a high degree of accuracy. The noise model incorporates a Digital Terrain Model (DTM).

4.4 Assessment methodology

The data derived using the previously described methodologies has been used to undertake an assessment using the procedures set out BS4142:2014+A1:2019 with no deviations. During consideration of context, which is required by BS4142:2014+A1:2019, consideration has been paid to guidance published by the World Health Organization. This is described further in section 6.3.

5. Noise monitoring data and predictions

5.1 Summary of baseline sound level survey results

The measurement sheets in Appendix C provide further statistical analysis of the measured levels. In all cases, the modal $L_{A90,15min}$ value is considered representative of the typical background sound level; this is the value presented in Table 1 and used as the basis of the assessment.

Table 1 – Typical background sound levels (L_{A90})

Period	AL1 – Thorney Lodge	AL2 - Meadow Farm / Strawberry Cottage	AL4 - Welgrove House / Budec
Weekday day (0700-2300)	39 dB L_{A90}	30 dB L_{A90}	39 dB L_{A90}
Weekday night (2300-0700)	19 dB L_{A90}	20 dB L_{A90}	19 dB L_{A90}
Weekend day (0700-2300)	40 dB L_{A90}	30 dB L_{A90}	42 dB L_{A90}
Weekend night (2300-0700)	20 dB L_{A90}	21 dB L_{A90}	20 dB L_{A90}

Table 1 demonstrates that typical background sound levels during the night are fairly constant between locations, as well as between weeks and weekends. At all locations, typical background sound levels are between 19-21 dB L_{A90}, which is considered very low, even in the context of rural environments in the UK.

At locations AL1 and AL4, which are close to the A158, there is a large increase in background sound levels during the day to around 39-42 dB L_{A90}. At AL2, which is further from the A158, background sound levels increase to 30 dB L_{A90} during the day. In general, no significant variations in background noise level between the weekday and weekend periods were measured.

Table 2 presents the logarithmically averaged ambient sound levels (i.e. $L_{Aeq,T}$) for each period. In addition to the day and night periods, noise levels have been averaged over a ‘quiet night’ period between 2300 and 0500, as a strong influence of the ‘dawn chorus’ was observed on the hourly graphs (presented in Appendix C) between 0500 and 0700. As the dawn chorus is not a permanent feature of the ambient noise climate, the average over the full night between 2300 and 0700 is likely to be an overestimate of the typical night time ambient levels at other times of the year. The ‘quiet night’ average excludes this period, and is likely to represent quieter nights when the dawn chorus is not a feature of the noise climate.

Table 2 – Typical ambient sound levels (L_{Aeq})

Period	AL1 – Thorney Lodge	AL2 - Meadow Farm / Strawberry Cottage	AL4 - Welgrove House / Budec
Weekday day (0700-2300)	50 dB L_{Aeq}	43 dB L_{Aeq}	54 dB L_{Aeq}
Weekday night (2300-0700)	46 dB L_{Aeq}	41 dB L_{Aeq}	48 dB L_{Aeq}
Weekday quiet night (2300-0500)	41 dB L_{Aeq}	36 dB L_{Aeq}	44 dB L_{Aeq}
Weekend day (0700-2300)	51 dB L_{Aeq}	40 dB L_{Aeq}	54 dB L_{Aeq}
Weekend night (2300-0700)	47 dB L_{Aeq}	40 dB L_{Aeq}	48 dB L_{Aeq}
Weekend quiet night (2300-0500)	43 dB L_{Aeq}	34 dB L_{Aeq}	45 dB L_{Aeq}

At locations AL1 and AL4, which are close to the A158, the ambient sound levels are 23 – 25 dB higher than the background sound levels during the 'quiet night' periods. This large difference indicates a large variability in noise levels; this is typically observed in rural locations next to main roads, where the night time noise climate is a combination of high noise levels when vehicles pass by, interspersed with quiet moments when no vehicles are passing.

At AL2, the difference between ambient and background sound level is only 10 dB, due to its increased distance to the A158.

5.2 Influence of Covid-19 related restrictions on measured sound levels

The dominant local noise source for receptors surrounding the site is traffic on the A158. During the baseline survey period, Covid-19 related national restrictions were in place, which is likely to have resulted in reduced volumes of traffic on the A158 compared to the likely long-term situation. Therefore, the measured baseline levels are likely to be somewhat lower than might be expected in the long term.

No traffic data describing the traffic volumes during the survey are available, so it is not possible to quantify the degree to which the measured noise levels might be lower than the likely long-term noise levels.

5.3 Operational noise sources

The noise emission data for the proposed new gas turbine and noise enclosure has been provided by Siemens, who are supplying the SGT 750 gas turbine driven compressor unit for this project. The noise emission data on which the noise predictions are based are provided in Section 5.4.

Noise from pipework has been modelled using emission data sourced by Jacobs, from measurements of similar equipment at other facilities or from the manufacturers. The sources associated with operation of the existing VSD equipment are based on the results of far field measurements, and have been iteratively adjusted in the noise model to provide the closest agreement with the levels at receptors reported in the 2016 INVC report[2] (see Appendix E).

[2] Report 7938D: Hatton Compressor Station – Unit D Compressor Final Noise Assessment, Industrial Noise and Vibration Centre Limited, July 2016

It is assumed that all the equipment is running simultaneously in the noise models, in order to represent worst case operating conditions. A number of noise sources are not included in the noise models (for any of the scenarios described later in Section 5.5); these either operate infrequently, or are not considered to generate sufficient noise to warrant inclusion. These sources are:

- 'Straight through' valves, as with the valves open in normal operation there would be almost no additional turbulence in the gas flow to cause noise.
- The standby generator, as electrical power failure to the site is rare; periodic testing and maintenance to the standby generator will be undertaken during normal working hours.
- The vent stack, which is used to degas the compressor units if required for maintenance or extended periods of non-operation. Venting is a short process; while it can result in elevated noise levels, typically it only lasts for around 5 minutes with noise levels reducing rapidly over this period from the initial level. Venting involves releasing valuable gas into the atmosphere, and National Gas Transmission operational procedures avoid this whenever possible. Where it is necessary, all planned venting will occur during the core working day to minimise noise impacts. Unplanned venting only occurs as a key safety control and is very rare.

5.4 Sound power levels and data sources

Table 3 sets out the sound power levels used in the calculations of operational noise. Table 4 describes the source of the data and provides commentary on the potential uncertainty associated with each source level.

Table 3 – Sound power values used

Area of site	Noise Source	Unweighted Sound Power (L_W dB) / Octave band centre frequency (Hz)									Overall L_{WA} dB
		31.5	63	125	250	500	1k	2k	4k	8k	
Existing VSD	VSD Cab	99	86	76	69	63	60	59	59	61	70 / m^2
	VSD Surge Recycle Pipework	96	96	96	89	83	90	79	79	81	92 / m
New SGT 750	SGT 750 Stack outlet	125	112	100	94	94	85	75	87	95	95
	SGT 750 Air intake filterhouse	105	86	77	72	68	67	73	72	61	78
	SGT 750 GT Cab	99	95	85	77	74	81	77	57	54	84
	SGT 750 Enclosure ventilation outlet and inlet, GT enclosure ventilation	111	101	91	70	52	51	60	83	78	86
	SGT 750 Air intake opening	112	99	88	78	71	67	65	69	70	80
	Gas fuel unit	92	81	97	101	94	85	82	73	66	96
	Lube oil cooler	102	102	100	94	89	89	86	86	70	95
	AC LER	79	71	69	71	62	60	56	52	46	66
	11 kV Transformer	83	89	91	86	86	80	75	70	63	86
Various	Pipework (suction / discharge / AGI metering / pits)	73	73	80	81	73	70	67	60	41	83 / m

Table 4 – Data sources and estimation of uncertainty

Area of site	Noise Source	Data source	Uncertainty
Existing VSD	VSD Cab	The VSD sources have been iteratively adjusted in the noise model to provide the closest agreement with the levels at receptors reported in the 2016 INVC report.	Low. Levels are based on far field noise results from this particular unit in-situ.
	VSD Surge Recycle Pipework		
New SGT 750	SGT 750 Stack outlet	Provided by manufacturer	Low. The supplier (Siemens) has a verified track record of providing acoustic data that forms that basis of binding contractual guarantees. Siemens has a team of acoustic design engineers who verify data at similar installations.
	SGT 750 Air intake filterhouse	Provided by manufacturer	
	SGT 750 GT Cabin total	Provided by manufacturer	
	SGT 750 Enclosure ventilation outlet	Provided by manufacturer	

Area of site	Noise Source	Data source	Uncertainty
	SGT 750 Enclosure ventilation inlet	Provided by manufacturer	
	Gas fuel unit	Provided by manufacturer	
	Lube oil cooler	Provided by manufacturer	
	Seal air cooler	Provided by manufacturer	
	AC LER	Provided by manufacturer	
	11 kV Transformer	Calculated based on formulae in 'Handbook of Acoustics'[3] and 'Noise and Vibration Control'[4]	Low. Empirically derived, well established formulae derived from studies in the 1970s / 1980s.
Various	Pipework (suction / discharge / AGI / metering / pits)	Derived from various measurements near operational pipework during high gas flow conditions at this and other similar National Gas Transmission gas compressor sites.	Medium. Noise due to fluid flow in pipes is a complex field due to the various mechanisms involved. Data used in modelling has been empirically selected to best represent likely levels at full flow conditions (i.e. likely to be conservative), and includes an additional safety margin to account for uncertainty.

5.5 Operational scenarios

The following three scenarios have been considered in the operational noise assessment. These scenarios have been selected to best describe the impact from the currently proposed new equipment both on its own, and within the context of the existing equipment in the wider compressor station site.

- Existing. This represents the operation of the current lead unit – the electrically powered Variable Speed Drive (VSD) Unit D that was commissioned in 2016, together with the currently installed associated AGI (above ground installation) pipework. This scenario represents the noise levels currently experienced at noise sensitive receptors during high gas flow conditions.
- New. This represents the new equipment for which the permit variation is being sought, i.e. the Siemens, SGT 750 gas turbine driven compressor unit, associated equipment and pipework.
- Worst case (future). This represents a future scenario, with both the VSD Unit D and the SGT 750 operating at full load simultaneously, together with the AGI (above ground installation) pipework. This is a 'worst case' scenario. Whilst there could be occasions where very high gas flows require a maximum of two units to be run in parallel, there are no 'real world' gas demand conditions that would occur at the site that would require the use of both the existing VSD Unit D and proposed new SGT 750 unit at full load. This case therefore represents an abundance of caution on behalf of National Gas Transmission for assessment purposes only.

The existing and future noise modelling scenarios are based on operation of the existing VSD Unit D (on its own or with the SGT 750), rather than the existing RB211 Unit A, for the following reasons:

[3] Crocker, M. J. 1998. *Handbook of Acoustics*. Hoboken, New Jersey, USA: John Wiley and Sons.

[4] United States Department of Defense. 2003. Unified Facilities Criteria (UFC) *Noise And Vibration Control*, UFC 3-450-01.

- Operation of the RB211 units is the least preferred option, the VSD Unit D is used in preference whenever possible. Following commissioning of the proposed SGT 750 unit, the RB211 Unit A would only operate as a backup or in the case of a network gas supply emergency. In any event, the unit is under the Emergency Use Derogation (EUD), which limits its running to a maximum of 500 hours per year.
- Sound levels at receptors during operation of the VSD Unit D are higher than those during operation with the RB211 Unit A. The adoption of the VSD unit in the assessment therefore ensures a 'worst case' scenario when considering the total site noise impact assessment.

6. Noise impact assessment

6.1 Summary of operational noise calculation results

Table 5 presents a summary of the calculated $L_{Aeq,T}$ levels at the selected representative receptors for each of the scenarios described in Section 5.5. In the language of BS 4142:2014+A1:2019, the levels are equivalent to the specific sound level.

As stipulated in the standard, the specific sound levels are rounded to the nearest whole decibel (with 0.5 dB being rounded up).

Table 5 – Calculated operational noise levels

Receptor	Existing (Unit D)	New (Unit E)	Worst case (future) (Unit D & Unit E)
AL1 - Thorney Lodge	33 dB L_{Aeq}	37 dB L_{Aeq}	38 dB L_{Aeq}
AL2 - Meadow Farm / Strawberry Cottage	38 dB L_{Aeq}	31 dB L_{Aeq}	38 dB L_{Aeq}
AL3 – Walkers Farm	33 dB L_{Aeq}	36 dB L_{Aeq}	38 dB L_{Aeq}
AL4 - Welgrove House / Budec	34 dB L_{Aeq}	30 dB L_{Aeq}	35 dB L_{Aeq}

The results for AL1 and AL3 are identical, due to their similar distances away from the existing and proposed developments. The background noise level measured at AL1 has been selected to represent the noise environment at AL3 - this is a conservative approach, as AL3 is closer to the A158 and is likely to be associated with higher background noise levels. The assessment of noise at AL1 and AL3 has therefore been considered together in this report for brevity.

Figures 2-4 in Appendix B show the predicted noise contours for each operational scenario.

6.2 Initial estimate of the noise impact according to BS 4142:2014+A1:2019

BS 4142:2014+A1:2019 advises that the difference between the rating level and the background sound level at a receptor can be used to determine an initial estimate of the noise impact. The rating level used in the standard includes a correction (penalty) for any tonal, impulsive, intermittent or distinctive characteristics that the sound exhibits.

The compressor equipment comprises items of rotating machinery which are expected to exhibit some degree of tonality. Although it is difficult to accurately predict the degree with which tonality from the unit will be perceptible at nearby receptors, it is considered that there is potential for residual tonality to be readily perceptible, even with the mitigation measures described in Section 7. For this reason, the maximum acoustic character correction of +6 dB has been added to the specific sound level (L_{Aeq}) when calculating the rating level for the 'new' and 'future' scenarios.

A study into the noise impact of the current lead compressor unit at the site (Unit D) undertaken in 2016[5] (attached for ease of reference in Appendix E) included a fast fourier transform (FFT) frequency analysis of noise from Unit D recorded at the nearest residential receptors. This demonstrates that there is significant tonality associated with the operation of the existing Unit D. It is therefore appropriate to include the

[5] Report 7938D: Hatton Compressor Station – Unit D Compressor Final Noise Assessment, Industrial Noise and Vibration Centre Limited, July 2016

maximum acoustic character correction of +6 dB to the specific sound level (L_{Aeq}) when calculating the rating level.

A summary of the acoustic feature corrections during initial estimate of noise impact is provided in Table 6, together with commentary and justification for each type.

Table 6 - Acoustic feature corrections applied during initial estimate of noise impact

Type	Correction	Commentary / justification
Tonality correction	+6 dB	It is considered that there is the potential for tonality from the compressor to be readily perceivable outdoors at the receptor locations. Operation of existing compressor units is known to give rise to readily perceptible tonality.
Intermittency correction	0 dB	In the context of the day and night assessment periods, the compressor would operate steadily, and is not likely to be perceived as intermittent.
Distinctiveness correction	0 dB	This correction is only applicable where the specific sound features characteristics that are neither tonal nor impulsive, nor intermittent. Due to the tonality correction already applied, this penalty is not applicable.
Impulsiveness correction	0 dB	The mechanisms associated with the operation of the compressor are combustion, operation of rotating machinery, and gas flow in pipes. None of these mechanisms is known to give rise to impulsive noise events.
Acoustic feature correction overall	+6 dB	There is potential for the specific sound level to exhibit tonality, but is not likely to be distinctive, intermittent or impulsive at the receptor locations.

Table 7 and Table 8 present a comparison of the rating and background sound levels for the day and night periods respectively.

Table 7 - Initial estimate of the noise impact (day)

	AL1 – Thorney Lodge / AL3 Walkers Farm			AL2 - Meadow Farm / Strawberry Cottage			AL4 - Welgrove House / Budec		
Typical background sound level $L_{A90,T}$	39			30			39		
Scenario	Existing	New	Worst case	Existing	New	Worst case	Existing	New	Worst case
Calculated specific sound level, dB L_{Aeq}	33	37	38	38	31	38	34	30	35
Acoustic feature correction, dB	+6	+6	+6	+6	+6	+6	+6	+6	+6
Rating level, dB	39	43	44	44	37	44	40	36	41
Excess of rating over background sound level, dB	+0	+4	+5	+14	+7	+14	+1	-3	+2

Table 8 - Initial estimate of the noise impact (night)

	AL1 – Thorney Lodge / AL3 Walkers Farm			AL2 - Meadow Farm / Strawberry Cottage			AL4 - Welgrove House / Budec		
Typical background sound level $L_{A90,T}$	19			20			19		
Scenario	Existing	New	Worst case	Existing	New	Worst case	Existing	New	Worst case
Calculated specific sound level, dB L_{Aeq}	33	37	38	38	31	38	34	30	35
Acoustic feature correction, dB	+6	+6	+6	+6	+6	+6	+6	+6	+6
Rating level, dB	39	43	44	44	37	44	40	36	41
Excess of rating over background sound level, dB	+20	+24	+25	+24	+17	+24	+21	+17	+22

BS 4142:2014+A1:2019 states that "*A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context*".

Considered in isolation, the excess of rating over background sound level would indicate a significant adverse impact at all receptors during the night, and at AL2 during the day. This is true for both for the existing and proposed operating scenarios.

This being the initial estimate of the impact - BS 4142:2014+A1:2019 then requires that various relevant contextual factors need to be considered using professional judgement when determining the overall impact. These contextual factors are discussed below.

6.3 Contextual factors

6.3.1 Annual variability of site operations

A key contextual consideration is the annual variability of site operations. The noise output from the site depends on the national gas supply and demand patterns, at any given time. The site typically has lower utilisation during the summer months, with maximum noise output occurring on the coldest days of the year. Based on historical patterns of site usage and national gas demand, it is expected that there would be no compressor operation (and therefore negligible noise output) for the majority of the year. At this site, and comparable compressor stations around the network, compressor operations may occur for approximately 1%-30% of a typical year, although actual running is variable year on year at all stations.

Periods of highest noise output would generally be expected to occur when residents are least likely to be sleeping with open windows. During the summer, when people are more likely to sleep with open windows, the operation of the compressors would be much less frequent.

The sound power levels upon which the calculations are based relate to a full load operating condition, as this is referred to in performance specifications, and is adopted when manufacturers undertake acoustic testing. In practice, of the small proportion of the year during which the equipment would be operated at any load, operations at higher load conditions would be even less frequent. This further reduces the likelihood of adverse noise impacts.

6.3.2 Historic context and complaint history

Hatton gas compressor station has operated for over 30 years, during which time there has been no complaint of noise relating to gas compression activity. The proposed new gas compressor would not change the type of activity undertaken at the site, and is not expected to change the character of the noise, or the patterns of national gas demand that dictate when gas compression is required. Although the absence of complaint does not in itself prove an absence of impact, there has been open dialogue with the local community/authorities, and it is considered likely that if local noise related issues had occurred they would have been communicated to either National Gas Transmission, the Environment Agency, or ELDC.

National Gas Transmission has operated gas compressor stations for decades at various rural sites around the UK, where the background noise profile is comparable to that at Hatton, and where noise levels associated with gas compressor operations are similar to the levels considered in this assessment. The very small number of historic complaints related to noise from gas compressor operations across the UK provides an indication that the noise level, character and operating pattern of gas compressors is unlikely to cause an adverse noise impact.

6.3.3 Absolute noise levels

In relation to contextual factors, BS 4142:2014+A1:2019 states the following:

"Where the initial estimate of the impact needs to be modified due to the context, take all pertinent factors into consideration, including the following.

For a given difference between the rating level and the background sound level, the magnitude of the overall impact might be greater for an acoustic environment where the residual sound level is high than for an acoustic environment where the residual sound level is low. Where background sound levels and rating levels are low, absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night."

It is therefore appropriate to consider potential impacts with reference to the relevant absolute levels. The most relevant guidance in relation to absolute levels are considered to be that published by the World Health Organization (WHO). The 2018 Environmental Noise Guidelines for the European Region do not consider industrial noise and are therefore not relevant to this assessment.

The threshold levels in the 1999 Guidelines for Community Noise are considered relevant. Although these guidelines are primarily derived from research into transportation noise effects, and therefore may not relate to the impact from industrial noise in isolation, they are considered to provide a useful indication of likely health effects for mixed traffic and industrial noise.

6.3.3.1 Consideration of outdoor annoyance during the day

The 1999 WHO Guidelines for Community Noise state that, to protect the majority of people from being seriously annoyed during the daytime, the sound pressure level on balconies, terraces and outdoor living areas should not exceed 55 dB L_{Aeq} for a steady, continuous noise. To protect the majority of people from being moderately annoyed during the daytime, the outdoor sound pressure level should not exceed 50 dB L_{Aeq}.

Table 9 presents a comparison of the existing daytime L_{Aeq} ambient noise levels, which are dominated by road traffic noise, with the combined level including the contribution from the site in the 'Worst case (future)' scenario.

Table 9 – Average daytime L_{Aeq} levels in existing and future scenarios

Period	AL1 – Thorney Lodge / AL3 Walkers Farm			AL2 - Meadow Farm / Strawberry Cottage			AL4 - Welgrove House / Budec		
	Existing ambient	Worst Case (Future) site	Worst Case (Future) total	Existing ambient	Worst Case (Future) site	Worst Case (Future) total	Existing ambient	Worst Case (Future) site	Worst Case (Future) total
Weekday day	50 dB(A)	40 dB(A)	50 dB(A)	43 dB(A)	38 dB(A)	44 dB(A)	54 dB(A)	35 dB(A)	54 dB(A)
Weekend day	51 dB(A)	40 dB(A)	52 dB(A)	40 dB(A)	38 dB(A)	42 dB(A)	54 dB(A)	35 dB(A)	54 dB(A)

Whilst the worst case (future) total level would be between the thresholds for moderate and serious annoyance at AL1, AL3 and AL4, these exceedances also occur in the existing scenario, and the noise contribution from the future site at all locations is at least 10dB below the threshold for the onset of moderate annoyance.

Outdoor annoyance due to operations even under the conservative (worst case, future) scenario is therefore considered unlikely to occur.

6.3.3.2 Effects on sleep disturbance during the night

The 1999 Guidelines for Community Noise recommend an outdoor level of 45dB $L_{Aeq,8h}$ for the avoidance of sleep disturbance, assuming windows are partly open for ventilation.

Table 10 presents a comparison of the existing ambient noise levels during the night, which are dominated by road traffic noise, with the combined level including the contribution from the site in the 'future' scenario.

Table 10 – Average annual night L_{Aeq} levels in existing and future scenarios

Period	AL1 – Thorney Lodge / AL3 Walkers Farm			AL2 - Meadow Farm / Strawberry Cottage			AL4 - Welgrove House / Budec		
	Existing ambient	Future site	Future total	Existing ambient	Future site	Future total	Existing ambient	Future site	Future total
Weekday night	46 dB(A)	40 dB(A)	47 dB(A)	41 dB(A)	38 dB(A)	43 dB(A)	48 dB(A)	35 dB(A)	48 dB(A)
Weekday quiet night	41 dB(A)	40 dB(A)	44 dB(A)	36 dB(A)	38 dB(A)	40 dB(A)	44 dB(A)	35 dB(A)	45 dB(A)
Weekend night	47 dB(A)	40 dB(A)	48 dB(A)	40 dB(A)	38 dB(A)	42 dB(A)	48 dB(A)	35 dB(A)	49 dB(A)
Weekend quiet night	43 dB(A)	40 dB(A)	45 dB(A)	34 dB(A)	38 dB(A)	40 dB(A)	45 dB(A)	35 dB(A)	45 dB(A)

In the worst case (future) scenario, there are some minor exceedances of the 45dB $L_{Aeq,8h}$ recommended level. However, these exceedances also occur in the existing scenario, and where these exceedances occur the relative contribution of the future site is small (between 7 – 15 dB below that of the road).

Sleep disturbance due to the operations even under the conservative (worst case, future) scenario is therefore considered unlikely to occur.

6.3.4 Tonality indoors

For the reasons described in section 6.2, the maximum acoustic character correction of +6 dB has been added to the external specific sound level (L_{Aeq}) when determining the initial estimate of the noise impact.

However, during the night, residents are likely to be indoors: going to sleep, asleep, or waking up. Although some degree of tonality is likely to be perceptible outdoors, it is considered that the likelihood of this tonality being clearly perceptible indoors is lower, due to masking by other sources of sound within the dwelling. This principle is discussed in the worked example A.6.1 in BS 4142:2014+A1:2019.

In addition, periods of the highest noise output would generally be expected to occur when residents are least likely to be sleeping with open windows, which further reduces the likelihood of tonality being perceptible indoors.

The initial estimates of impact are therefore likely to overstate the impact during the night.

6.4 Estimate of noise impact adjusted for context

The various factors discussed in Section 6.3 are relevant to the estimation of noise impact, and taken together they indicate that the overall magnitude of impact in the existing and future scenarios is lower than indicated by the 'initial estimate of the impact' (identified in Section 6.2).

It is recognised in BS 4142:2014+A1:2019 that professional judgement must be applied when taking context into consideration, as there is no prescriptive numeric method for doing so. In the professional judgement of the assessor, it is considered that the likelihood of adverse impact in the existing and worst case (future) scenarios is low, due to consideration of each contextual factor discussed in Section 6.3. Indeed, it is considered that these factors are more likely to influence the impact experienced at nearby receptors than the margin by which the rating level exceeds the background.

7. Noise control

7.1 Consideration of noise control during design evolution

The selection and design of the proposed new unit and associated infrastructure has been developed in accordance with the National Gas Transmission Specification for Environmental Noise Assessment for Compressor Projects (T/SP/ENV/26) to ensure that potential environmental noise effects are minimised. A basic principle of T/SP/ENV/26 is that noise emissions are considered from the outset of the design process for gas compressor projects, and that preliminary noise assessments are undertaken to support the identification of Best Available Techniques (BAT) as the design progresses.

The outcome of the BAT assessment was the selection of the following:

- An engineered close-fitting noise enclosure around the gas compressor unit, with the best available noise reduction performance for the selected model of compressor.
- The enclosed gas compressor unit is then located within a bespoke secondary full cabinet (or ‘cab’) enclosure, which provides substantially increased sound insulation performance.
- Air intake/exhaust silencers with the best available noise attenuation performance for the selected model of compressor.
- Reduced noise variants of anti-icing equipment, fuel gas skid and lube oil cooler have been specified to reduce noise emissions.
- Pipework design has followed best practice guidance for the avoidance of noise issues.
- High performance acoustic lagging around ‘above ground’ sections of new pipework

The cost of providing the cabinet and other noise mitigation measures represents a multi-million pound investment for National Gas Transmission. Discussions with suppliers have indicated that further reductions in noise are not technically feasible. The design is therefore considered to represent the Best Environmental Option (BEO), BAT, and is in accordance with the requirements of the ‘mitigate and minimise’ aspect of the NPSE.

Table 11 presents the noise sources on site from highest to lowest, based on the contribution at the closest receptor (AL1), with the above mitigation measures in place. The relevant design mitigation is also provided.

Table 11 – Rank order of proposed sources in terms of noise contribution at AL1

Source	**Estimated Contribution at AL1**	**Mitigation**
Stack outlet	32 dB L_{Aeq}	Highest available performance stack silencer included in stack design
Lube Oil Cooler	30 dB L_{Aeq}	Quietest available lube oil cooler has been selected
Proposed Suction / Discharge Pipework	30 dB L_{Aeq}	Highest available class of pipework acoustic lagging (Class D2), included in the pipework design.
Fuel Gas Unit	27 dB L_{Aeq}	Quietest available fuel gas has been selected
GT Enclosure	23 dB L_{Aeq}	High performance air intake/exhaust silencers, engineered close-fitting noise enclosure around the gas compressor unit, bespoke secondary full cabinet enclosure.

The contribution of all other sources is expected to be less than 20 dB(A) at the closest receptor, and would not require further mitigation.

7.2 European Commission BAT conclusions

BAT conclusions for large combustion plant were published by the European Commission on 17th August 2017. The European Commission states that the techniques listed and described in their BAT conclusions are 'neither prescriptive nor exhaustive, and that other techniques may be used that ensure at least an equivalent level of environmental protection'.

The BAT conclusions relevant to the control of noise emissions are reproduced in Table 12, with examples of how the techniques have been applied in the design and specification of the new compressor unit at Hatton Compressor Station.

Table 12 – European Commission BAT conclusions for noise emissions from large combustion plant

Technique	Description	Applicability	Example of technique in proposed development
a. Operational measures	These include – improved inspection and maintenance of – closing of doors and windows of enclosed areas, if possible – equipment operated by experienced staff – avoidance of noisy activities at night, if possible – provisions for noise control during maintenance activities	General applicable	The noise management plan (see Appendix F) includes various operational measures aimed at reducing noise impact.
b. Low-noise equipment	This potentially includes compressors, pumps and disks	Generally applicable when the equipment is new or replaced	The key low-noise equipment included in the design of the proposed facility includes: – the selected compressor unit is the quietest commercially available. Noise was a key differentiator between suppliers during the procurement process – lube oil cooler – fuel gas unit – ventilation systems – anti-icing systems

Technique	Description	Applicability	Example of technique in proposed development
c. Noise attenuation	Noise propagation can be reduced by inserting obstacles between the emitter and the receiver. Appropriate obstacles include protection walls, embankments and buildings	Generally applicable to new plants. In the case of existing plants, the insertion of obstacles may be restricted by lack of space	The new compressor cab building itself will provide screening to existing noise sources such as Unit D for receptors to the west.
d. Noise control equipment	This includes: – noise-reducers – equipment insulation – enclosure of noisy equipment – soundproofing of buildings	The applicability may be restricted by lack of space	The key noise attenuation included in the design of the proposed facility includes: – close fitting enclosure around gas compressor – secondary full cabinet around gas compressor – air intake/exhaust silencers High performance lagging around 'above ground' sections of new pipework
e. Appropriate location of equipment and buildings	Noise levels can be reduced by increasing the distance between the emitter and the receiver and by using buildings as noise screens	Generally applicable to new plant	The new compressor equipment has been located as far as possible from nearby receptors, taking into the constraints associated with the existing infrastructure at the site

8. Uncertainty

BS 4142:2014+A1:2019 requires the assessor to consider the level of uncertainty in the data and associated calculations, and this is described in Table 13. Uncertainty associated with the sound power values of the various sources is considered in Table 4.

Table 13 – Consideration of uncertainty in assessment

Aspect of assessment	Consideration of uncertainty
Measured baseline values	Measurement uncertainty reduced by: • Undertaking a high number of 15-minute measurements (approximately 670 measurements at each location). • Selecting locations considered to be closely representative of the associated assessment locations. • Excluding measurements adversely affected by weather, identified using highly accurate meteorological measurement equipment. • Using appropriately calibrated Class 1 monitoring equipment. The residual uncertainty in the measured baseline values is considered to be low.
Uncertainty in calculations	Calculation uncertainty reduced by: • Using ISO9613-2, a well-recognised methodology that predicts noise levels under meteorological conditions favourable to noise propagation from the sound source to the receiver, such as downwind propagation, or equivalently, propagation under a well-developed moderate ground based (surface) temperature inversion as can occur during low wind conditions at night. • Using data that reflects the 'worst-case' operating conditions (e.g. all equipment operating at 100% load) to ensure a conservative assessment. The residual uncertainty in the calculated values is considered to be low.
Sound power input data	Considered in detail in Table 4. In general, uncertainty in sound power input data is considered to be low. Where there is a medium degree of uncertainty, an additional corrections factor has been applied to ensure a conservative assessment approach.

9. Non-technical summary and conclusions

This report presents the results of a baseline sound level survey, noise modelling, details of the noise mitigation employed in the design of the compressor station, and subsequent assessment of the predicted noise levels at the closest dwellings to Hatton Compressor Station.

The overall likelihood of adverse impact in the existing and future scenarios is considered low, due to consideration of various contextual factors that reduce the likelihood of adverse impact.

Noise emissions have been considered from the outset of the design process, in order to minimise the potential for adverse noise impacts. The most substantial noise mitigation measures included in the design are an engineered close-fitting noise enclosure around the gas compressor unit, a bespoke secondary full cabinet (or 'cab') enclosure, and air intake/exhaust silencers with the best available noise attenuation performance for the selected model of compressor.

It is therefore considered that the current design proposals reduce adverse noise impacts to the minimum that can be achieved, and are consistent with BAT conclusions for large combustion plant published by the European Commission.

Appendix A. Glossary of acoustic terminology

General

A sound wave travelling through the air is a regular disturbance in ambient atmospheric pressure. These pressure fluctuations, when of frequencies within the audible range, are detected by the human ear which passes nerve responses to the brain, producing the sensation of hearing. Noise has been defined in a variety of ways and is very much dependent on factors such as the listener's attitude to the source of the sound and their environment, but is essentially any sound that is unwanted by the recipient.

The human ear is sensitive to a wide range of sound levels; the sound pressure level of the threshold of pain is over a million times that of the quietest audible sound. In order to reduce the relative magnitude of the numbers involved, a logarithmic scale of decibels (dB) based on a reference level of the lowest audible sound is used.

Also, the response of the human ear is not constant over all frequencies. It is therefore usual to weight the measured frequency to approximate human response. This is achieved by using filters to vary the contribution of different frequencies to the measured level. The "A" weighting network is the most commonly used and has been shown to correlate closely to the non-linear and subjective response of humans to sound. The use of this weighting is denoted by a capital A in the unit abbreviation (i.e. L_{Amax}, L_{Aeq}, L_{A90} etc.) or a capital A (in brackets) after a dB level, i.e. 3 dB(A).

Sound Pressure Level

The sound pressure level (LP or SPL) is the instantaneous acoustic pressure and is measured in decibels (dB). Since the ear is sensitive to variations in pressure, rather than source power or intensity, the measurement of this parameter gives an indication of the impact on people. The SPL is defined as:

$$SPL = 10\log_{10}\left(\frac{p^2}{p_{ref}^2}\right) \quad \text{or} \quad SPL = 20\log_{10}\left(\frac{p}{p_{ref}}\right)$$

where:

p is the rms pressure of the sound in question (in pascals)

p_{ref} is the reference sound pressure, defined as the limit of human audibility (2 x 10^{-5} Pa)

L_{eq}: The L_{eq} is defined as the equivalent continuous sound level and is the most widely used parameter for assessing environmental noise. Since this descriptor is a type of average level, it must by definition have an associated time period over which the measurement is referring to. This is often included in the abbreviation in the form $L_{eq, T}$, where T is the time period (i.e. $L_{Aeq, 5\ min}$). The formula for calculating the L_{eq} is:

$$L_{eq} = 10\log_{10}\left(\frac{1}{t_2 - t_1}\int_{t_1}^{t_2}\frac{p^2}{p_{ref}^2}.dt\right)$$

In practice, since most modern sound level meters are digital and hence take periodic samples of the sound pressure level, the L_{eq} will be the logarithmic average of all the SPL samples taken in the measurement period.

Noise Descriptors

$L_{Ar,T}$: The $L_{Ar,T}$ is defined as the L_{Aeq} during a specified period (T) with corrections for tonality and/or impulsiveness of the sound in question.

L_{90}: The L_{90} refers to the level exceeded for 90% of the measurement period and is widely considered to represent background noise, or the underlying noise in an area between noisy events (such as cars passing etc.).

Terms

Free-Field: The term “free-field” refers to noise levels that have been measured or predicted in the absence of any influence of reflections from nearby surfaces. In practice, a measurement is considered to be free-field if it was taken at a distance of over 3.5 m from any reflecting surfaces.

Appendix B. Maps showing compressor station site, receptors, monitoring locations and noise contours

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Appendix C. Noise measurement details

Project / site:	National Gas Transmission Hatton Compressor Station
Measurement position:	ID1 - Thorney Lodge
Description	Near field boundary, directly northeast of Thorney Lodge main building
Conditions:	Free-field at 1.2m height a.g.l
Coordinates:	[redacted]
Measurement start time:	14/04/2021 13:45
Measurement end time:	21/04/2021 13:30

Photographs of sound level meter in situ

Looking northwest

Looking south-southeast

Looking north-northwest

Looking southwest, towards the A158

Subjective field notes made by engineer during equipment setup/retrieval:
Dominant sources are combination of passing traffic and more distant road traffic, birdsong. Occasional dog barking from adjacent property heard during equipment setup.

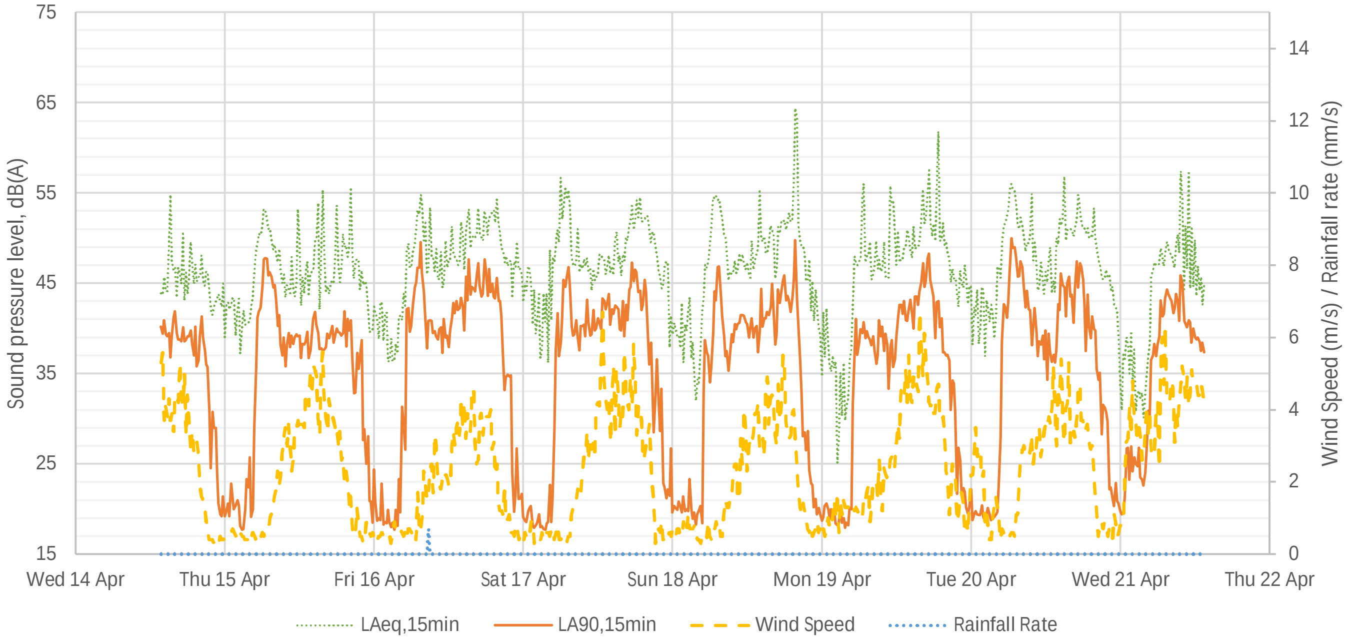
Equipment Records

Item	Manufacturer	Type	Serial Number	Lab Calibration Record
SLM	Rion	NL-52	887270	13/04/2021
Preamplifier	Rion	NH-25	87426	13/04/2021
Microphone	Rion	UC-59	14021	13/04/2021
Calibrator	Rion	NC-74	34825717	07/01/2021

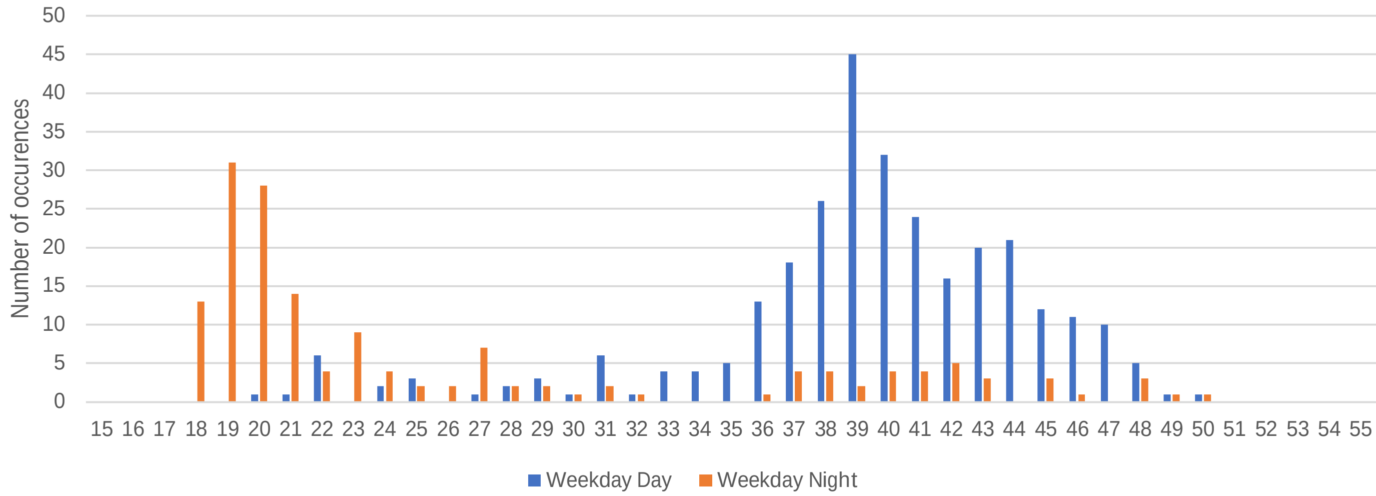
Field Calibration Records

Date	Time	Level	Drift	Operator
14/04/2021	12:35	94.1	-	MA
21/04/2021	12:32	94.0	-	MA

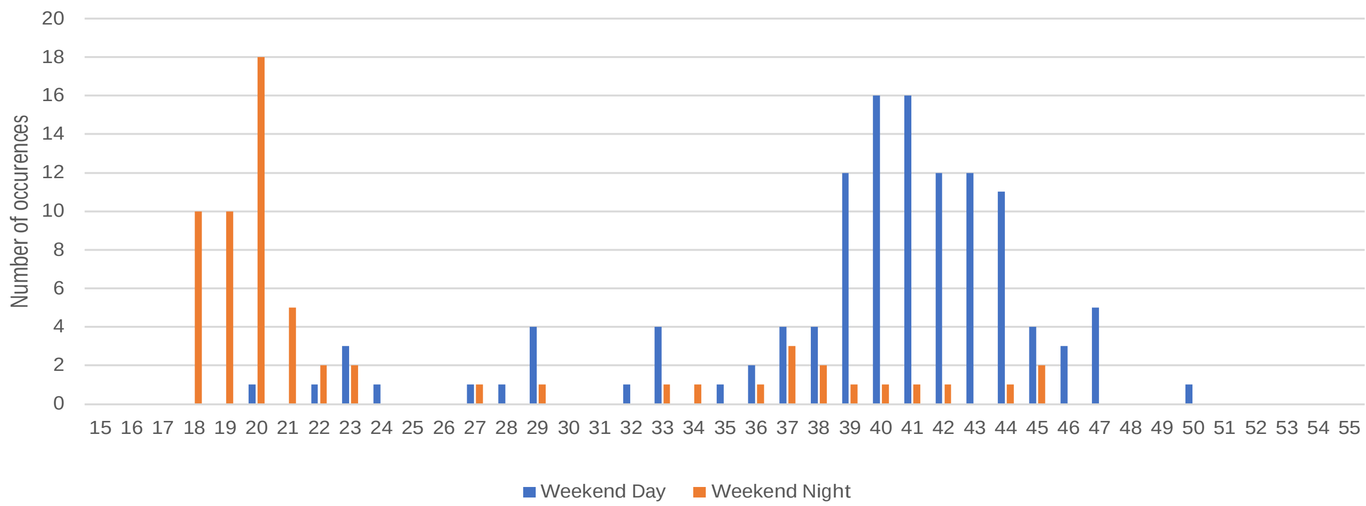
Time history of recorded sound levels and weather data



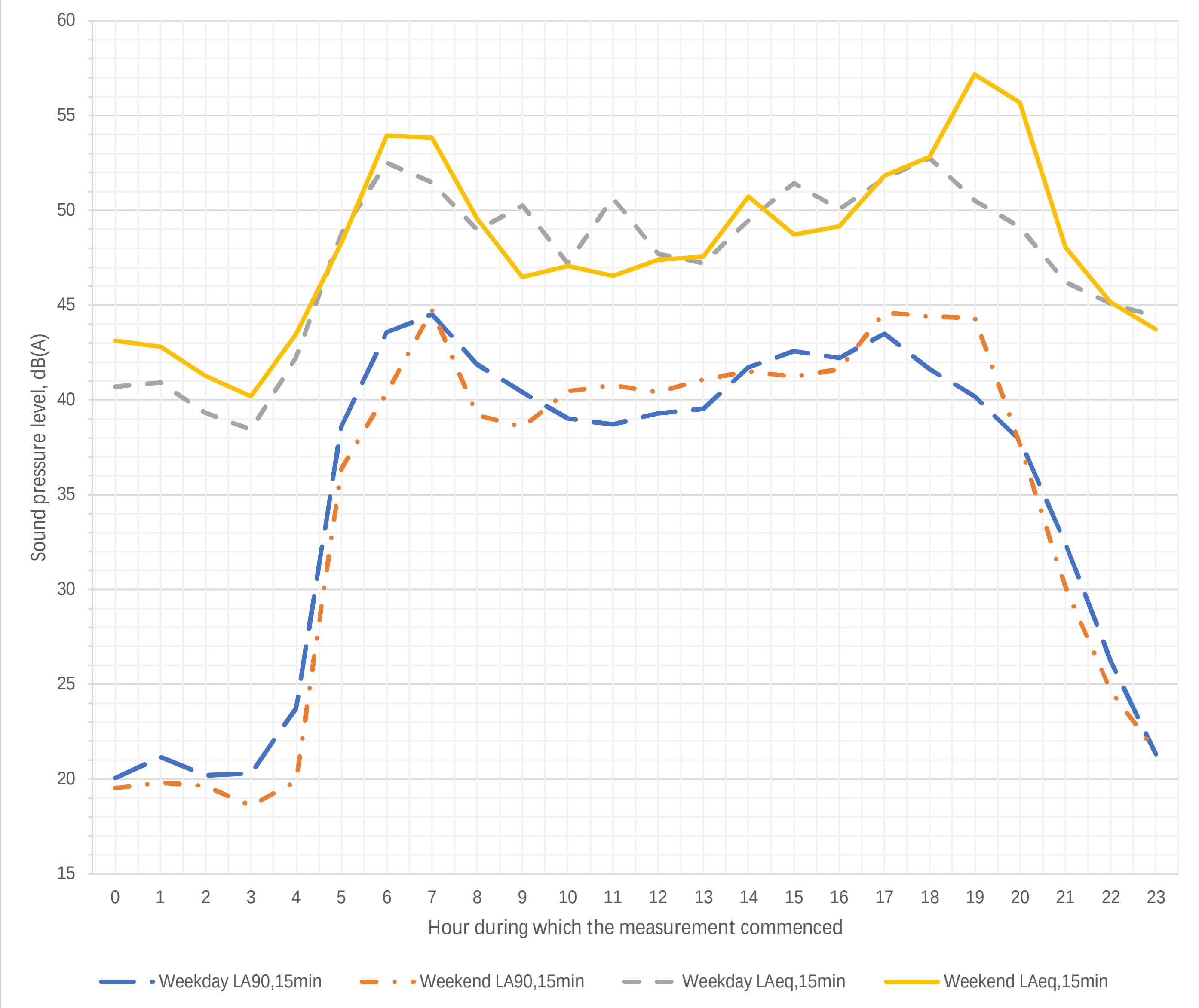
Statistical distribution of rounded $L_{A90,15min}$ values during weekday day and night periods



Statistical distribution of rounded LA90,15min values during weekend day and night periods



Average values measured during each hour of the day/night



Note: this graph presents the arithmetic average of the LA90,15min values and the logarithmic average of the LAeq,15min values during each hour, for those periods that are unaffected by wind or rain

Identification of typical $L_{A90,15min}$ values for basis of BS4142:2014+A1:2019 assessment

Period	Level		Reason
Weekday day:	39	dB L_{A90}	Statistical mode
Weekday night:	19	dB L_{A90}	Statistical mode
Weekend day:	40	dB L_{A90}	Statistical mode
Weekend night:	20	dB L_{A90}	Statistical mode

Identification of logarithmically averaged $L_{Aeq,15min}$ values

Period	Level	
Weekday day:	50	dB L_{Aeq}
Weekday night:	46	dB L_{Aeq}
Weekend day:	51	dB L_{Aeq}
Weekend night:	47	dB L_{Aeq}

Project / site:	National Gas Transmission Hatton Compressor Station
Measurement position:	ID2 - Meadow Farm / Strawberry Cottage
Description	Near field boundary
Conditions:	Free-field at 1.2m height a.g.l
Coordinates:	[redacted]
Measurement start time:	14/04/2021 14:15
Measurement end time:	21/04/2021 13:45

Photographs of sound level meter in situ

Looking northwest

Looking southeast

Looking northeast

Looking northwest (from a distance)

Subjective field notes made by engineer during equipment setup/retrieval:
Dominant sources: birdsong, distant road traffic and occasional passing traffic. Subjective impression: very calm.

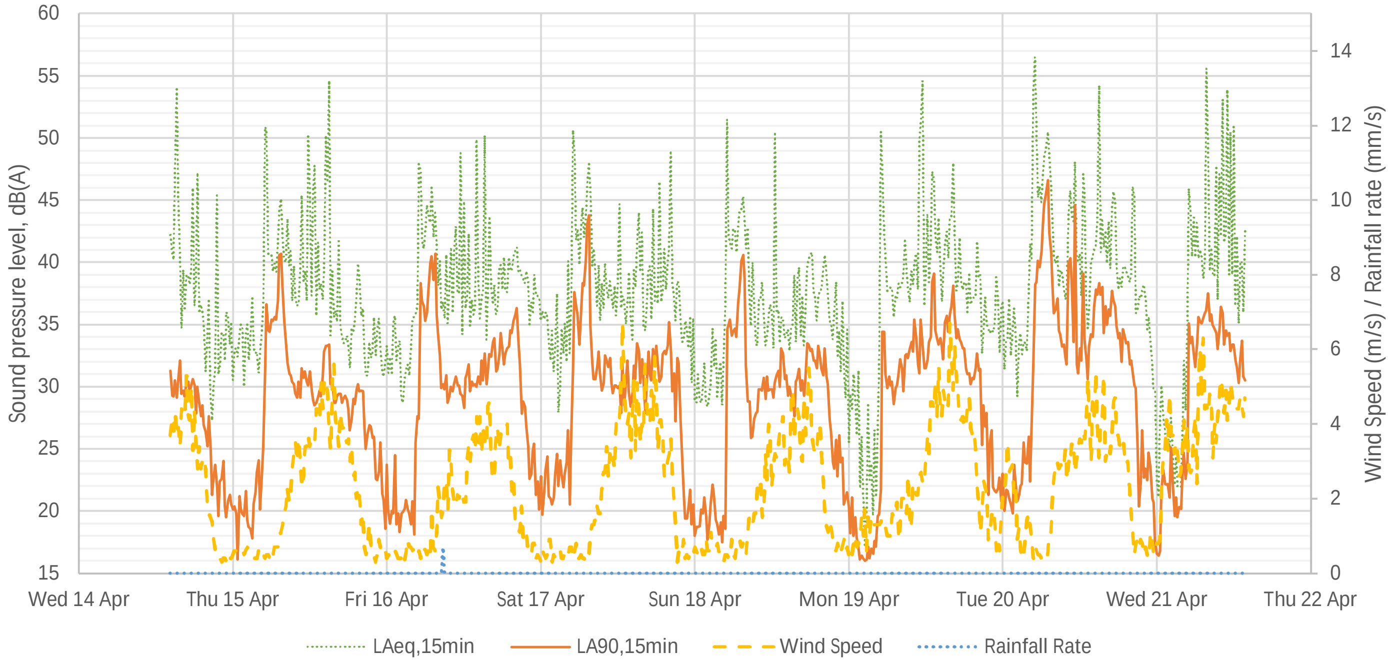
Equipment Records

Item	Manufacturer	Type	Serial Number	Lab Calibration Record
SLM	Rion	NL-52	976220	22/09/2020
Preamplifier	Rion	NH-25	76337	22/09/2020
Microphone	Rion	UC-59	15747	22/09/2020
Calibrator	Rion	NC-74	34825717	07/01/2021

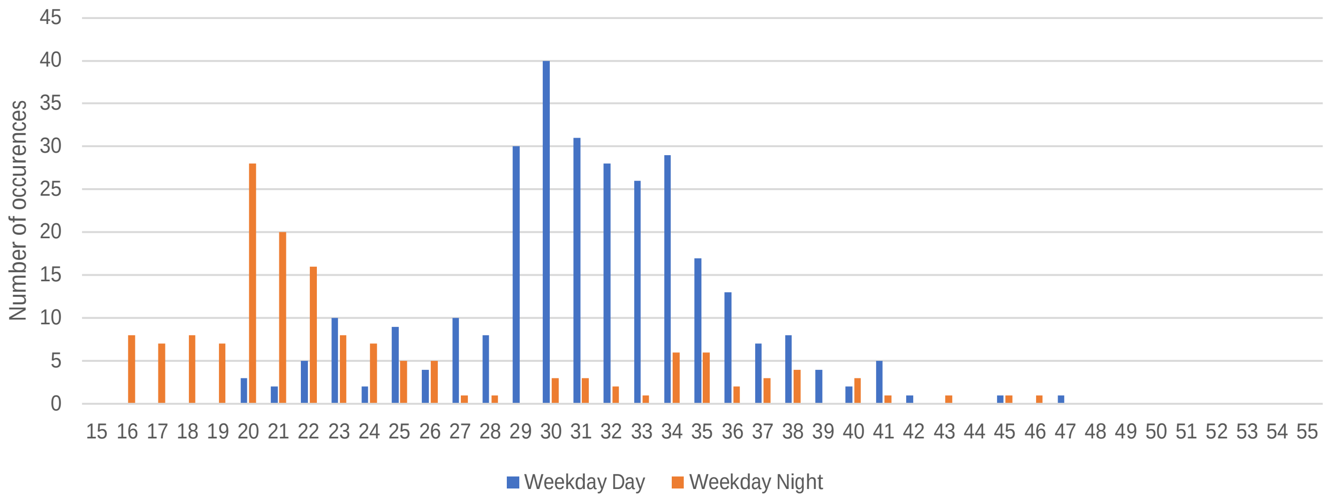
Field Calibration Records

Date	Time	Level	Drift	Operator
14/04/2021	14:08	94.0	-	MA
21/04/2021	14:04	94.0	-	MA

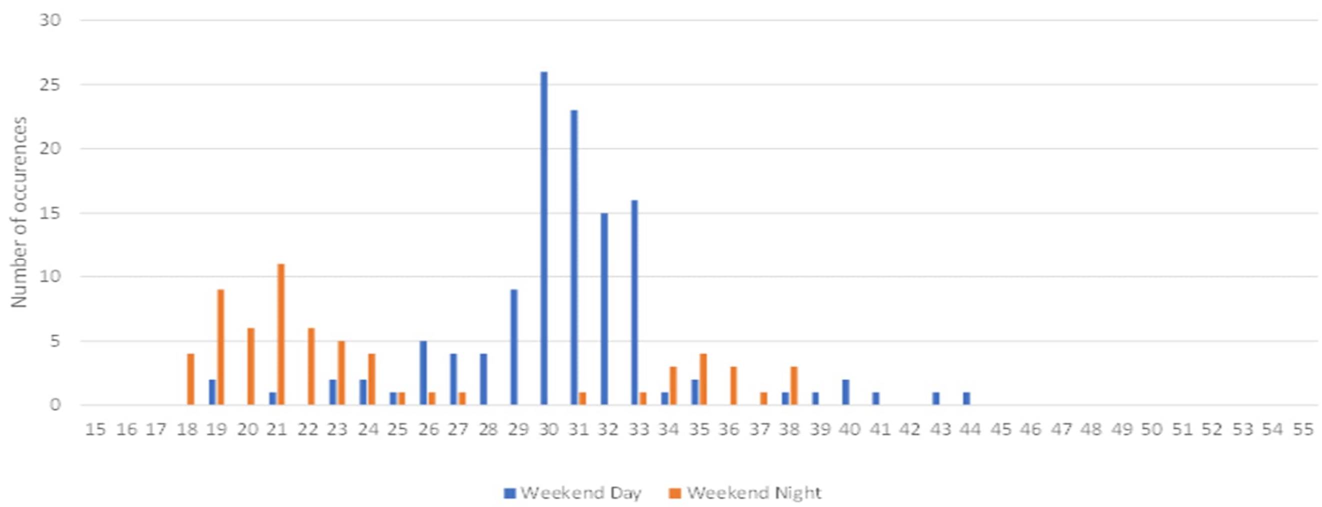
Time history of recorded sound levels and weather data



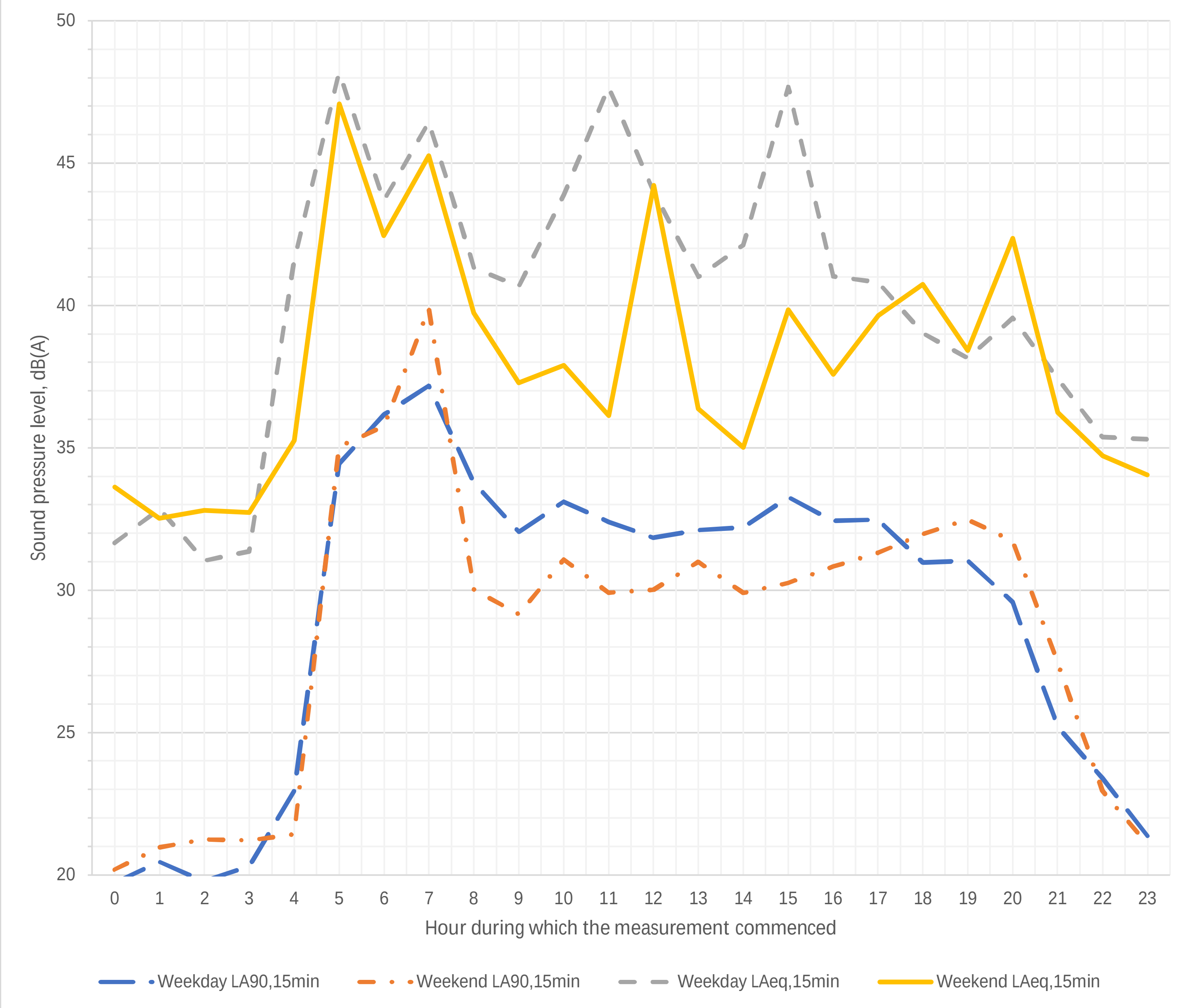
Statistical distribution of rounded $L_{A90,15min}$ values during weekday day and night periods



Statistical distribution of rounded $L_{A90,15min}$ values during weekend day and night periods



Average values measured during each hour of the day/night



Note: this graph presents the arithmetic average of the LA90,15min values and the logarithmic average of the LAeq,15min values during each hour, for those periods that are unaffected by wind or rain

Identification of typical $L_{A90,15min}$ values for basis of BS4142:2014+A1:2019 assessment

Period	Level	Reason
Weekday day:	30 dB L_{A90}	Statistical mode
Weekday night:	20 dB L_{A90}	Statistical mode
Weekend day:	30 dB L_{A90}	Statistical mode
Weekend night:	21 dB L_{A90}	Statistical mode

Identification of logarithmically averaged $L_{Aeq,15min}$ values

Period	Level
Weekday day:	43 dB L_{Aeq}
Weekday night:	41 dB L_{Aeq}
Weekend day:	40 dB L_{Aeq}
Weekend night:	40 dB L_{Aeq}

Project / site:	National Gas Transmission Hatton Compressor Station
Measurement position:	ID4 - Welgrove House / Budec
Description	Near field boundary, directly northeast of 'Budec' main building
Conditions:	Free-field at 1.2m height a.g.l
Coordinates:	[redacted]
Measurement start time:	14/04/2021 14:45
Measurement end time:	21/04/2021 14:00

Photographs of sound level meter in situ

Looking northwest

Looking southwest

Looking west

Looking east

Subjective field notes made by engineer during equipment setup/retrieval:
Dominant source is passing traffic on the A158. Some birdsong. Distant animals heard during equipment setup.

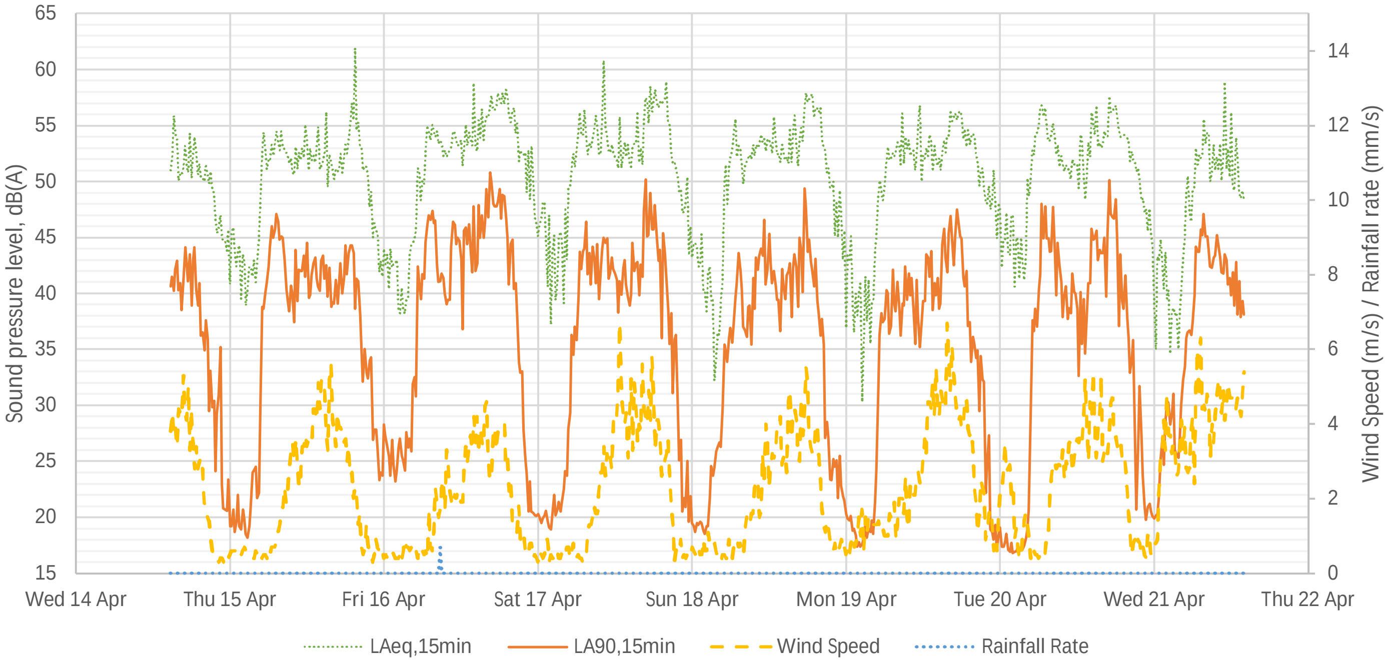
Equipment Records

Item	Manufacturer	Type	Serial Number	Lab Calibration Record
SLM	Rion	NL-52	620868	24/02/2021
Preamplifier	Rion	NH-25	20928	24/02/2021
Microphone	Rion	UC-59	03922	24/02/2021
Calibrator	Rion	NC-74	34825717	07/01/2021

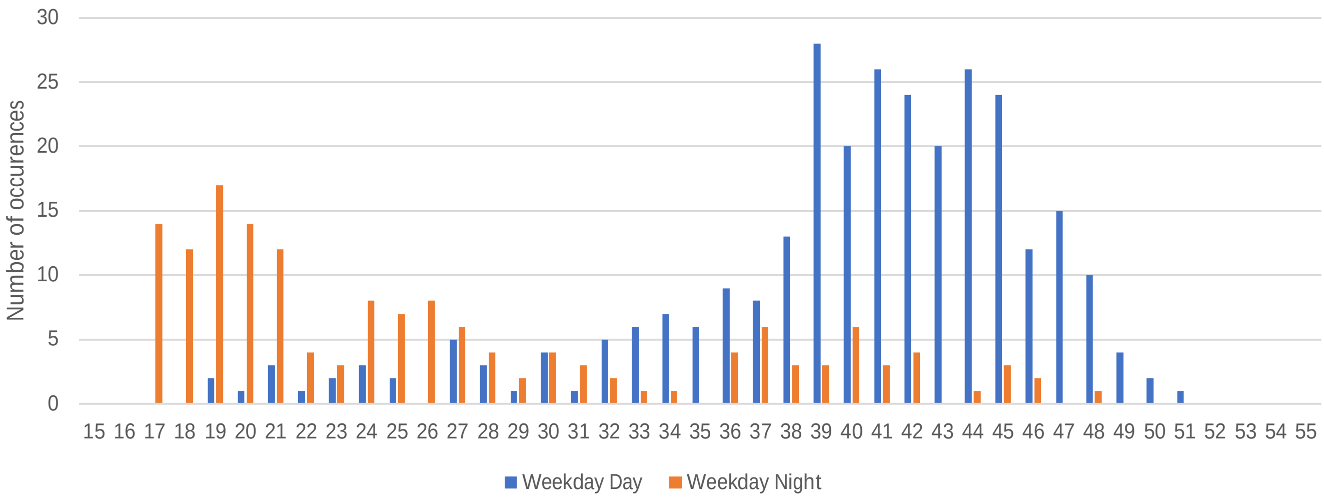
Field Calibration Records

Date	Time	Level	Drift	Operator
14/04/2021	14:38	94.0	-	MA
21/04/2021	14:18	94.0	-	MA

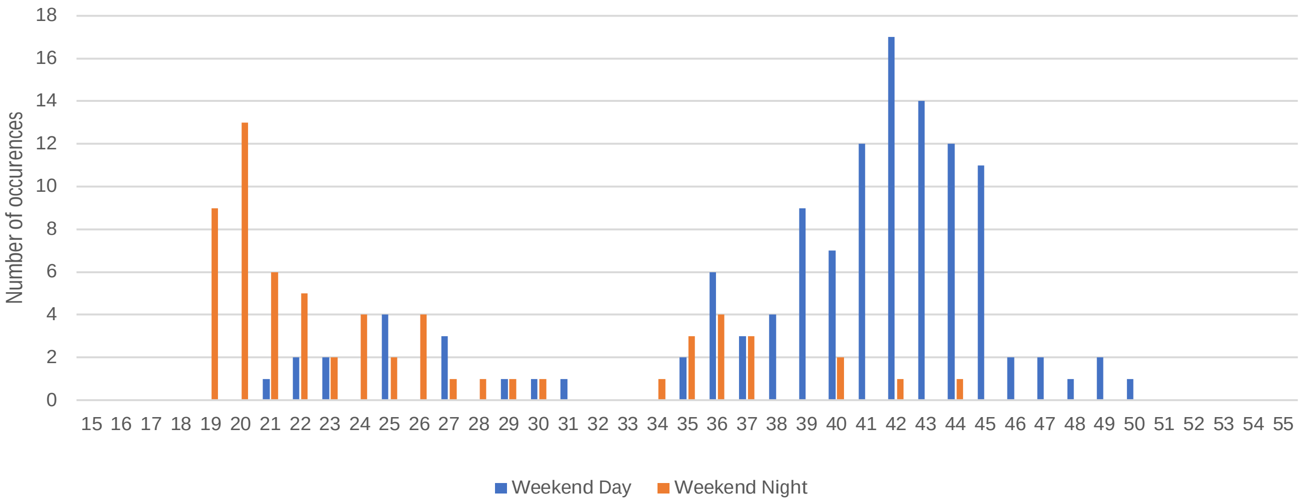
Time history of recorded sound levels and weather data



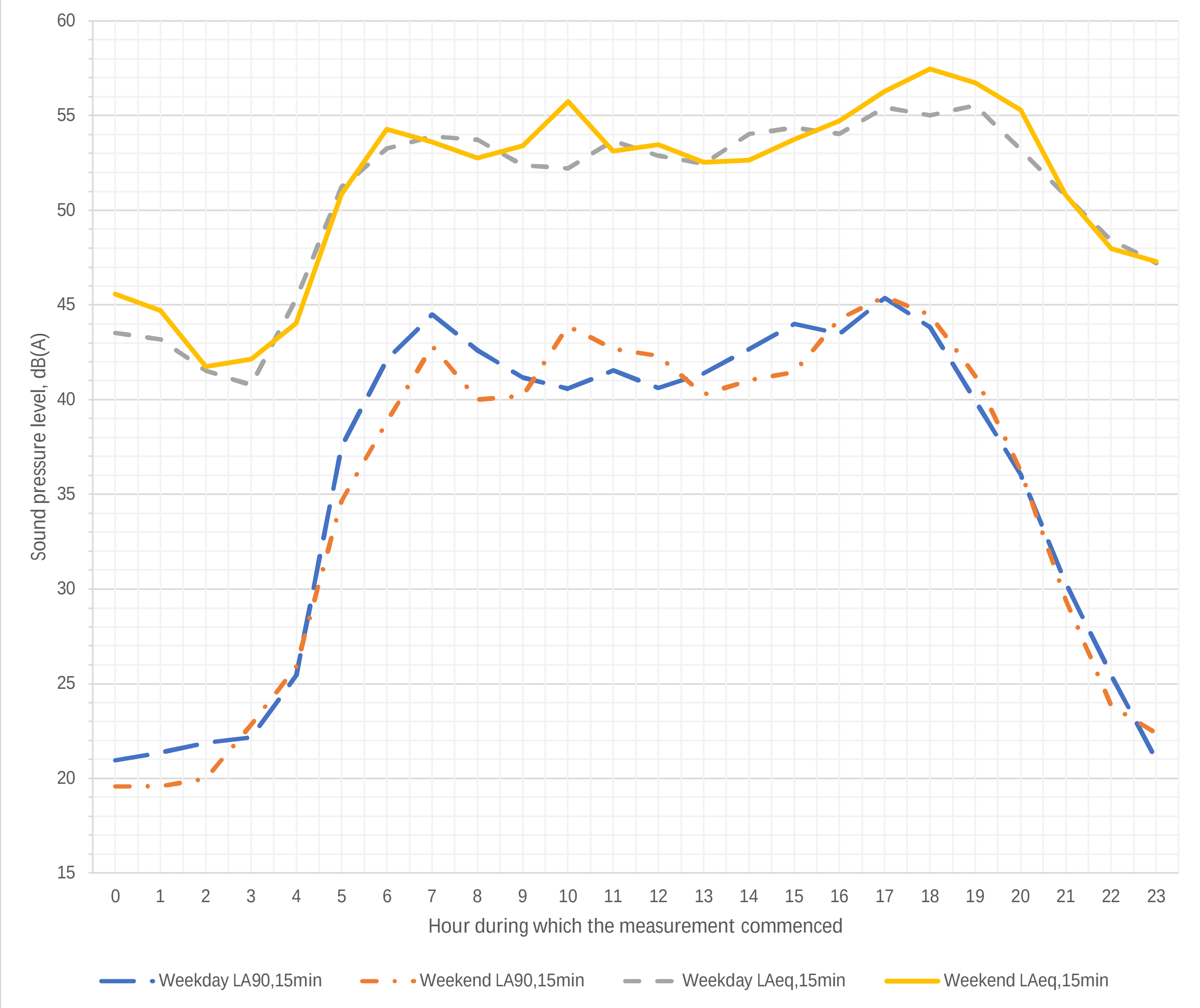
Statistical distribution of rounded $L_{A90,15min}$ values during weekday day and night periods



Statistical distribution of rounded $L_{A90,15min}$ values during weekend day and night periods



Average values measured during each hour of the day/night



Note: this graph presents the arithmetic average of the LA90,15min values and the logarithmic average of the LAeq,15min values during each hour, for those periods that are unaffected by wind or rain

Identification of typical $L_{A90,15min}$ values for basis of BS4142:2014+A1:2019 assessment

Period	Level		Reason
Weekday day:	39	dB L_{A90}	Statistical mode
Weekday night:	19	dB L_{A90}	Statistical mode
Weekend day:	42	dB L_{A90}	Statistical mode
Weekend night:	20	dB L_{A90}	Statistical mode

Identification of logarithmically averaged $L_{Aeq,15min}$ values

Period	Level	
Weekday day:	54	dB L_{Aeq}
Weekday night:	48	dB L_{Aeq}
Weekend day:	54	dB L_{Aeq}
Weekend night:	48	dB L_{Aeq}

Appendix D. Calibration certificates

CERTIFICATE OF CALIBRATION

0653

Date of Issue: 07 January 2021 **Certificate Number: UCRT21/1034**

Calibrated at & Certificate issued by:
ANV Measurement Systems
Beaufort Court
17 Roebuck Way
Milton Keynes MK5 8HL
Telephone 01908 642846 Fax 01908 642814
E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Approved Signatory

K. Mistry

Customer	ANV Measurement Systems Beaufort Court 17 Roebuck Way Milton Keynes MK5 8HL			
Order No.	ANV MS HIRE			
Test Procedure	Procedure TP 1 Calibration of Sound Calibrators			
Description	Acoustic Calibrator			
Identification	*Manufacturer*	*Instrument*	*Model*	*Serial No.*
	Rion	Calibrator	NC-74	34825717

The calibrator has been tested as specified in Annex B of IEC 60942:2003. As public evidence was available from a testing organisation (PTB) responsible for approving the results of pattern evaluation tests, to demonstrate that the model of sound calibrator fully conformed to the requirements for pattern evaluation described in Annex A of IEC 60942:2003, the sound calibrator tested is considered to conform to all the class 1 requirements of IEC 60942:2003.

ANV Job No.	UKAS21/01010	
Date Received	06 January 2021	
Date Calibrated	07 January 2021	
Previous Certificate	*Dated*	11 March 2020
	Certificate No.	UCRT20/1300
	Laboratory	0653

CERTIFICATE OF CALIBRATION

UKAS Accredited Calibration Laboratory No. 0653

Certificate Number
UCRT21/1034

Measurements

The sound pressure level generated by the calibrator in its WS2 configuration was measured five times by the Insert Voltage Method using a microphone as detailed below. The mean of the results obtained is shown below. It is corrected to the standard atmospheric pressure of 101.3 kPa (1013 mBar) using original manufacturers information.

Test Microphone	*Manufacturer*	*Type*
	Brüel & Kjær	4134

Results

The level of the calibrator output under the conditions outlined above was

94.01 ± 0.10 dB rel 20 µPa

Functional Tests and Observations

The frequency of the sound produced was	1003.14 Hz	±	0.13 Hz
The total distortion was	1.21 %	±	6.8 % of Reading

During the measurements environmental conditions were

Temperature	24	to	24	°C
Relative Humidity	31	to	37	%
Barometric Pressure	100.6	to	100.7	kPa

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a coverage probability of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

The uncertainties refer to the measured values only with no account being taken of the ability of the instrument to maintain its calibration.

A small correction factor may need to be applied to the sound pressure level quoted above if the device is used to calibrate a sound level meter which is fitted with a free-field response microphone. See manufacturers handbook for details.

……………………………………………… END ………………………………………………

Note:

Calibrator adjusted prior to calibration?	NO	
Initial Level	N/A	dB
Initial Frequency	N/A	Hz

Additional Comments The results on this certificate only relate to the items calibrated as identified above.

None

Calibrated by: B. Bogdan R 2

CERTIFICATE OF CALIBRATION

ANV MEASUREMENT SYSTEMS

0653

Date of Issue: 24 February 2021 **Certificate Number: UCRT21/1262**

Calibrated at & Certificate issued by:
ANV Measurement Systems
Beaufort Court
17 Roebuck Way
Milton Keynes MK5 8HL
Telephone 01908 642846 Fax 01908 642814
E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Approved Signatory

K. Mistry

Customer	ANV Measurement Systems Beaufort Court 17 Roebuck Way Milton Keynes MK5 8HL
Order No.	ANV MS LAB
Description	Sound Level Meter / Pre-amp / Microphone / Associated Calibrator

Identification	*Manufacturer*	*Instrument*	*Type*	*Serial No. / Version*
	Rion	Sound Level Meter	NL-52	00620868
	Rion	Firmware		2.0
	Rion	Pre Amplifier	NH-25	20928
	Rion	Microphone	UC-59	03922
	Rion	Calibrator	NC-74	34536109
		Calibrator adaptor type if applicable		NC-74-002

Performance Class 1

Test Procedure TP 2.SLM 61672-3 TPS-49

Procedures from IEC 61672-3:2006 were used to perform the periodic tests.

Type Approved to IEC 61672-1:2002 YES Approval Number 21.21 / 13.02

If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2003

Date Received 24 February 2021 ANV Job No. UKAS21/02138

Date Calibrated 24 February 2021

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed. As public evidence was available, from an independent testing organisation responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2:2003, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002, the sound level meter submitted for testing conforms to the class 1 requirements of IEC 61672-1:2002.

Previous Certificate	*Dated*	*Certificate No.*	*Laboratory*
	23 March 2020	UCRT20/1327	0653

CERTIFICATE OF CALIBRATION

UKAS Accredited Calibration Laboratory No. 0653

Certificate Number UCRT21/1262

Sound Level Meter Instruction manual and data used to adjust the sound levels indicated.

SLM instruction manual title	Sound Level Meter NL-42 / NL-52		
SLM instruction manual ref / issue	11-03		
SLM instruction manual source	Manufacturer		
Internet download date if applicable	N/A		
Case corrections available	Yes		
Uncertainties of case corrections	Yes		
Source of case data	Manufacturer		
Wind screen corrections available	Yes		
Uncertainties of wind screen corrections	Yes		
Source of wind screen data	Manufacturer		
Mic pressure to free field corrections	Yes		
Uncertainties of Mic to F.F. corrections	Yes		
Source of Mic to F.F. corrections	Manufacturer		
Total expanded uncertainties within the requirements of IEC 61672-1:2002	Yes		
Specified or equivalent Calibrator	Specified		
Customer or Lab Calibrator	Lab Calibrator		
Calibrator adaptor type if applicable	NC-74-002		
Calibrator cal. date	11 February 2021		
Calibrator cert. number	UCRT21/1195		
Calibrator cal cert issued by	0653		
Calibrator SPL @ STP	94.00	dB	Calibration reference sound pressure level
Calibrator frequency	1002.00	Hz	Calibration check frequency
Reference level range	25 - 130	dB	

Accessories used or corrected for during calibration - Extension Cable & Wind Shield WS-15

Note - if a pre-amp extension cable is listed then it was used between the SLM and the pre-amp.

Environmental conditions during tests	Start	End		
Temperature	24.34	24.53	± 0.30	°C
Humidity	46.1	46.0	± 3.00	%RH
Ambient Pressure	100.99	100.99	± 0.03	kPa

Response to associated Calibrator at the environmental conditions above.

Initial indicated level	94.1	dB	Adjusted indicated level	94.0	dB
The uncertainty of the associated calibrator supplied with the sound level meter ±				0.10	dB

Self Generated Noise This test is currently not performed by this Lab.

Microphone installed (if requested by customer) = Less Than	N/A	dB	A Weighting
Uncertainty of the microphone installed self generated noise ±	N/A	dB	

Microphone replaced with electrical input device - UR = Under Range indicated

Weighting	A			C			Z		
	11.9	dB	UR	16.3	dB	UR	22.5	dB	UR
Uncertainty of the electrical self generated noise ±							0.12	dB	

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a coverage probability of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

For the test of the frequency weightings as per paragraph 12. of IEC 61672-3:2006 the actual microphone free field response was used.

The acoustical frequency tests of a frequency weighting as per paragraph 11 of IEC 61672-3:2006 were carried out using an electrostatic actuator.

.... END ....

Calibrated by: B. Giles R 1

Additional Comments The results on this certificate only relate to the items calibrated as identified above.

None

MEASUREMENT SYSTEMS

CERTIFICATE OF CALIBRATION

0653

Date of Issue: 13 April 2021

Certificate Number: UCRT21/1483

Calibrated at & Certificate issued by:
ANV Measurement Systems
Beaufort Court
17 Roebuck Way
Milton Keynes MK5 8HL
Telephone 01908 642846 Fax 01908 642814
E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Approved Signatory

K. Mistry

Customer	ANV Measurement Systems Beaufort Court 17 Roebuck Way Milton Keynes MK5 8HL
Order No.	ANV MS HIRE
Description	Sound Level Meter / Pre-amp / Microphone / Associated Calibrator

Identification	*Manufacturer*	*Instrument*	*Type*	*Serial No. / Version*
	Rion	Sound Level Meter	NL-52	00887270
	Rion	Firmware		2.0
	Rion	Pre Amplifier	NH-25	87426
	Rion	Microphone	UC-59	14021
	Rion	Calibrator	NC-74	34536109
		Calibrator adaptor type if applicable		NC-74-002

Performance Class 1

Test Procedure TP 2.SLM 61672-3 TPS-49

Procedures from IEC 61672-3:2006 were used to perform the periodic tests.

Type Approved to IEC 61672-1:2002 YES Approval Number 21.21 / 13.02

If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2003

Date Received 08 April 2021 ANV Job No. UKAS21/04233

Date Calibrated 13 April 2021

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed. As public evidence was available, from an independent testing organisation responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2:2003, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002, the sound level meter submitted for testing conforms to the class 1 requirements of IEC 61672-1:2002.

Previous Certificate	*Dated*	*Certificate No.*	*Laboratory*
	Initial Calibration		

CERTIFICATE OF CALIBRATION

UKAS Accredited Calibration Laboratory No. 0653

Certificate Number
UCRT21/1483

Sound Level Meter Instruction manual and data used to adjust the sound levels indicated.

SLM instruction manual title	Sound Level Meter NL-42 / NL-52		
SLM instruction manual ref / issue	11-03		
SLM instruction manual source	Manufacturer		
Internet download date if applicable	N/A		
Case corrections available	Yes		
Uncertainties of case corrections	Yes		
Source of case data	Manufacturer		
Wind screen corrections available	Yes		
Uncertainties of wind screen corrections	Yes		
Source of wind screen data	Manufacturer		
Mic pressure to free field corrections	Yes		
Uncertainties of Mic to F.F. corrections	Yes		
Source of Mic to F.F. corrections	Manufacturer		
Total expanded uncertainties within the requirements of IEC 61672-1:2002	Yes		
Specified or equivalent Calibrator	Specified		
Customer or Lab Calibrator	Lab Calibrator		
Calibrator adaptor type if applicable	NC-74-002		
Calibrator cal. date	18 March 2021		
Calibrator cert. number	UCRT21/1370		
Calibrator cal cert issued by	0653		
Calibrator SPL @ STP	94.01	dB	Calibration reference sound pressure level
Calibrator frequency	1001.96	Hz	Calibration check frequency
Reference level range	25 - 130	dB	

Accessories used or corrected for during calibration - Extension Cable & Wind Shield WS-15

Note - if a pre-amp extension cable is listed then it was used between the SLM and the pre-amp.

Environmental conditions during tests	Start	End		
Temperature	24.04	24.21	± 0.30	°C
Humidity	36.3	34.6	± 3.00	%RH
Ambient Pressure	102.23	102.22	± 0.03	kPa

Response to associated Calibrator at the environmental conditions above.

Initial indicated level	93.8	dB	Adjusted indicated level	94.0	dB
The uncertainty of the associated calibrator supplied with the sound level meter ±				0.10	dB

Self Generated Noise This test is currently not performed by this Lab.

Microphone installed (if requested by customer) = Less Than	N/A	dB	A Weighting
Uncertainty of the microphone installed self generated noise ±	N/A	dB	

Microphone replaced with electrical input device - UR = Under Range indicated

Weighting	A			C			Z		
	10.8	dB	UR	16.3	dB	UR	22.2	dB	UR
Uncertainty of the electrical self generated noise ±							0.12	dB	

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a coverage probability of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

For the test of the frequency weightings as per paragraph 12. of IEC 61672-3:2006 the actual microphone free field response was used.

The acoustical frequency tests of a frequency weighting as per paragraph 11 of IEC 61672-3:2006 were carried out using an electrostatic actuator.

.... END ....

Calibrated by: B. Bogdan R 2

Additional Comments The results on this certificate only relate to the items calibrated as identified above.

None

MEASUREMENT SYSTEMS

CERTIFICATE OF CALIBRATION

ilac-MRA UKAS CALIBRATION 0653

Date of Issue: 22 September 2020 **Certificate Number: UCRT20/1901**

Calibrated at & Certificate issued by:
ANV Measurement Systems
Beaufort Court
17 Roebuck Way
Milton Keynes MK5 8HL
Telephone 01908 642846 Fax 01908 642814
E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Approved Signatory

B. Giles

Customer	ANV Measurement Systems Beaufort Court 17 Roebuck Way Milton Keynes MK5 8HL
Order No.	ANV MS HIRE
Description	Sound Level Meter / Pre-amp / Microphone / Associated Calibrator

Identification

Manufacturer	*Instrument*	*Type*	*Serial No. / Version*
Rion	Sound Level Meter	NL-52	00976220
Rion	Firmware		2.0
Rion	Pre Amplifier	NH-25	76337
Rion	Microphone	UC-59	15747
Rion	Calibrator	NC-74	34536109
	Calibrator adaptor type if applicable		NC-74-002

Performance Class 1

Test Procedure TP 2.SLM 61672-3 TPS-49

Procedures from IEC 61672-3:2006 were used to perform the periodic tests.

Type Approved to IEC 61672-1:2002 YES Approval Number 21.21 / 13.02

If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2003

Date Received 21 September 2020 ANV Job No. UKAS20/09510

Date Calibrated 22 September 2020

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed. As public evidence was available, from an independent testing organisation responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2:2003, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002, the sound level meter submitted for testing conforms to the class 1 requirements of IEC 61672-1:2002.

Previous Certificate	*Dated*	*Certificate No.*	*Laboratory*
	04 September 2019	UCRT19/1983	0653

CERTIFICATE OF CALIBRATION

UKAS Accredited Calibration Laboratory No. 0653

Certificate Number
UCRT20/1901

Sound Level Meter Instruction manual and data used to adjust the sound levels indicated.

SLM instruction manual title	Sound Level Meter NL-42 / NL-52		
SLM instruction manual ref / issue	11-03		
SLM instruction manual source	Manufacturer		
Internet download date if applicable	N/A		
Case corrections available	Yes		
Uncertainties of case corrections	Yes		
Source of case data	Manufacturer		
Wind screen corrections available	Yes		
Uncertainties of wind screen corrections	Yes		
Source of wind screen data	Manufacturer		
Mic pressure to free field corrections	Yes		
Uncertainties of Mic to F.F. corrections	Yes		
Source of Mic to F.F. corrections	Manufacturer		
Total expanded uncertainties within the requirements of IEC 61672-1:2002	Yes		
Specified or equivalent Calibrator	Specified		
Customer or Lab Calibrator	Lab Calibrator		
Calibrator adaptor type if applicable	NC-74-002		
Calibrator cal. date	19 August 2020		
Calibrator cert. number	UCRT20/1789		
Calibrator cal cert issued by	0653		
Calibrator SPL @ STP	94.02	dB	Calibration reference sound pressure level
Calibrator frequency	1001.89	Hz	Calibration check frequency
Reference level range	25 - 130	dB	

Accessories used or corrected for during calibration - Extension Cable & Wind Shield WS-15
Note - if a pre-amp extension cable is listed then it was used between the SLM and the pre-amp.

Environmental conditions during tests	Start	End	±	
Temperature	23.85	24.36	± 0.30	°C
Humidity	61.3	59.2	± 3.00	%RH
Ambient Pressure	100.03	99.93	± 0.03	kPa

Response to associated Calibrator at the environmental conditions above.

Initial indicated level	94.1	dB	Adjusted indicated level	94.0	dB
The uncertainty of the associated calibrator supplied with the sound level meter ±				0.10	dB

Self Generated Noise This test is currently not performed by this Lab.

Microphone installed (if requested by customer) = Less Than	N/A	dB	A Weighting
Uncertainty of the microphone installed self generated noise ±	N/A	dB	

Microphone replaced with electrical input device - UR = Under Range indicated

Weighting	A			C			Z		
	12.3	dB	UR	16.3	dB	UR	21.9	dB	UR
Uncertainty of the electrical self generated noise ±							0.12	dB	

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor $k=2$, providing a coverage probability of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

For the test of the frequency weightings as per paragraph 12. of IEC 61672-3:2006 the actual microphone free field response was used.

The acoustical frequency tests of a frequency weighting as per paragraph 11 of IEC 61672-3:2006 were carried out using an electrostatic actuator.

.... END ....

Calibrated by: C. Hirlav R 3

Additional Comments The results on this certificate only relate to the items calibrated as identified above.

None

Appendix E. Historic noise assessment of existing Unit D

Industrial Noise and Vibration Centre Limited
889 Plymouth Road • Slough • Berkshire • SL1 4LP
Tel : 01753 698800 Fax : 01753 567988
Email : consult@invc.co.uk
Web : www.invc.co.uk

INVC

report

Email to	:	Gary Adams National Grid, Hatton
Email address	:	<gary.adams@nationalgrid.com>
Email to	:	Russell Nattrass National Grid
Email address	:	<russell.nattrass@nationalgrid.com>
From	:	John Hustwick
Date	:	12 July 2016
Subject	:	Hatton Compressor Station – Unit D Compressor Final Noise Assessment
Report No	:	7938D

Summary

The high performance acoustic lagging has now been fitted to the surge/recycle line and valve in the pit, therefore completing the work on the suction and discharge pipe attenuation. The acoustic lagging has significantly reduced the noise radiation from the suction and discharge pipework and demonstrates that "best practicable means" has been used.

The overall noise levels at the nearest noise sensitive dwellings, with the Unit D compressor operating, were below the 35 dB(A) planning criterion set by East Lindsey District Council at residential locations MP1 and MP4 and only marginally above it at MP2. The compressor blade passing frequency, bpf tone was just perceptible when there was a lower level of other masking sound, such as distant traffic noise. Location MP3 is not considered relevant, as it is not near any residential dwellings.

Author J. M. Hustwick

John Hustwick

Introduction

At the request of National Grid, the **INVC** was commissioned to carry out a final noise survey following completion of the high performance acoustic lagging on the surge/recycle line section of the discharge pipework. This had not been carried out at the time of the previous noise survey on 16 December 2015, see **INVC** report number 7938C dated 8 January 2016.

Survey

Noise measurements and recordings were carried out during the afternoon (on site) and mid-evening (off site) on 30 June 2016, whilst the Unit D compressor was operating at high output conditions.

The noise levels were measured and digitally recorded for frequency analysis later using a Type 1 precision sound level meter, which complies with all relevant standards. The meter was check calibrated before and after the survey and the calibration tone recorded as a reference level for analysis.

The weather conditions were dry during the afternoon, with very light and intermittent precipitation during the evening. Wind conditions were still to a very light south westerly breeze, with a temperature of 18 to 22°C.

Due to ongoing roadworks which caused the A158 at Wragby to be closed overnight, the number of vehicles using this road was significantly reduced compared to the survey in December 2015. However, there were a few additional cars and vans using the local roads near the site.

report

Discussion

Off site assessment

East Lindsey District Council planning permission S76/1088/88 states *"The level of noise shall be controlled so as not to exceed 35 dB(A) continuous and 40 dB(A) intermittent at the boundary of the nearest dwelling when the station is operating at full load."* This was carried forward in the planning permission for the new electrically driven compressor (ref S/079/03683/08).

The following figures show amplitude – time plots and samples of the frequency spectra recorded at positions MP1, MP2 and MP4, along with the statistical noise parameters L_{Aeq}, L_{A10} and L_{A90}, see Appendix A and the Unit D compressor rotational speed, rpm. The gas flow was in the order of 80 mcsmd (millions of cubic metres per day).

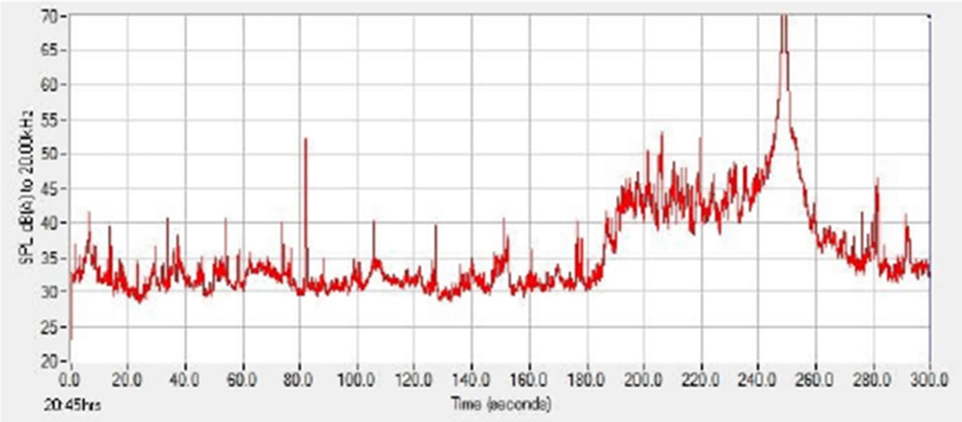


Figure 2 ***MP1*** ***L_{Aeq} 52 dB*** ***L_{A10} 45 dB*** ***L_{A90} 30 dB*** ***4687 rpm***

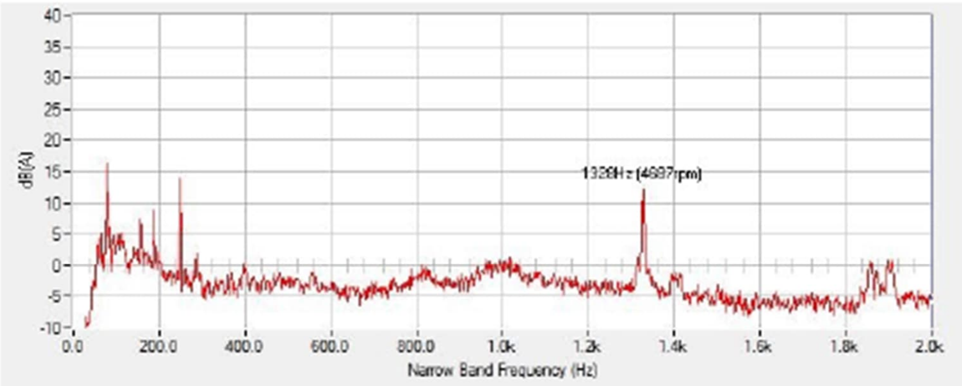


Figure 3 ***MP1***

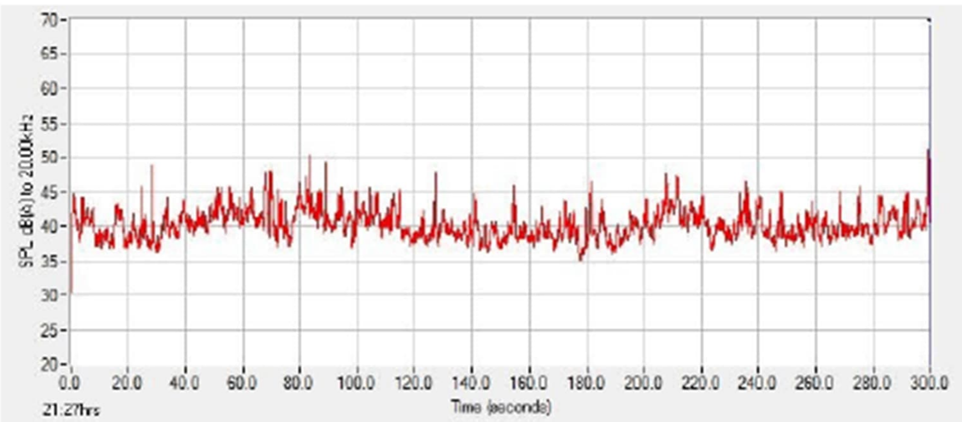


Figure 4 ***MP2*** ***L_{Aeq} 41 dB*** ***L_{A10} 43 dB*** ***L_{A90} 37 dB*** ***4644 rpm***

report

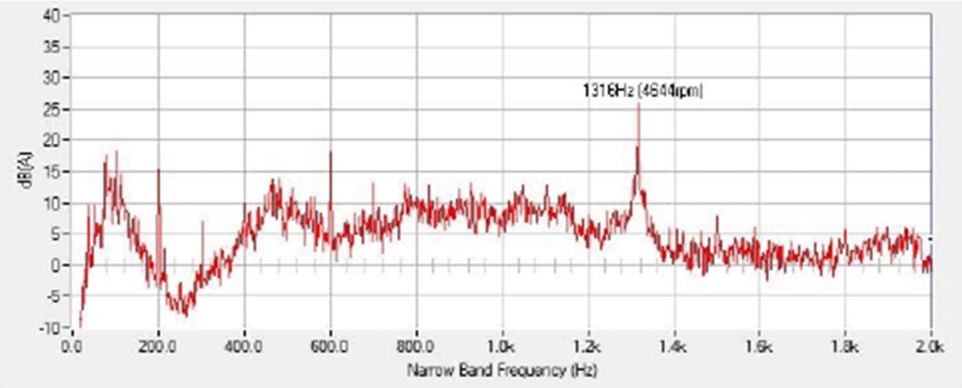


Figure 5 *MP2*

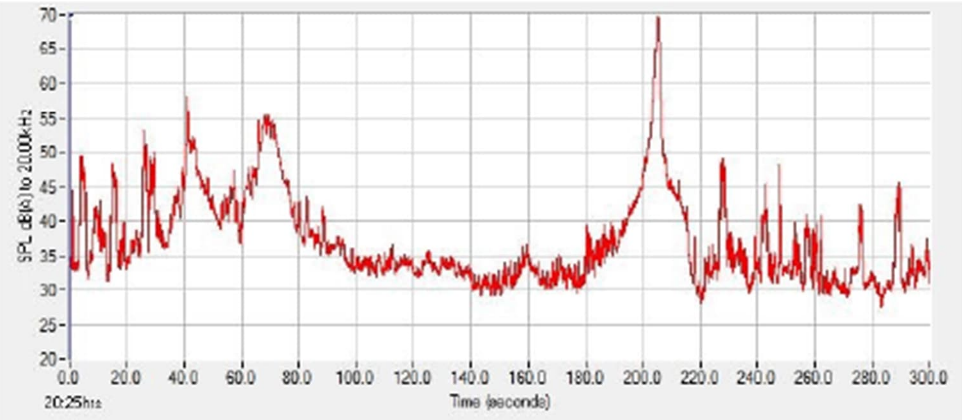


Figure 6 *MP4* L_{Aeq} *48 dB* L_{A10} *47 dB* L_{A90} *31 dB* *4518 rpm*

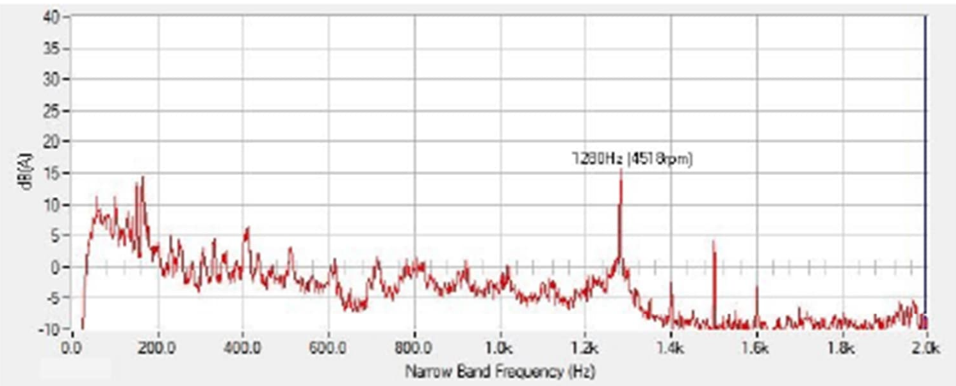


Figure 7 *MP4*

As the amplitude-time plots show, the overall noise levels at MP1 and MP4 were dipping to 30 and 31 dB(A) respectively between the elevated levels caused by passing vehicles with the Unit D compressor operating, thus demonstrating the noise level generated by it was below the planning criterion. At MP2 the noise level was only marginally above 35 dB(A) and was a combination of plant and distant traffic noise, the latter having been reduced by the closure of the A158 at Wragby. Birdsong had also been noticeable at all the measurement locations, as it was still daylight at the time of the survey.

report

Figure 8 shows the comparison of the frequency spectra recorded at MP2 during the current survey and in December 2015.

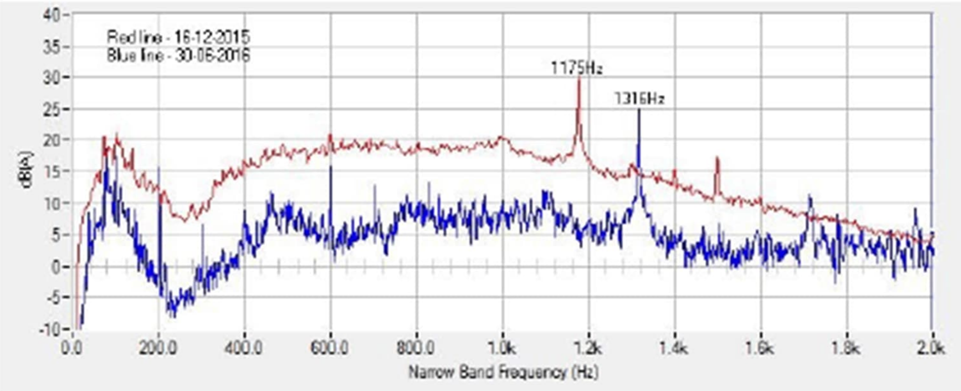


Figure 8

As Figure 8 shows, there was a fairly significant reduction in broadband noise compared to December 2015, due mainly to less distant traffic noise and also, although the compressor was operating at a higher speed, the bpf tone was 5 dB(A) lower.

On site assessment

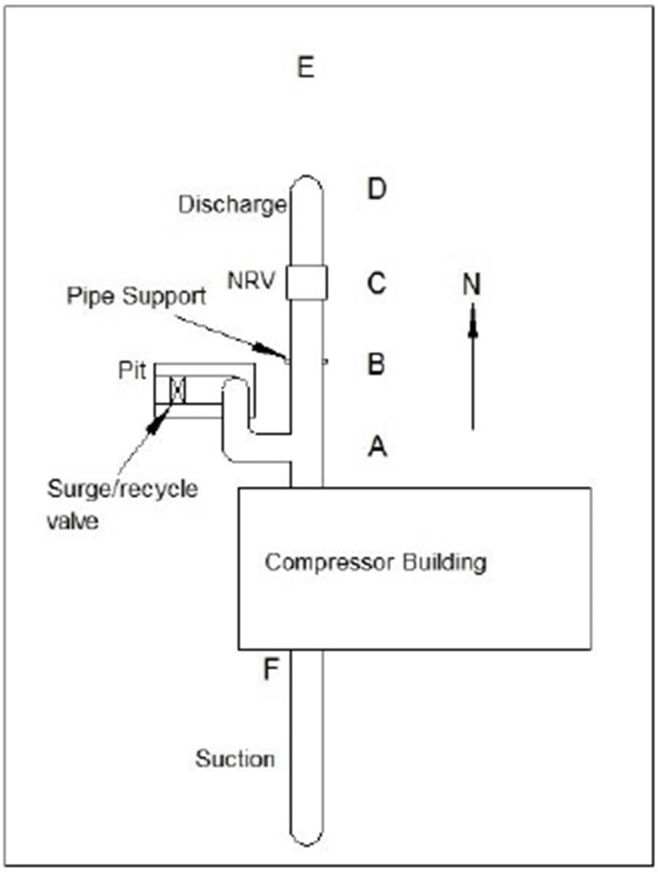


Figure 9 Pipe layout

Figure 9 shows a sketch of the general layout of the pipework, compressor building and pit and includes the original reference measurement positions.

For position A, a run-up in compressor speed was carried out. The overall noise level is shown in Figure 10 with the speed indicated at points on this.

report

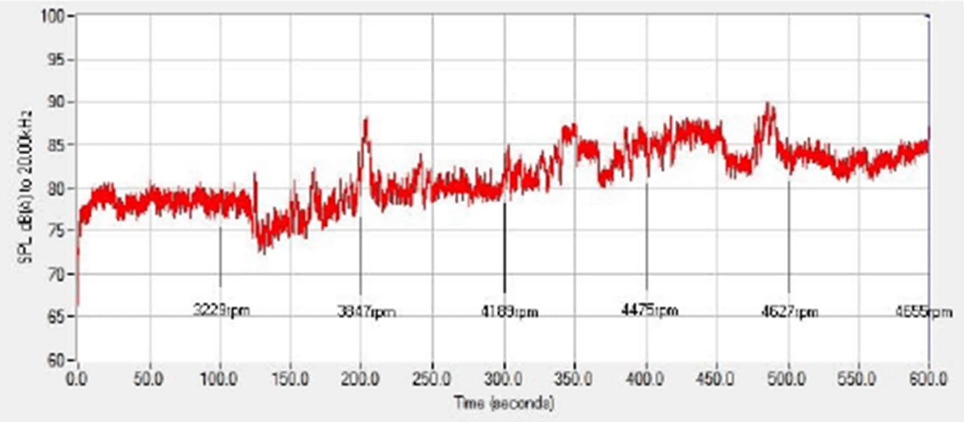


Figure 10

As this figure shows, the noise level did not increase uniformly with speed, which suggests there may be local resonances. However, as can be seen, the noise level at this position was around 85 dB(A) when the compressor was running close to its maximum operating conditions, compared to 95 - 100 dB(A) with the original pipe lagging.

With the surge/recycle pipework and valve now lagged, it was interesting to note that noise from the "vent isolation valve XZV 8405" was quite noticeable. This valve is above ground and adjacent to the pit. The noise radiating from this valve would have been masked by that from the whole discharge pipework initially and latterly by the surge/recycle pipework before it was relagged. As shown in Figure 11, which was a measurement/recording at approximately 0.5m from the valve and pipework, the dominant tone is the bpf of the compressor. Therefore there is a transmission path for the noise to travel along from the discharge pipework, although the actual details/mechanism of this are not known at this time.

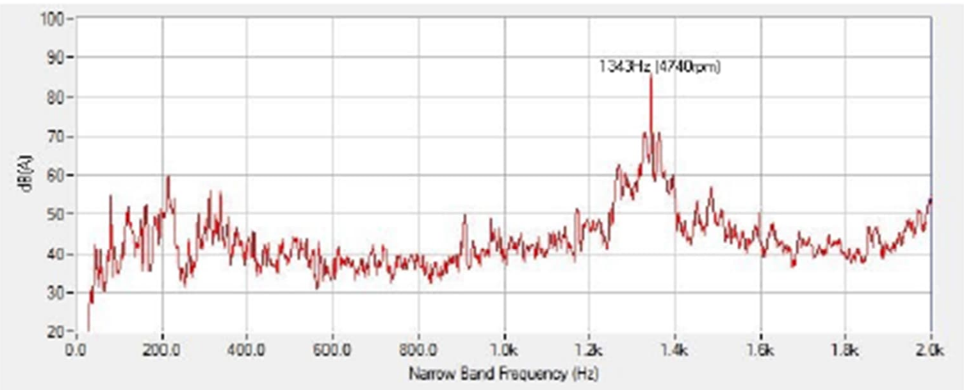


Figure 11

Some tonal noise is also breaking out of the compressor building via the louvres in the west and east façades. Figures 12 and 13 show the frequency spectra recorded at these positions respectively.

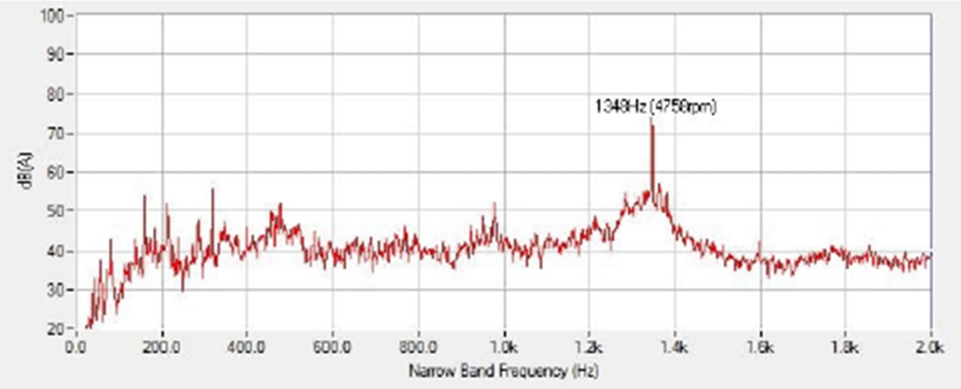


Figure 12

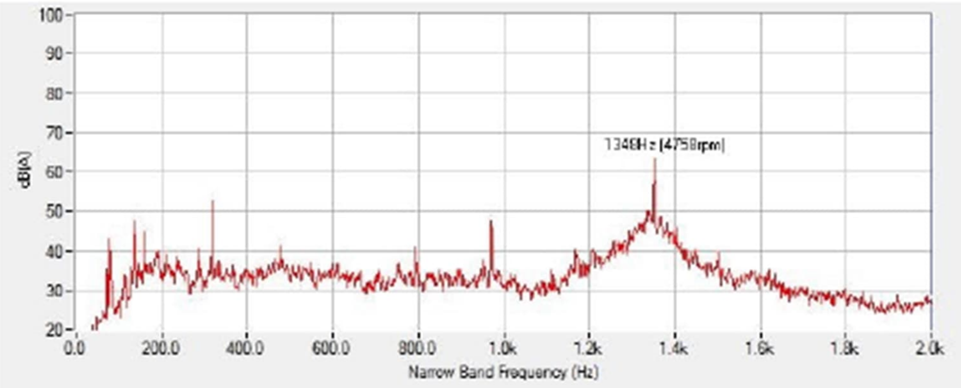


Figure 13

report

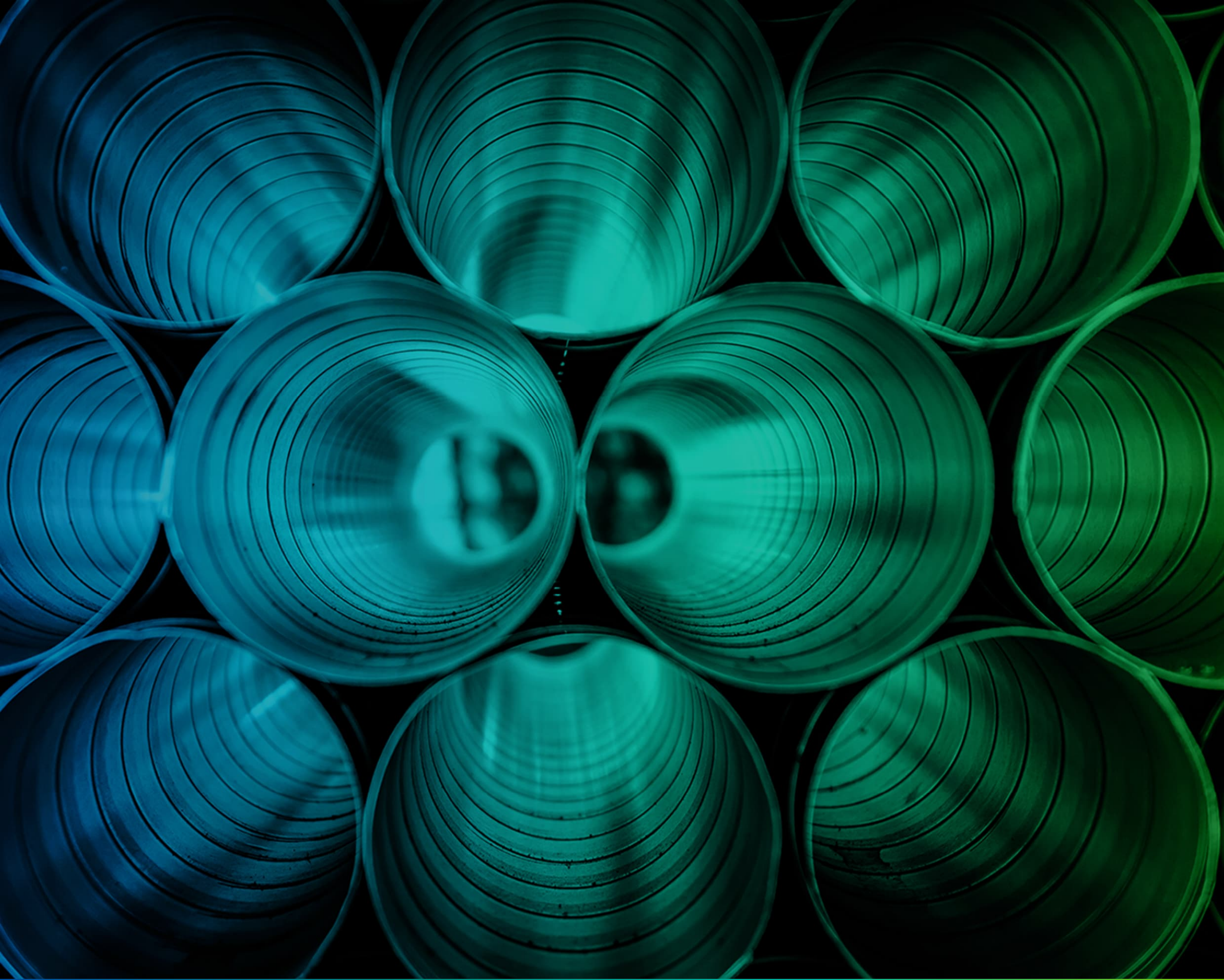
Conclusions

Completion of the high performance acoustic lagging with the fitting of it on the surge/recycle pipework and valve has demonstrated that "best practicable means" has been used to reduce the noise radiation from the suction and discharge pipework. This has resulted in noise levels at the nearest noise sensitive dwellings being at or below the original planning criterion set by East Lindsey District Council.

Although the blade passing frequency tonal noise generated by the Unit D compressor is likely to be perceptible during periods when the masking effect of other sources is at a low level, this is not considered to be significant based on the likely operating regime, which would see only minimal running time during the summer months when local residents would be expected to be spending more time outdoors and with windows in their properties open. It is very unlikely that it would be audible within a property with the windows closed.

Any further reduction in tonal noise will require a major and fairly complex investigation, in order to pinpoint and quantify individual transmission paths and potential noise control treatments.

Appendix F. Noise Management Plan



Hatton Compressor Station

Noise Management Plan

national gas transmission

Contents

Date and purpose

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Document revision history

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V1	April 2023	Initial version	N Billingham

1. Introduction

1.1 Purpose and scope

This Noise Management Plan (NMP) describes the process for managing noise associated with National Gas Transmission plc's (NGT) compressor station activities to minimise potential impacts at sensitive receptors.

This NMP is designed to be a 'living document'. It shall be subject to review and amendment as necessary, to take account of significant changes to on-site activities, equipment, or priorities for noise control. NGT will review the NMP at least every four years, and after any changes to plant / processes that could result in increased noise emissions.

1.2 Regulatory framework

1.2.1 Planning consent

Planning consent for a new compressor unit, ancillary buildings and equipment was granted by East Lindsey District Council (ELDC) (Application ref: S/079/01298/21) in September 2021 subject to conditions. Condition 12, which relates to a noise management plan, is reproduced below:

"No part of the development shall be brought into use until a noise management plan has been submitted to and approved in writing by the Local Planning Authority. The site shall be used only in accordance with the approved noise management plan. The management plan shall include but not be limited to, measures to control noise from activities and operations at the site (including the operation of any equipment, plant, building services, noise from vehicles and deliveries), noise complaint procedures, emergencies and exceptional events."

1.2.2 Environmental Permit

Hatton Compressor Station operates under conditions set out in Environmental Permit EPR/UP3333LL under the Environmental Permitting (England & Wales) Regulations 2016 (as amended). These regulations require noise emissions at the site to be controlled in accordance with Best Available Techniques (BAT).

BAT conclusions for large combustion plant were published by the European Commission on 17th August 2017, which included the following in relation to Environmental Management Systems:

> *1.1. Environmental management systems*
> *BAT 1. In order to improve the overall environmental performance, BAT is to implement and adhere to an environmental management system (EMS) that incorporates all of the following features:…*
> *(xv) a noise management plan where a noise nuisance at sensitive receptors is expected or sustained, including;*
> > *(a) a protocol for conducting noise monitoring at the plant boundary*
> > *(b) a noise reduction programme*
> > *(c) a protocol for response to noise incidents containing appropriate actions and timelines*
> > *(d) a review of historic noise incidents, corrective actions and dissemination of noise incident knowledge to the affected parties*

A noise nuisance is neither expected, or currently sustained at Hatton Compressor Station; additionally the current conditions of the existing Environmental Permit do not require the implementation of a noise management plan.

However, NGT recognises that the operations at Hatton Compressor Station have the potential to produce noise that can have adverse impacts at receptors in the immediate area. and considers that the implementation of a management plan minimises the risk of any such impact arising.

2. Noise sources

2.1 Noise sources

Key noise sources are defined as those that contribute to the potential for environmental nuisance. The fixed noise sources that give rise to are identified in Table 1.

Table 1 Fixed noise sources

Source
Compressor drive train noise through cab enclosure
Compressor turbine exhaust stack outlets
Compressor turbine air intake systems
Compressor cab ventilation systems
Compressor suction and discharge pipework, valves, scrubbers
Fuel Gas Units
Lube Oil Coolers
Transformers
Instrument Air
Emergency standby generators
Depressurisation valves and vents

Other sources identified as insignificant shall be screened out from further consideration due to their low contribution to site noise. These insignificant sources shall be listed in Table 2.

Table 2 Insignificant sources

Name of insignificant source	Justification
Vehicle	Low number of staff and contractor vehicles arriving to and departing from the site
Office building ventilation	Low noise level from small fan systems
Maintenance activities	Low level and generally infrequent

3. Noise management

3.1 Site noise sources and management measures

The above identified noise sources have been risk assessed to identify the level of possible impact, firstly with no mitigation or controls, “Inherent impact” and then applying the identified mitigation and control measures, “residual impact”. This risk assessment is detailed in Table 3.

Table 3 Risk assessment of noise sources

Asset	Aspect	Condition			Inherent Risk Assessment			Noise control included in site design	Site management measures	Residual Risk Assessment		
		Normal Ops	Exceptional events	Emergency Ops	L	S	Impact			L	S	Impact
Gas Turbine Compressor	Drive train noise	✓			5	5	25	High performance air intake/exhaust silencers, engineered close-fitting noise enclosure around the gas compressor unit, bespoke secondary full cabinet enclosure.	Maintenance and inspections to ensure integrity of close-fitting compressor enclosure and cab walls/roof. Periodic site noise measurements to include positions aimed at quantifying noise from cab walls.	1	5	5
Gas Turbine Compressor	Turbine exhaust stack	✓			5	5	25	High performance exhaust silencer included in stack design	Maintenance and inspections to ensure integrity of stack silencer. Periodic site noise measurements to include positions aimed at quantifying noise from exhaust stack (as far as is practical).	2	5	10

Asset	Aspect	Condition			Inherent Risk Assessment			Noise control included in site design	Site management measures	Residual Risk Assessment		
		Normal Ops	Exceptional events	Emergency Ops	L	S	Impact			L	S	Impact
Gas Turbine Compressor	Air intake systems	✓			4	5	20	Acoustic attenuator included in air intake system	Maintenance and inspections to ensure integrity of intake silencer. Periodic site noise measurements to include positions aimed at quantifying noise from air intake aperture. Any increases above historic levels to be investigated.	2	5	10
Gas Turbine Compressor	Cab ventilation systems	✓			3	4	12	Acoustic splitter attenuators in ventilation system design	Maintenance and inspections to ensure integrity of acoustic attenuation in ventilation systems. Periodic site noise measurements to include positions aimed at quantifying noise from ventilation system. Any increases above historic levels to be investigated.	1	4	4
Suction and discharge pipework, valves, scrubbers	Noise via suction and discharge pipework, valves, scrubbers	✓			4	5	20	Acoustic lagging systems	Maintenance and inspections to ensure integrity of lagging systems. Periodic site noise measurements to include positions aimed at quantifying noise from ductwork. Any increases above historic levels to be investigated.	2	5	10

Asset	Aspect	Condition			Inherent Risk Assessment			Noise control included in site design	Site management measures	Residual Risk Assessment		
		Normal Ops	Exceptional events	Emergency Ops	L	S	Impact			L	S	Impact
Fuel Gas Units	Direct noise to atmosphere	✓			3	3	9	Low noise units	Maintenance and inspections to ensure integrity of units. Periodic site noise measurements to include positions aimed at quantifying noise from fuel gas units. Any increases above historic levels to be investigated.	2	3	6
Lube Oil Coolers	Direct noise to atmosphere	✓			3	3	9	Low noise cooling fans	Maintenance and inspections to ensure integrity of units. Periodic site noise measurements to include positions aimed at quantifying noise lube oil coolers. Any increases above historic levels to be investigated.	2	3	6
Instrument air buildings	Direct noise to atmosphere	✓			2	2	4	GRP kiosk around equipment	Maintenance and inspections to ensure integrity of kiosk. Periodic site noise measurements to include positions aimed at quantifying noise from kiosk. Any increases above historic levels to be investigated.	1	2	2

Asset	Aspect	Condition			Inherent Risk Assessment			Noise control included in site design	Site management measures	Residual Risk Assessment		
		Normal Ops	Exceptional events	Emergency Ops	L	S	Impact			L	S	Impact
Transformers	Direct noise to atmosphere	✓			2	3	6	Low noise cooling fans	Maintenance and inspections to ensure integrity of transformers. Periodic site noise measurements to include positions aimed at quantifying noise from transformers. Any increases above historic levels to be investigated.	1	3	3
Site	Noise from venting of systems	✓		✓	3	4	12	-	Planned gas venting only to be undertaken during daytime, work hours.	1	4	4
Standby Generator	Generator drive train noise	✓	✓		4	5	20	Low noise enclosure surrounding standby generator. Exhaust silencer.	Maintenance and inspections to ensure integrity of transformers. Periodic site noise measurements to include positions aimed at quantifying noise from transformers. Any increases above historic levels to be investigated.	1	5	5

3.2 Routine maintenance

The following best practice and preventative maintenance procedures have been adopted at the site, employing good practice measures to control noise emissions to the environment. This is an effective way of managing the noise, as substantial noise control measures will have already been incorporated into the plant design. The list is not exhaustive and general routine maintenance should be carried out on all items of plant to ensure a satisfactory standard of noise control is achieved.

- As the compressor cabs are acoustically enclosed, the integrity of the fabric of the cabs should be subject to frequent visual inspection, both informally and as part of housekeeping audits –
    - Formal inspections covered in
        - T/PM/MAINT/6 –Maintenance of Terminals and compressor stations operating on the NTS - inspection frequency
        - T/PR/MAINT/6050 – Work procedure for civil engineering assets - inspection requirements
        - T/SP/CE/15 - Specification for the inspection, assessment and reporting of Civil Engineering assets on the NTS
    - Cab doors should be kept closed at all times to minimise the breakout of noise and especially while the compressor unit is running.
    - All pipe work is buried as far as is practical, eliminating tonal components and this should be regularly checked to prevent future mechanical failure.
        - T/PM/COMP/32 – Specification for mechanical equipment on compressor installations – detailing requirements for buried pipework and above ground pipework
    - During maintenance lagging can be removed for numerous reasons such as access or inspection. Removal or lagging should be undertaken with great care so as to protect it for reinstatement after work as much as possible. The removal of cladding to inspect the condition of the underlying pipework is not required, unless there are critical points with evidence of damage. In such cases, the guidance in Appendix B of T/SP/CM/4 on the inspection and removal of defective cladding should be followed.
        - T/SP/CM/4 - The assessment and reporting of plant coatings, painting & cladding inspections for national transmission system assets
    - When there is a requirement to replace lagging then the assessment of the acoustic requirements of the lagging for the application must be made. Suitable lagging or alternate options must be identified and installed. This is to ensure that the noise levels from the installation do not increase from the original state, and where possible improvement in noise levels should be made.
    - The planning conditions for the installation states environmental noise limits - see Section 4.2. Any changes to the site's lagging shall be assessed for the impact on the compliance to the noise limits and guidance on replacement material and processes can be found in the following procedures.
        - T/PM/PWC/10 – Management of pipework cladding requirements
        - T/SP/PWC/11 – Specification for pipework acoustic cladding

- A maintenance regime should be followed for the station vent on site to prevent failure and to minimise the noise impact. Extensive pressure monitoring devices should be in place to initiate Emergency Shut Down (ESD). Controlled venting should take place during maintenance or where compressors will not be used for extended periods.
    - T/PM/MAINT/6 –Maintenance of Terminals and compressor stations operating on the NTS
- Vehicle movements on site should be restricted to ensure continued safe operation of the site. Any requirement to take vehicles into the main site processing areas should be subject to a strictly enforced speed limit of 10 mph.

3.3 Plant Modifications or Installation of New Plant

Likely noise emissions should be considered as part of the selection process when replacing plant items. In all cases, the principle of BAT shall be applied during the decision-making process to take account of cost effectiveness and other potential environmental impacts, along with the specific BAT guidelines for the combustion sector.

Noise from stationary plant can be actively controlled by the use of a range of noise abatement systems. To be effective, and thus provide the level of sound reduction necessary, these systems must be constructed of an adequate material providing good sound insulation characteristics. Tender documents should specify that any necessary enclosure should provide noise mitigation appropriate to what is required.

Advice should be obtained from the manufacturer of the plant equipment, in order to fully assess the level of ventilation, access and noise mitigation that will be required for any enclosure or noise abatement system.

Any modifications to existing plant and equipment or the installation of new plant and equipment shall be controlled by the following main procedures, to ensure that noise impacts are identified in design and mitigated.

- T/PM/G/35 - The Management of New Works, Modifications and Repairs
    - Control of modifications is essential to protect people, assets and the environment and in order to meet legislative requirements under core UK Legislation and it requires that all designs are evaluated for their compliance and impact.
- T/PM/ENV/20 - Management Procedure for the application of Formal Environmental Assessments (FEA) during engineering design and project delivery phases
    - FEAs allow all disciplines involved in a design process to review the environmental aspects of the scheme in a holistic manner, to ensure that design objectives are achieved, and appropriate mitigation measures are implemented (specifically applied to noise impacts). Each FEA addresses different aspects of the project. Applying a range of techniques at different project stages will help to ensure that potential environmental impacts are comprehensively identified, assessed and controlled, to ensure that risks to employees, the public and sensitive environmental receptors are minimised.

3.4 Best practice guidance for other site activities

In order to maintain the integrity of the noise control measures and achieve their necessary performance, it is extremely important that the upkeep and maintenance procedures detailed in Section 3.2 are followed. The following procedures should also be adopted throughout the site, for NGT or employed contractors, to ensure that those measures already in place continue to be effective in preventing and minimising the impact on sensitive receptors.

- Ensure a satisfactory standard of maintenance on items of plant and equipment, as noise can increase over time due to normal wear and tear.
  - Ensure that generator and vehicle/plant engine hatches are kept closed.
  - Switch off plant items when not in use, paying particular attention to idling vehicles.
  - Locate mobile plant away from sensitive receptors.
  - Ensure careful use and volume control of public address systems.
  - Where possible plan to complete maintenance or noisy operation activities during daytime hours (08:00 to 17:00) avoiding weekends and holiday periods
  - Notify sensitive receptors of abnormal noise events in advance, where possible.

4. Noise measurements

4.1 On-site noise audit

An on-site noise survey shall be undertaken at least every four years, in order to ensure that noise emissions from each item of site equipment do not gradually increase over time, and to identify potential maintenance issues.

Measurements shall be undertaken at a series of on-site noise measurement positions aimed at quantifying noise from each source listed in Table 1. These measurement positions shall be defined during the first on-site noise audit, and identical measurement positions shall be adopted for each subsequent noise audit thereafter.

Noise monitoring shall be undertaken by a competent party, either NGT or external contractor. As far as is practicable, the surveys should be undertaken during identical operating conditions, that are representative of the highest noise output of the site.

The results of the survey shall be compared to the historically measured values, in order to identify either of the following:

- Increases in noise levels for a particular source; (an increase in the overall $L_{Aeq,T}$ of 2dB or more, compared to historically measured values); or
- Increases/changes in tonality for a particular source (an increase of 3dB or more in any octave or third octave band, compared to historically measured values)

If any such increases are identified, then NGT shall investigate the cause and undertake corrective actions to reduce the noise level to its previous long term value. If the increase has the potential to increase noise levels at receptor locations, then noise measurements at the relevant receptor locations shall be undertaken (see section 4.2).

4.2 Noise measurements at receptor locations

A noise survey at locations representative the closest sensitive receptors to the site shall be undertaken:

- Following significant changes or additions to operational processes at the site.
- In response to specific, justifiable complaints received by NGT.
- If an on-site noise audit has identified an increase in noise level with the potential to increase noise levels at receptor locations.

4.2.1 Noise sensitive receptor locations

Table 4 identifies the closest sensitive receptors to the site.

Table 4 Details of noise sensitive receptors

Reference	Name of receptor
AL1	Thorney Lodge
AL2	Meadow Farm/Strawberry Cottage
AL3	Walkers Farm
AL4	Welgrove House/Budec

4.3 Noise measurement Instrumentation

Noise levels should be measured using an integrating-averaging sound level meter (SLM) or equivalent system conforming to Class 1 as defined by BS EN 61672:Part1:2003 (Electroacoustics, Sound Level Meters, Specifications).

The SLM should be field calibrated before and at the end of each survey by applying an acoustic calibrator conforming to the latest versions of BS EN 60942:2003 (Electroacoustics - Sound Calibrators) to the microphone to check the sensitivity of the measuring equipment. Any drift in calibration levels should be noted.

The equipment used for the noise monitoring should also have undergone more extensive independent laboratory tests of the performance of the system within a period of 2 years prior to use.

5. Logs and records

All monitoring data and logs shall be kept for a minimum of six years and made available on site for inspection

5.1 Maintenance logs

A programme of routine maintenance is carried out on all identified activities to minimise the impact from noise emissions as detailed in Section 3. Regular inspections should be undertaken to highlight any non-compliance when excessive noise is generated from any activity.

The maintenance details shall be logged in the Planned Preventative Maintenance System – Ellipse

These records shall be reviewed and audited as part of standard business assurance systems

5.2 Complaints

All complaints received by NGT shall be logged in the NGT Complaints Database and investigated to establish whether the complaint is justifiable and to determine all corrective and preventative actions required to reduce the impact to a satisfactory.

Guidance for the management of complaints is detailed in the following documents -

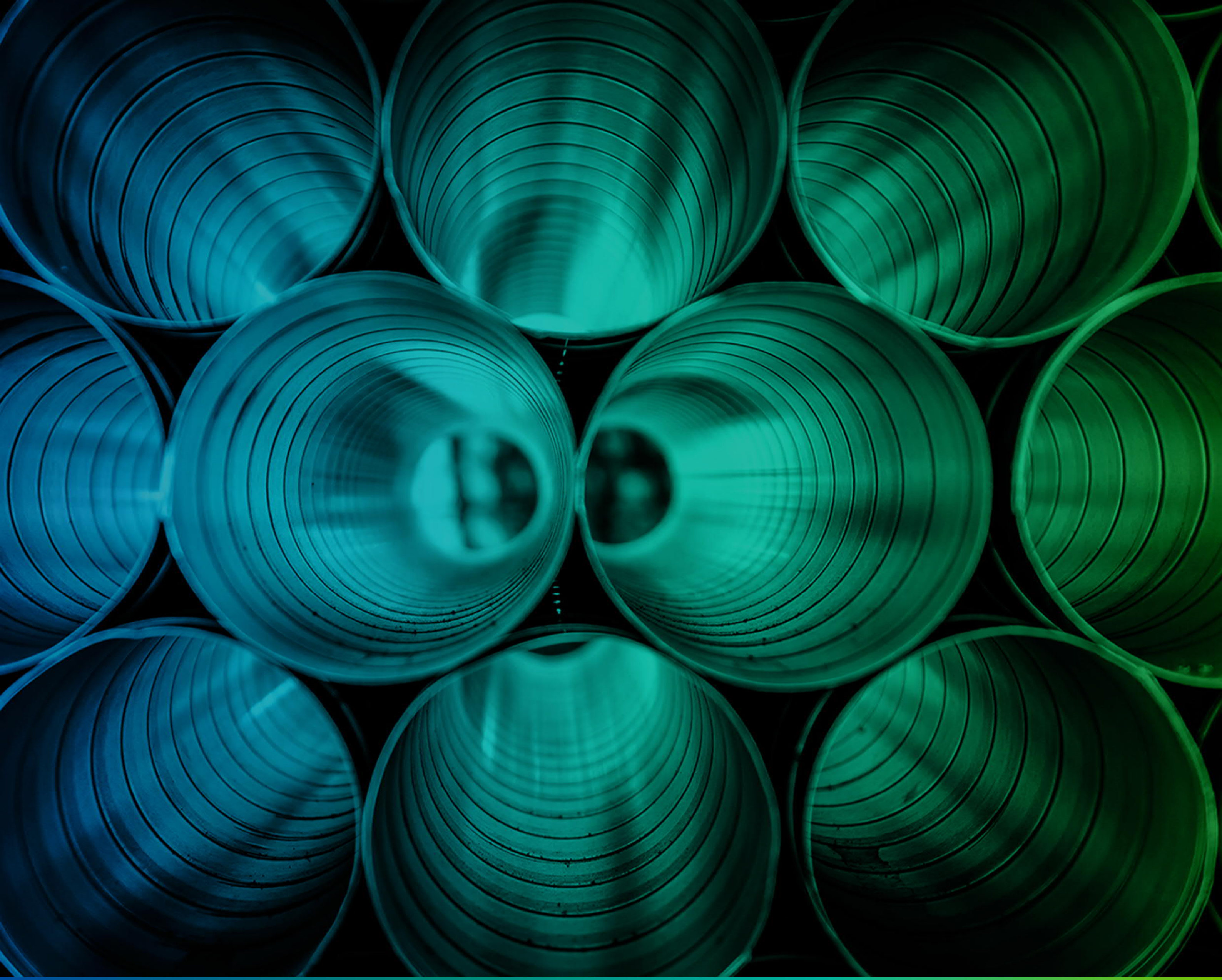
- EMS - Statutory nuisance supporting document
- NGT complaints procedure

In the event a complaint is received from local residents the following information should be obtained where possible.

1) Log the time and date of the complaint along with the name and address of complainant.
2) Record the details of the perceived noise event if not already completed by the complainant.
3) Contact NGT Environmental Engineering and pass on the complaint details.

NGT Environmental Engineering will manage the complaint recording, investigation and agree with Operations site staff any actions and further communication with the complainant.

Appendix 4: Noise management plan



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> *(b) a noise reduction programme*
> *(c) a protocol for response to noise incidents containing appropriate actions and timelines*
> *(d) a review of historic noise incidents, corrective actions and dissemination of noise incident knowledge to the affected parties*

A noise nuisance is neither expected, or currently sustained at Hatton Compressor Station; additionally the current conditions of the existing Environmental Permit do not require the implementation of a noise management plan.

However, NGT recognises that the operations at Hatton Compressor Station have the potential to produce noise that can have adverse impacts at receptors in the immediate area. and considers that the implementation of a management plan minimises the risk of any such impact arising.

2. Noise sources

2.1 Noise sources

Key noise sources are defined as those that contribute to the potential for environmental nuisance. The fixed noise sources that give rise to are identified in Table 1.

Table 1 Fixed noise sources

Source
Compressor drive train noise through cab enclosure
Compressor turbine exhaust stack outlets
Compressor turbine air intake systems
Compressor cab ventilation systems
Compressor suction and discharge pipework, valves, scrubbers
Fuel Gas Units
Lube Oil Coolers
Transformers
Instrument Air
Emergency standby generators
Depressurisation valves and vents

Other sources identified as insignificant shall be screened out from further consideration due to their low contribution to site noise. These insignificant sources shall be listed in Table 2.

Table 2 Insignificant sources

Name of insignificant source	Justification
Vehicle	Low number of staff and contractor vehicles arriving to and departing from the site
Office building ventilation	Low noise level from small fan systems
Maintenance activities	Low level and generally infrequent

3. Noise management

3.1 Site noise sources and management measures

The above identified noise sources have been risk assessed to identify the level of possible impact, firstly with no mitigation or controls, “Inherent impact” and then applying the identified mitigation and control measures, “residual impact”. This risk assessment is detailed in Table 3.

Table 3 Risk assessment of noise sources

Asset	Aspect	Condition			Inherent Risk Assessment			Noise control included in site design	Site management measures	Residual Risk Assessment		
		Normal Ops	Exceptional events	Emergency Ops	L	S	Impact			L	S	Impact
Gas Turbine Compressor	Drive train noise	✓			5	5	25	High performance air intake/exhaust silencers, engineered close-fitting noise enclosure around the gas compressor unit, bespoke secondary full cabinet enclosure.	Maintenance and inspections to ensure integrity of close-fitting compressor enclosure and cab walls/roof. Periodic site noise measurements to include positions aimed at quantifying noise from cab walls.	1	5	5
Gas Turbine Compressor	Turbine exhaust stack	✓			5	5	25	High performance exhaust silencer included in stack design	Maintenance and inspections to ensure integrity of stack silencer. Periodic site noise measurements to include positions aimed at quantifying noise from exhaust stack (as far as is practical).	2	5	10

Asset	Aspect	Condition			Inherent Risk Assessment			Noise control included in site design	Site management measures	Residual Risk Assessment		
		Normal Ops	Exceptional events	Emergency Ops	L	S	Impact			L	S	Impact
Gas Turbine Compressor	Air intake systems	✓			4	5	20	Acoustic attenuator included in air intake system	Maintenance and inspections to ensure integrity of intake silencer. Periodic site noise measurements to include positions aimed at quantifying noise from air intake aperture. Any increases above historic levels to be investigated.	2	5	10
Gas Turbine Compressor	Cab ventilation systems	✓			3	4	12	Acoustic splitter attenuators in ventilation system design	Maintenance and inspections to ensure integrity of acoustic attenuation in ventilation systems. Periodic site noise measurements to include positions aimed at quantifying noise from ventilation system. Any increases above historic levels to be investigated.	1	4	4
Suction and discharge pipework, valves, scrubbers	Noise via suction and discharge pipework, valves, scrubbers	✓			4	5	20	Acoustic lagging systems	Maintenance and inspections to ensure integrity of lagging systems. Periodic site noise measurements to include positions aimed at quantifying noise from ductwork. Any increases above historic levels to be investigated.	2	5	10

Asset	Aspect	Condition			Inherent Risk Assessment			Noise control included in site design	Site management measures	Residual Risk Assessment		
		Normal Ops	Exceptional events	Emergency Ops	L	S	Impact			L	S	Impact
Fuel Gas Units	Direct noise to atmosphere	✓			3	3	9	Low noise units	Maintenance and inspections to ensure integrity of units. Periodic site noise measurements to include positions aimed at quantifying noise from fuel gas units. Any increases above historic levels to be investigated.	2	3	6
Lube Oil Coolers	Direct noise to atmosphere	✓			3	3	9	Low noise cooling fans	Maintenance and inspections to ensure integrity of units. Periodic site noise measurements to include positions aimed at quantifying noise lube oil coolers. Any increases above historic levels to be investigated.	2	3	6
Instrument air buildings	Direct noise to atmosphere	✓			2	2	4	GRP kiosk around equipment	Maintenance and inspections to ensure integrity of kiosk. Periodic site noise measurements to include positions aimed at quantifying noise from kiosk. Any increases above historic levels to be investigated.	1	2	2

Asset	Aspect	Condition			Inherent Risk Assessment			Noise control included in site design	Site management measures	Residual Risk Assessment		
		Normal Ops	Exceptional events	Emergency Ops	L	S	Impact			L	S	Impact
Transformers	Direct noise to atmosphere	✓			2	3	6	Low noise cooling fans	Maintenance and inspections to ensure integrity of transformers. Periodic site noise measurements to include positions aimed at quantifying noise from transformers. Any increases above historic levels to be investigated.	1	3	3
Site	Noise from venting of systems	✓		✓	3	4	12	-	Planned gas venting only to be undertaken during daytime, work hours.	1	4	4
Standby Generator	Generator drive train noise	✓	✓		4	5	20	Low noise enclosure surrounding standby generator. Exhaust silencer.	Maintenance and inspections to ensure integrity of transformers. Periodic site noise measurements to include positions aimed at quantifying noise from transformers. Any increases above historic levels to be investigated.	1	5	5

3.2 Routine maintenance

The following best practice and preventative maintenance procedures have been adopted at the site, employing good practice measures to control noise emissions to the environment. This is an effective way of managing the noise, as substantial noise control measures will have already been incorporated into the plant design. The list is not exhaustive and general routine maintenance should be carried out on all items of plant to ensure a satisfactory standard of noise control is achieved.

- As the compressor cabs are acoustically enclosed, the integrity of the fabric of the cabs should be subject to frequent visual inspection, both informally and as part of housekeeping audits –
    - Formal inspections covered in
        - T/PM/MAINT/6 –Maintenance of Terminals and compressor stations operating on the NTS - inspection frequency
        - T/PR/MAINT/6050 – Work procedure for civil engineering assets - inspection requirements
        - T/SP/CE/15 - Specification for the inspection, assessment and reporting of Civil Engineering assets on the NTS
    - Cab doors should be kept closed at all times to minimise the breakout of noise and especially while the compressor unit is running.
    - All pipe work is buried as far as is practical, eliminating tonal components and this should be regularly checked to prevent future mechanical failure.
        - T/PM/COMP/32 – Specification for mechanical equipment on compressor installations – detailing requirements for buried pipework and above ground pipework
    - During maintenance lagging can be removed for numerous reasons such as access or inspection. Removal or lagging should be undertaken with great care so as to protect it for reinstatement after work as much as possible. The removal of cladding to inspect the condition of the underlying pipework is not required, unless there are critical points with evidence of damage. In such cases, the guidance in Appendix B of T/SP/CM/4 on the inspection and removal of defective cladding should be followed.
        - T/SP/CM/4 - The assessment and reporting of plant coatings, painting & cladding inspections for national transmission system assets
    - When there is a requirement to replace lagging then the assessment of the acoustic requirements of the lagging for the application must be made. Suitable lagging or alternate options must be identified and installed. This is to ensure that the noise levels from the installation do not increase from the original state, and where possible improvement in noise levels should be made.
    - The planning conditions for the installation states environmental noise limits - see Section 4.2. Any changes to the site's lagging shall be assessed for the impact on the compliance to the noise limits and guidance on replacement material and processes can be found in the following procedures.
        - T/PM/PWC/10 – Management of pipework cladding requirements
        - T/SP/PWC/11 – Specification for pipework acoustic cladding

- A maintenance regime should be followed for the station vent on site to prevent failure and to minimise the noise impact. Extensive pressure monitoring devices should be in place to initiate Emergency Shut Down (ESD). Controlled venting should take place during maintenance or where compressors will not be used for extended periods.
  - T/PM/MAINT/6 –Maintenance of Terminals and compressor stations operating on the NTS
- Vehicle movements on site should be restricted to ensure continued safe operation of the site. Any requirement to take vehicles into the main site processing areas should be subject to a strictly enforced speed limit of 10 mph.

3.3 Plant Modifications or Installation of New Plant

Likely noise emissions should be considered as part of the selection process when replacing plant items. In all cases, the principle of BAT shall be applied during the decision-making process to take account of cost effectiveness and other potential environmental impacts, along with the specific BAT guidelines for the combustion sector.

Noise from stationary plant can be actively controlled by the use of a range of noise abatement systems. To be effective, and thus provide the level of sound reduction necessary, these systems must be constructed of an adequate material providing good sound insulation characteristics. Tender documents should specify that any necessary enclosure should provide noise mitigation appropriate to what is required.

Advice should be obtained from the manufacturer of the plant equipment, in order to fully assess the level of ventilation, access and noise mitigation that will be required for any enclosure or noise abatement system.

Any modifications to existing plant and equipment or the installation of new plant and equipment shall be controlled by the following main procedures, to ensure that noise impacts are identified in design and mitigated.

- T/PM/G/35 - The Management of New Works, Modifications and Repairs
  - Control of modifications is essential to protect people, assets and the environment and in order to meet legislative requirements under core UK Legislation and it requires that all designs are evaluated for their compliance and impact.
- T/PM/ENV/20 - Management Procedure for the application of Formal Environmental Assessments (FEA) during engineering design and project delivery phases
  - FEAs allow all disciplines involved in a design process to review the environmental aspects of the scheme in a holistic manner, to ensure that design objectives are achieved, and appropriate mitigation measures are implemented (specifically applied to noise impacts). Each FEA addresses different aspects of the project. Applying a range of techniques at different project stages will help to ensure that potential environmental impacts are comprehensively identified, assessed and controlled, to ensure that risks to employees, the public and sensitive environmental receptors are minimised.

3.4 Best practice guidance for other site activities

In order to maintain the integrity of the noise control measures and achieve their necessary performance, it is extremely important that the upkeep and maintenance procedures detailed in Section 3.2 are followed. The following procedures should also be adopted throughout the site, for NGT or employed contractors, to ensure that those measures already in place continue to be effective in preventing and minimising the impact on sensitive receptors.

- Ensure a satisfactory standard of maintenance on items of plant and equipment, as noise can increase over time due to normal wear and tear.
  - Ensure that generator and vehicle/plant engine hatches are kept closed.
  - Switch off plant items when not in use, paying particular attention to idling vehicles.
  - Locate mobile plant away from sensitive receptors.
  - Ensure careful use and volume control of public address systems.
  - Where possible plan to complete maintenance or noisy operation activities during daytime hours (08:00 to 17:00) avoiding weekends and holiday periods
  - Notify sensitive receptors of abnormal noise events in advance, where possible.

4. Noise measurements

4.1 On-site noise audit

An on-site noise survey shall be undertaken at least every four years, in order to ensure that noise emissions from each item of site equipment do not gradually increase over time, and to identify potential maintenance issues.

Measurements shall be undertaken at a series of on-site noise measurement positions aimed at quantifying noise from each source listed in Table 1. These measurement positions shall be defined during the first on-site noise audit, and identical measurement positions shall be adopted for each subsequent noise audit thereafter.

Noise monitoring shall be undertaken by a competent party, either NGT or external contractor. As far as is practicable, the surveys should be undertaken during identical operating conditions, that are representative of the highest noise output of the site.

The results of the survey shall be compared to the historically measured values, in order to identify either of the following:

- Increases in noise levels for a particular source; (an increase in the overall $L_{Aeq,T}$ of 2dB or more, compared to historically measured values); or
- Increases/changes in tonality for a particular source (an increase of 3dB or more in any octave or third octave band, compared to historically measured values)

If any such increases are identified, then NGT shall investigate the cause and undertake corrective actions to reduce the noise level to its previous long term value. If the increase has the potential to increase noise levels at receptor locations, then noise measurements at the relevant receptor locations shall be undertaken (see section 4.2).

4.2 Noise measurements at receptor locations

A noise survey at locations representative the closest sensitive receptors to the site shall be undertaken:

- Following significant changes or additions to operational processes at the site.
- In response to specific, justifiable complaints received by NGT.
- If an on-site noise audit has identified an increase in noise level with the potential to increase noise levels at receptor locations.

4.2.1 Noise sensitive receptor locations

Table 4 identifies the closest sensitive receptors to the site.

Table 4 Details of noise sensitive receptors

Reference	Name of receptor
AL1	Thorney Lodge
AL2	Meadow Farm/Strawberry Cottage
AL3	Walkers Farm
AL4	Welgrove House/Budec

4.3 Noise measurement Instrumentation

Noise levels should be measured using an integrating-averaging sound level meter (SLM) or equivalent system conforming to Class 1 as defined by BS EN 61672:Part1:2003 (Electroacoustics, Sound Level Meters, Specifications).

The SLM should be field calibrated before and at the end of each survey by applying an acoustic calibrator conforming to the latest versions of BS EN 60942:2003 (Electroacoustics - Sound Calibrators) to the microphone to check the sensitivity of the measuring equipment. Any drift in calibration levels should be noted.

The equipment used for the noise monitoring should also have undergone more extensive independent laboratory tests of the performance of the system within a period of 2 years prior to use.

5. Logs and records

All monitoring data and logs shall be kept for a minimum of six years and made available on site for inspection

5.1 Maintenance logs

A programme of routine maintenance is carried out on all identified activities to minimise the impact from noise emissions as detailed in Section 3. Regular inspections should be undertaken to highlight any non-compliance when excessive noise is generated from any activity.

The maintenance details shall be logged in the Planned Preventative Maintenance System – Ellipse

These records shall be reviewed and audited as part of standard business assurance systems

5.2 Complaints

All complaints received by NGT shall be logged in the NGT Complaints Database and investigated to establish whether the complaint is justifiable and to determine all corrective and preventative actions required to reduce the impact to a satisfactory.

Guidance for the management of complaints is detailed in the following documents -

- EMS - Statutory nuisance supporting document
- NGT complaints procedure

In the event a complaint is received from local residents the following information should be obtained where possible.

1) Log the time and date of the complaint along with the name and address of complainant.
2) Record the details of the perceived noise event if not already completed by the complainant.
3) Contact NGT Environmental Engineering and pass on the complaint details.

NGT Environmental Engineering will manage the complaint recording, investigation and agree with Operations site staff any actions and further communication with the complainant.

Appendix 5: Air quality impact assessment

Air Quality Impact Assessment

Document no: NGHGC-AQIA
Revision no: Rev 2

National Gas Transmission

Hatton Gas Compressor Station Upgrade
5 May 2023

Air Quality Impact Assessment

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Project name:	Hatton Gas Compressor Station Upgrade		
Document no:	NGHGC-AQIA	**Project no:**	B2600015
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Contents

Appendices

1. Introduction

1.1 Background

National Gas Transmission PLC (National Gas Transmission) is responsible for the safe and efficient delivery of natural gas from the coastal reception terminals to the point of use. It operates twenty-four compressor stations as part of the National Transmission System (NTS). This is a network of high pressure, buried pipelines over 7,600 kilometres in length that enables natural gas from terminals and entry points to be transported to customers (which include the gas Distribution Network Operators) across the country. Within this system, compressor stations are used to compress the gas being transported to maintain flow and safe system operating pressures.

Hatton Compressor Station (hereafter referred to as 'the station') is in the east of the UK and has a pivotal role in the operation of the NTS. With nine connecting pipelines, Hatton is used to facilitate gas flows from terminals to the north, to support the operation of storage sites in the north west, to provide demand support in the south east and to support the interconnector flows between the UK and continental Europe at Bacton.

The station is a regulated installation, which currently operates under conditions set out in an Environmental Permit (permit number: EPR/UP3333LL) granted by the Environment Agency under the Environmental Permitting (England & Wales) Regulations 2016 (as amended) (hereafter referred to as 'the EPR').

The operation of gas fired compressor units results in the emission of air pollutants, such as oxides of nitrogen (NOx) and carbon monoxide (CO). National Gas Transmission is obliged under law to control and manage the release of these air pollutants, via operation under an EPR permit, which in the case of Hatton implements emission limits set for large combustion plant in the Industrial Emissions Directive (IED).

In response to these obligations, and following a detailed analysis of all options available at Hatton compressor station and interacting stations, Ofgem has approved the need for a single new, low emission gas turbine (jet engine) driven natural gas compressor unit at the station to replace two older legacy compressor units at the site (the third existing legacy unit being retained for standby purposes under the Emergency Use Derogation, allowed under the IED).

Jacobs has been commissioned by National Gas Transmission to undertake an air quality impact assessment (AQIA) of the new compressor and related infrastructure in support of the application to the Environment Agency to vary EPR permit EPR/UP3333LL. The main design parameters relating to the installation of one new gas turbine driven compressor have been confirmed. The gas turbine (a Siemens SGT-750) and associated compressor unit and equipment will be located within the existing site boundary, with ancillary plant and infrastructure on land adjacent to the three existing gas turbine driven compressors to the east and the Above Ground Installation (AGI) to the west. There is a further existing gas compressor unit to the eastern end of the existing compressor station, this is driven by an electrical variable speed drive and has no direct emissions of the products of combustion and thus no direct impact on local air quality.

1.2 Study Outline

This AQIA is required to support the EPR permit variation application and assesses the likely significant air quality effects of emissions to air from the new gas turbine and retained existing legacy unit (a RB211 gas turbine) at the site. The air quality assessment has been carried out following the relevant Environment Agency guidance (Environment Agency, 2021; 2022). The AQIA considers:

- the potential impact on human health due to emissions of pollutants resulting from the combustion of natural gas by the gas turbines. The pollutants considered include nitrogen dioxide (NO_2) and CO; and
- the potential impact on vegetation and ecosystems due to emissions of NOx.

The following two scenarios have been considered in the AQIA.

- Existing, worst case. This is based on operation of two out of the three existing RB211 units (emission points A1 and A2) currently permitted at the station during peak site operations and represents the worst case air quality impacts at air quality receptors. This scenario provides a comparative case against which the emissions from future operations, including the proposed new plant, can be considered. The two

existing RB211 units were assumed to operate continuously for the full year (i.e. 8,760 hours). This represents a significant overestimate of total running hours.
- Future, worst case. This represents a future scenario, with both the SGT-750 gas turbine (emission point A46) and one remaining RB211 unit (Unit A – emission point A1) operating at the maximum anticipated load simultaneously. This is a 'worst case' scenario which would not occur in practice as the respective maximum loads for each unit occur for different gas compression scenarios. Whilst there could be occasions where very high gas flows require a maximum of two units to be run in parallel, there are no 'real world' gas demand conditions that would occur at the site that would require the use of both the existing RB211 Unit A and proposed new SGT 750 gas turbine unit at full (i.e. 100% load). The new SGT-750 gas turbine was modelled for continuous operation for the full year (i.e. 8,760 hours), which is considerably higher than the actual anticipated operating hours (see Appendix B), and the RB211 was modelled at 500 hours per annum, its legal maximum operating allowance. This case therefore represents an abundance of caution on behalf of National Gas Transmission for assessment purposes only. For this scenario, the SGT-750 gas turbine was modelled with a stack height of 25m. Further information on the effect of stack height on the predicted concentrations is provided in Section 5.3.

The site boundary (represented by the approximate land ownership boundary) is presented in Figure 1.

This report draws upon information provided from the following parties:

- National Gas Transmission;
- Siemens;
- ADM Ltd;
- Centre for Ecology and Hydrology (CEH);
- Department for Environment, Food and Rural Affairs (Defra); and
- East Lindsey District Council (ELDC).

This report includes a description of the emission sources, description of methodology and significance criteria, a review of the baseline conditions including an exploration of the existing environment of the site and surrounding area, an evaluation of results and the potential impact of emissions on human health and protected conservation areas during operation and, finally, conclusions of the assessment.

2. Emission Sources

2.1 Emission Sources to Air

The location of the assessed new gas turbine (emission point reference A46) and existing gas turbines (emission point references A1 and A2) are presented in Figure 1.

Table 2-1 presents the emissions sources to air considered in this assessment.

Table 2-1: Combustion plant considered in this assessment

Parameter	Siemens SGT-750 gas turbine	RB211 Gas Turbine (Unit A)	RB211 Gas Turbine (Unit B)
Status	New	Existing, to be retained	Existing, to be decommissioned
Fuel	Natural gas	Natural gas	Natural gas
Thermal input (MW_{th})	101.5[1]	70.6	70.6
Emission point reference	A46	A1	A2

[1] At 0°C.

2.2 Emissions Data

2.2.1 Emission concentration of pollutants

For the new Siemens SGT-750 gas turbine, the NOx and CO emission concentrations were modelled at 40 mg/Nm^3 (at reference conditions 273 K, 101.3 kPa, dry gas and oxygen content of 15%).

For the existing RB211 units, the NOx and CO emission concentrations were modelled at 239 mg/Nm^3 and 139 mg/Nm^3, respectively (at reference conditions 273 K, 101.3 kPa, dry gas and oxygen content of 15%). These emission concentrations were based on those used for a previous AQIA undertaken by ADM Ltd on behalf of Atkins Environment (ADM Ltd, 2005)

2.2.2 Other emission parameters

Information on the location and stack dimensions were supplied by National Gas Transmission (National Gas Transmission, 2021). Information on the SGT-750 gas turbine emission characteristics were obtained from Siemens (Siemens, 2021).

The emissions inventory of releases to air from the new and existing gas turbines is provided in Appendix A.

3. Assessment Methodology

3.1 Assessment Location

For this assessment, 32 of the closest sensitive human receptors (such as residential properties and public footpaths) near the site were identified for modelling purposes. The locations of these receptors are presented in Figure 2.

In line with the Environment Agency guidance *Air emissions risk assessment for your environmental permit* (Environment Agency, 2022), for some larger emitters (greater than 50 MW$_{th}$) and natural gas fired combustion plants greater than 500 MW$_{th}$, it is necessary to identify sites designated for their ecological value (ecological receptors) within the following distances from the site:

- European sites (i.e. Special Area of Conservation (SAC), Special Protection Area (SPA) and Ramsar sites) and Site of Special Scientific Interest (SSSI) up to 15 km; and
- Local nature sites (i.e. ancient woodlands, local wildlife sites (LWS) and national and local nature reserves (NNR and LNR, respectively), up to 2 km.

Although the total thermal input for the installation is less than the threshold of 500 MW$_{th}$, a precautionary approach was taken on the selection of screening distances, with the largest distances adopted for the AQIA.

Based on the above criteria, there are no European sites included in the assessment. There are 17 SSSIs within 15 km and 10 local nature sites within 2 km of the site [redacted]. The locations of the assessed ecological receptors are presented in Figure 3 and further details are set out in Appendix A.

3.2 Overall Methodology

The assessment was carried out using an atmospheric dispersion modelling technique. Atmospheric Dispersion Modelling System (ADMS) version 5.2.4 was used to model releases of the identified substances. The ADMS model predicts the dispersion of operational emissions from a specific source (e.g. a stack), and the subsequent concentrations over an identified area (e.g. at ground level across a grid of receptor points) or at specified points (e.g. a residential property). ADMS was selected because this model is fit for the purpose of modelling the emissions from the type of sources on-site (i.e. point source emissions from a combustion source) and is accepted as a suitable assessment tool by the Environment Agency.

The modelling assessment was undertaken in accordance with the Environment Agency Air emissions risk assessment for your environmental permit guidance (Environment Agency, 2022).

A summary of the dispersion modelling procedure is set out below.

1. Information on plant location and stack parameters were supplied by National Gas Transmission (National Gas Transmission, 2021). Information on the gas turbine emission characteristics were obtained from Siemens (Siemens, 2021).
2. Five years of hourly sequential data recorded at the Waddington meteorological station (2016 – 2020 inclusive) were used for the assessment (ADM Ltd, 2021).
3. Information on the existing buildings located on-site that could influence dispersion of emissions from the gas turbine(s) were obtained from the previous assessment (ADM Ltd, 2005) or estimated from Defra's environmental open-data applications and datasets (Defra, 2021) and Grid Reference Finder (UK Grid Reference Finder, 2021). Information on the proposed SGT-750 gas compressor building was provided by National Gas Transmission (National Gas Transmission, 2021).
4. The maximum predicted concentrations (at a modelled height of 1.5 m or 'breathing zone') at the assessed sensitive human receptor locations R1 – R23 (representing long-term exposure at residential properties) were considered for the assessment of annual mean, 8-hour mean, 1-hour mean and pollutant concentrations within the study area. For receptors R24-R32 (representing a public right of way (PRoW) and minor roads along which people could walk) only the 1-hour mean concentrations were considered. The maximum predicted concentrations at an off-site location in the vicinity of the site were considered for the assessment of short-term (1-hour mean) concentrations, although these would not necessarily be representative of human exposure locations.
5. The above information was entered into the dispersion model.
6. The dispersion model was run to provide the Process Contribution (PC). The PC is the estimated maximum environmental concentration of substances due to releases from the process alone. The results were then combined with baseline concentrations to provide the Predicted Environmental Concentration (PEC) of the substances of interest.
7. The PECs were then assessed against the appropriate environmental standards for air emissions for each substance set out in Environment Agency guidance (Environment Agency, 2022) to determine the nature and extent of any potential adverse effects.
8. Modelled concentrations were processed using geographic information system (GIS) software (ArcMap 10.8.1) to produce contour plots of the model results. These are provided for illustrative purposes only; assessment of the model results was based on the numerical values outputted by the dispersion model on the model grid (see Figure 2) and at the specific receptor locations and were processed using Microsoft Excel.
9. The predicted concentrations of NOx were also used to assess the potential impact on critical levels and critical loads (i.e. nutrient nitrogen and acid deposition) at the assessed ecological receptors. Details of the deposition calculation methodology are provided in Appendix B.

A review of existing ambient air quality in the area was undertaken to understand the baseline conditions at the site and at receptors within the study area. These existing conditions were determined by reviewing the monitoring data already available for the area and other relevant sources of information. The review of baseline air quality is set out in Section 4.

Where appropriate, a conservative approach has been adopted throughout the assessment to increase the robustness of the model predictions. These are discussed in Appendix A.

3.3 Assessment Criteria

3.3.1 Environmental Quality Standards: Human Receptors

In the UK, the focus on local air quality is reflected in the air quality objectives (AQOs) set out in the Air Quality Strategy for England, Scotland, Wales and Northern Ireland (AQS) (Defra and the Devolved Administrations, 2007). The AQS stipulates a number of air quality objectives for nine main air pollutants with respect to ambient levels of air quality. The AQOs are similar to the limit values that were transposed from the relevant EU directives into UK legislation by *The Air Quality Standards Regulations 2010*. The objectives are based on the current understanding of health effects of exposure to air pollutants and have been specified to control health and environmental risks to an acceptable level. They apply to places where people are regularly present over the relevant averaging period. The objectives set for the protection of human health and vegetation of relevance to the project are summarised in Table 3-1. Relevant Environmental Assessment Levels (EALs) set out in the Environment Agency guidance (Environment Agency, 2022) are also included in Table 3-1 where these supplement the AQOs.

For the purposes of reporting, the AQOs and EALs have been collectively termed as Environmental Quality Standards (EQSs).

Table 3-1: Air quality objectives and environmental assessment levels

Pollutant	EQS (µg/m^3)	Concentration measured as
NO_2	40	Annual mean
	200	1-hour mean, not to be exceeded more than 18 times a year (99.79th percentile)
CO	10,000	Maximum daily 8 hour running mean (100th percentile)
	30,000	Maximum 1-hour mean (100th percentile)

For the assessment of long-term average concentrations (i.e. the annual mean concentrations) at human receptors, impacts were described using the following criteria:

- if the PC is less than 1% of the long-term EQS, the contribution can be considered as 'insignificant' and not representative of a significant effect (i.e. not significant) (Environment Agency, 2021, 2022);
- if the PC is greater than 1% of the EQS but the PEC is less than 70% of the long-term air quality objective, based on professional judgement, this would be classed as 'not significant'; and
- where the PC is greater than 1% of the EQS and the PEC is greater than 70% of the EQS, professional judgement is used to determine the overall significance of the effect (i.e. whether the effect would be 'not significant' or 'significant'), taking account of the following:
  - the scale of the changes in concentrations;
  - whether or not an exceedance of an EQS is predicted to arise in the study area where none existed before, or an exceedance area is substantially increased as a result of the development; and
  - uncertainty, including the influence and validity of any assumptions adopted in undertaking the assessment.

For the assessment of short-term average concentrations (i.e. the 1-hour mean NO_2 and CO concentrations and 8-hour CO concentrations), impacts were described using the following criteria:

- if the PC is less than 10% of the short-term EQS, this would be classed as 'insignificant' and not representative of a significant effect (i.e. not significant) (Environment Agency, 2021, 2022);
- if the PC is greater than 10% of the EQS but less than 20% of the headroom between the short-term background concentration and the EQS, based on professional judgement, this can also be described as not significant; and
- where the PC is greater than 10% of the EQS and 20% of the headroom, professional judgement is used to determine the overall significance of the effect (i.e. whether the effect would be not significant or significant) in line with the approach specified above for long-term average concentrations.

Environment Agency guidance recommends that further action will not be required if proposed emissions comply with Best Available Techniques Associated Emission Levels (BAT AELs) and resulting PECs do not exceed the relevant EQS (Environment Agency, 2022).

3.3.2 Environmental Quality Standards: Protected Conservation Areas

3.3.2.1 Critical levels

The environmental standards set for protected conservation areas of relevance to the project are summarised in Table 3-2 (Environment Agency, 2022).

Table 3-2: Air Quality Objectives and Environmental Assessment Levels for protected conservation areas

Pollutant	EQS (µg/m^3)	Concentration measured as
NOx	30	Annual mean limit value for the protection of vegetation (referred to as the "critical level")
	75	Maximum 24-hour mean for the protection of vegetation (referred to as the "critical level")

3.3.2.2 Critical loads

Critical loads for pollutant deposition to statutorily designated habitat sites in the UK and for various habitat types have been published by the CEH and are available from the Air Pollution Information System (APIS) website. Critical Loads are defined on the APIS website (Centre for Ecology and Hydrology, 2022) as:

"a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge".

Compliance with these benchmarks is likely to result in no significant adverse effects on the natural environment at these locations.

For the SSSIs, the Site Relevant Critical Loads tool function on the APIS website was used to determine the relevant critical load for the assessed protected conservation area. For local sites, the Search by Location tool function was used, these critical loads are representative of the deposition value for tall and short vegetation (i.e. depending on the vegetation types present at each of the designated sites as identified by Greater Lincolnshire Nature Partners).

The critical loads for the designated habitat sites considered in this assessment are set out in Table 3-3.

Table 3-3: Critical loads for modelled protected conservation areas

Rec ref	Protected conservation area	Habitat feature applied	Vegetation type (for deposition velocity)	Critical load			
				Acid deposition (kEqH$^+$/ha/year)			Nitrogen deposition (kg N/ha/year)
				CLMaxS	CLMinN	CLMaxN	Minimum
H1	Hainton Sheepwalk SSSI	Acid grassland	Short	1.600	0.438	2.038	8
H2	Withcall and South Willingham Tunnels SSSI	No critical loads available					
H3	Benniworth Haven Cuttings SSSI	No critical loads available					
H4	Red Hill SSSI	Calcareous grassland	Short	4.000	0.856	4.856	15
H5	Silverines Meadows SSSI	Fen, marsh and swamp	Short	0.830	0.223	1.053	8
H6	Sotby Meadows SSSI	Neutral grassland	Short	4.000	1.071	5.071	20
H7	High Barn, Oxcombe SSSI	Calcareous grassland	Short	4.000	0.856	4.856	15

Rec ref	Protected conservation area	Habitat feature applied	Vegetation type (for deposition velocity)	Critical load			
				Acid deposition ($kEqH^+/ha/year$)			Nitrogen deposition (kg N/ha/year)
				CLMaxS	CLMinN	CLMaxN	Minimum
H8	Woodhall Spa Golf Course SSSI	Dwarf shrub heath	Short	0.820	0.714	1.534	10
H9	Moor Farm SSSI	Bogs	Short	0.145	0.321	0.466	5
H10	Kirkby Moor SSSI	Dwarf shrub heath	Short	0.420	0.714	1.134	10
H11	Bardney Limewoods, Lincolnshire SSSI & Bardney Limewoods NNR	Broad-leaved, mixed and yew woodland	Tall	8.245	0.357	8.602	10
H12	Potterhanworth wood SSSI	Broad-leaved, mixed and yew woodland	Tall	2.224	0.357	2.581	15
H13	Little Scrubbs Meadow SSSI	Neutral grassland	Short	4.000	1.071	5.071	20
H14	Gosling's Corner SSSI and Gosling's Corner AW (ID 1115503)	Broad-leaved, mixed and yew woodland	Tall	2.263	0.357	2.620	15
H15	Wickenby Wood SSSI	Broad-leaved, mixed and yew woodland	Tall	2.291	0.357	2.648	15
H16	Linwood Warren SSSI	Broad-leaved, mixed and yew woodland	Tall	0.704	0.285	0.989	10
H17	Hatton Wood Ancient and Semi Natural Woodland (ID 1115511)	Broad-leaved/Coniferous unmanaged woodland	Short	8.245	0.357	8.602	10
H18	Hatton Wood Ancient Replanted Woodland (ID 1115511)	Broad-leaved/Coniferous unmanaged woodland	Short	8.216	0.357	8.573	10
H19	Sotby Wood LWS	Calcareous grassland	Short	4.000	1.071	5.071	10
		Broad-leaved/Coniferous unmanaged woodland	Tall	8.258	0.357	8.615	5
H20	Hatton Meadows LWS	Calcareous grassland	Short	4.000	1.071	5.071	10
H21	Chambers Plantation LWS	Calcareous grassland	Short	4.000	1.071	5.071	10

Rec ref	Protected conservation area	Habitat feature applied	Vegetation type (for deposition velocity)	Critical load			
				Acid deposition ($kEqH^{+}/ha/year$)			Nitrogen deposition (kg N/ha/year)
				CLMaxS	CLMinN	CLMaxN	Minimum
		Broad-leaved/Coniferous unmanaged woodland	Tall	8.245	0.357	8.602	5
H22	Minting Wood LWS	Calcareous grassland	Short	4.000	1.071	5.071	10
		Broad-leaved/Coniferous unmanaged woodland	Tall	8.216	0.357	8.573	5
H23	Coultas Wood LWS	Calcareous grassland	Short	4.000	1.071	5.071	10
		Broad-leaved/Coniferous unmanaged woodland	Tall	8.241	0.357	8.598	5
H24	Hoop Lane Road Verges LWS	Calcareous grassland	Short	4.000	1.071	5.071	5
		Broad-leaved/Coniferous unmanaged woodland	Tall	2.249	0.357	2.606	10
H25	Withcall Meadow LWS	Calcareous grassland	Short	4.000	1.071	5.071	10

Critical load functions for acid deposition are specified on the basis of both nitrogen and sulphur derived acid. The critical load function contains a value for sulphur derived acid and two values for nitrogen derived acid deposition (a minimum and maximum value). The APIS website provides advice on how to calculate the PC (i.e. emissions from the modelled process alone) and the PEC (i.e. the PC added to the existing deposition) as a percentage of the acid critical load function and how to determine exceedances of the critical load function. This guidance was adopted for this assessment. The minimum of the range of nitrogen critical loads was used for the assessment in line with the advice on the APIS website (Centre for Ecology and Hydrology, 2022).

3.3.2.3 Significance criteria – SSSIs

Where appropriate, the significance of the predicted long-term (annual mean) concentrations or deposition at protected conservation areas were determined in line with Environment Agency guidance (Environment Agency, 2021, 2022), summarised as follows:

- Where the PC is less than 1% of the relevant critical level or critical load, the emission is not likely to have a significant effect alone or in combination irrespective of the existing concentrations or deposition rates. This would be classed as 'insignificant.'
- Where the PC is above 1%, further consideration of existing background concentrations or deposition rates is required, and where the total concentration or deposition is less than 70% of the critical level or critical load, calculated in combination with other committed projects or developments as appropriate, the emission is not likely to have a significant effect.
- Where the contribution is above 1%, and the total concentration or deposition rate is greater than 70% of the critical level or critical load, either alone or in combination with other committed projects or developments, then this may indicate a significant effect and further consideration is likely to be required.

The above approach is used to give a clear definition of what effects can be disregarded as 'insignificant', and which need to be considered in more detail in relation to the predicted annual mean concentrations or deposition.

For short-term mean concentrations (i.e. the 24-hour mean critical level for NOx) where the PC is less than 10% of the critical level then it would be regarded as 'insignificant'. A potentially significant effect would be identified where the short-term PC from the modelled sources would lead to the PEC exceeding the critical level. Further consideration is likely to be required in this situation.

3.3.2.4 Significance criteria – local nature sites

The relevant significance criteria for these protected conservation areas are set out below.

With regard to concentrations or deposition rates at local nature sites, the Environment Agency guidance (Environment Agency, 2022) states emissions can be described as 'insignificant' and no further assessment is required (including the need to calculate PECs) if:

- the short-term PC is less than 100% of the short-term environmental standard for protected conservation areas; or
- the long-term PC is less than 100% of the long-term environmental standard for protected conservation areas.

4. Existing Environment

4.1 Site Location

Hatton Compressor Station is off the A158 at Hatton, Lincolnshire, and is shown on Figure 1. The postcode for the site is LN8 5QE. The site is approximately [redacted] southwest of the village of Hatton. The area surrounding the site generally comprises agricultural land with one main road (A158) travelling in an approximate east-west direction approximately [redacted] to the south of the operational site area at its nearest point. Minor local roads are immediately to the west and to the north of the site.

There are several potentially sensitive human receptors such as residential properties in the vicinity of the site in respect of air emissions from the process. The most relevant human receptors have been identified from local mapping and are summarised in Appendix A and presented in Figure 2. The nearest assessed residential property is approximately [redacted] south-southwest of the SGT-750 gas turbine [redacted].

4.2 Existing Site Equipment

Hatton compressor station is currently equipped with three Rolls Royce RB211-24 gas turbine driven compressor units (Units A, B and C) and an additional 35 MW electrically powered Variable Speed Drive (VSD) unit (Unit D) that was commissioned in 2016. Unit D is the station lead unit, the other three units can be operated either individually or in parallel; only two machines of any type can be operated concurrently to provide gas compression duty.

Hatton Units A, B and C are all impacted by the IED. Unit A is under Emergency Use Derogation (EUD), which limits running to 500 hours per year in perpetuity. Units B and C are operated under the Limited Life Derogation (LLD) which allows for a maximum of 17,500 hours operation per unit or until 31 December 2023 (whichever comes first) after which the units must be decommissioned.

4.3 Local Air Quality

ELDC has not declared any AQMAs within its area. The closest AQMA is the Lincoln AQMA within the City of Lincoln Council area, which has been declared due to elevated annual mean and one hour mean NO_2 concentrations from road traffic emissions. It is approximately 20 km west southwest of the site location and is not considered further in the assessment.

A review of baseline air quality was carried out prior to undertaking the air quality assessment. This was carried out to determine the availability of baseline air quality data recorded in the vicinity of the site and also if data from other regional or national sources such as the UK Air Information Resource (UK-AIR) (Defra, 2022) website could be used to represent background concentrations of the relevant pollutants in the vicinity of the site.

As noted in Section 2, ELDC carries out regular assessments and monitoring of air quality within the borough as part of the LAQM process. ELDC does not currently undertake any automatic (continuous) monitoring. The nearest non-automatic monitoring location to the site is a NO_2 diffusion tube urban roadside location in Horncastle (Site ID: Bull Ring Horncastle H4[redacted]) approximately 11 km south east of the site. In 2019, an annual mean NO_2 concentration of 28 µg/m^3 was recorded at this location. This monitoring location is not considered representative of the site due to its distance from the site and its town centre location. It should be noted none of the other assessed pollutants are monitored by ELDC.

For the assessed pollutants, information on background air quality in the vicinity of the site was obtained from Defra background map datasets (Defra, 2022). The 2018-based background maps produced by Defra are estimates based upon the principal local and regional sources of emissions and ambient monitoring data. For CO concentrations, the 2001-based background maps were used. The range of background NO_2 and CO concentrations for the assessment at human receptors are presented in Table 4-1.

As it is necessary to determine the potential impact of NOx emissions from the site at the assessed ecological receptors, the background concentrations of NOx were also identified. These background concentrations were also obtained from the Defra background map datasets (Defra, 2022) and are displayed in Table 4-1. The background concentrations at each specific human and ecological receptor are shown in the results tables presented in Appendix C.

Table 4-1: Background concentrations: adopted for use in assessment for human receptors and protected conservation areas

Pollutant	Annual mean concentration (µg/m^3)	Description
Human receptors		
NO_2	7.3 – 7.8	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, 2022 map concentration
CO	101 – 102	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, scaled from 2001-based map1 to 2022 concentration
Ecological receptors		
NOx	9.0 – 10.1	Defra 1 km x 1 km background map value for the assessed ecological receptors, 2022 map concentration

The long-term background concentrations were doubled to estimate the short-term background concentrations in line with the Environment Agency guidance (Environment Agency, 2022).

4.4 Existing Deposition Rates

Existing acid and nutrient nitrogen deposition levels were obtained from APIS (Centre for Ecology and Hydrology, 2022). As a conservative approach to the assessment, it is assumed the vegetation type selected is present at the specific modelled location within the assessed protected conservation area. The existing deposition values at the assessed ecological designations are set out in Table 4-2.

Table 4-2: Existing deposition at modelled protected conservation areas

Rec ref	Protected conservation area	Vegetation type (for deposition velocity)	Existing deposition rates		
			Acid deposition (kEqH+/ha/year)		Nitrogen deposition (kg N/ha/year)
			Nitrogen	Sulphur	Nitrogen
H1	Hainton Sheepwalk SSSI	Short	1.68	0.16	23.5
H2	Withcall and South Willingham Tunnels SSSI	Not assessed – no critical loads			
H3	Benniworth Haven Cuttings SSSI	Not assessed – no critical loads			
H4	Red Hill SSSI	Short	1.64	0.15	23.0
H5	Silverines Meadows SSSI	Short	1.66	0.15	23.3
H6	Sotby Meadows SSSI	Short	1.68	0.14	23.5
H7	High Barn, Oxcombe SSSI	Short	1.84	0.16	25.7
H8	Woodhall Spa Golf Course SSSI	Short	1.64	0.13	22.9
H9	Moor Farm SSSI	Short	1.63	0.13	22.8
H10	Kirkby Moor SSSI	Short	1.62	0.13	22.7
H11	Bardney Limewoods, Lincolnshire SSSI & Bardney Limewoods NNR	Tall	2.88	0.17	40.3
H12	Potterhanworth wood SSSI	Tall	2.85	0.17	39.9
H13	Little Scrubbs Meadow SSSI	Short	1.65	0.15	23.2
H14	Gosling's Corner SSSI and Gosling's Corner AW (ID 1115503)	Tall	2.86	0.18	40.1
H15	Wickenby Wood SSSI	Tall	2.60	0.17	36.4
H16	Linwood Warren SSSI	Tall	2.64	0.18	36.9
H17	Hatton Wood Ancient and Semi Natural Woodland (ID 1115511)	Short	2.91	0.17	40.7
H18	Hatton Wood Ancient Replanted Woodland (ID 1115511)	Short	2.84	0.16	39.8
H19	Sotby Wood LWS	Short	1.70	0.14	23.8
		Tall	2.91	0.17	40.7
H20	Hatton Meadows LWS	Short	1.70	0.14	23.8
H21	Chambers Plantation LWS	Short	1.70	0.14	23.8
		Tall	2.91	0.17	40.7
H22	Minting Wood LWS	Short	1.63	0.13	22.8
		Tall	2.84	0.16	39.8
H23	Coultas Wood LWS	Short	1.70	0.14	23.8
		Tall	2.91	0.17	40.7
H24	Hoop Lane Road Verges LWS	Short	1.70	0.14	23.8
		Tall	2.91	0.17	40.7
H25	Withcall Meadow LWS	Short	1.70	0.14	23.8

5. Results

The results presented below are the maximum modelled concentrations predicted at any of the 32 assessed sensitive human receptor locations and the maximum modelled concentrations at any off-site location for the five years of meteorological data used in the study.

The results of the dispersion modelling are set out in Table 5-1 to Table 5-6, which presents the following information:

- EQS (i.e. the relevant air quality standard);
- estimated annual mean background concentration (see Section 3.3) that is representative of the baseline;
- PC, the maximum modelled concentrations due to the emissions from the assessed combustion plant;
- PEC, the maximum modelled concentration due to process emissions combined with estimated baseline concentrations;
- PC and PEC as a percentage of the EQS; and
- PC as a percentage of headroom (i.e. the PC as a percentage of the difference between the short-term background concentration and the EQS, for short-term predictions only).

The full results at assessed human receptor locations are presented in Appendix C.

5.1 Human Receptors

5.1.1 Existing Operations

The dispersion modelling results at human receptors for the existing operations scenario are set out in Table 5-1.

The results indicate that the predicted modelled off-site concentrations and predicted concentrations at sensitive human receptors do not exceed any relevant long-term or short-term EQS for the worst-case existing operations.

The maximum PC for annual mean NO_2 at a sensitive human receptor location is 4.8 μg/m^3 (equating to 11.9% of the relevant EQS) and is predicted at R5 which represents a residential property approximately 0.35 km north-northeast of the site boundary in the village of Hatton.

For the assessment of 1-hour mean (99.79th percentile) NO_2 concentrations at a sensitive human receptor location and maximum off-site locations, the maximum PC of 102 μg/m^3 (which equates to 51 % of the relevant EQS) is predicted at R29 representing a minor road bordering the northeast site boundary. R27 to R32 are representative of a minor road located adjacent to the northern boundary of the site and is in relatively close proximity to the existing RB211 units. Due to their location adjacent to the northern site boundary, these receptors represent the highest modelled off-site short-term concentrations for CO and NO_2.

For short-term CO concentrations at both sensitive human receptor locations and the modelled off-site locations, the respective PCs are less than 10% of the relevant short-term EQS.

5.1.2 Proposed Future Operations

The dispersion modelling results at human receptors for the proposed future operations scenario are set out in Table 5-2.

The results indicate that the predicted modelled off-site concentrations and predicted concentrations at sensitive human receptors do not exceed any relevant long-term or short-term EQSs.

The maximum PC for annual mean NO_2 at a sensitive human receptor location is 0.5 μg/m^3 (equating to 1.2% of the relevant EQS) and is predicted at R4, which represents a residential property approximately 0.33 km north-northeast of the site boundary within the village of Hatton. As the PC is only 1.2% of the EQS and the PEC is less than 70% of the EQS (20.8%), the impact is considered to be 'not significant'. The proposed future worst case operations represent an improvement compared to the existing worst case operation.

For the assessment of 1-hour mean (99.79th percentile) NO_2 concentrations at sensitive human receptor locations, the maximum PC of 52.5 μg/m^3 (which equates to 26.2 % of the relevant EQS) is predicted at R29 representing a minor road location approximately 0.29 km northeast of the SGT-750 gas turbine stack location. The PC is more than 10% of the short-term EQS and more than 20% of the headroom. However, the PEC is considerably lower than the relevant EQS and, therefore, based on professional judgement, is considered 'not significant'. A similar outcome is predicted for the maximum off-site concentration at [redacted], which is situated 0.34 km to the northeast of the site. As for annual mean NO_2 concentrations, the proposed future worst case operations represent an improvement compared to the existing worst case operation.

It should be noted that the remaining RB211 unit has the greatest influence on the maximum predicted 1-hour mean concentrations for the proposed future scenario. Although it will only be able to legally operate a maximum of 500 hours in any year, it was modelled on a continuous basis for the full year to provide the worst case 1-hour mean predicted impacts. When considering the operation of the SGT-750 in isolation, which represents the vast majority of operations of a gas turbine, the maximum 1-hour mean (99.79th percentile) NO_2 PC at any human receptor location is only 3.5 µg/m^3, which is considerably lower than the combined PC of 52.5 µg/m^3. The RB211 is an existing unit which is consented and operating in full compliance with its existing EPR and planning approvals and subject to continuous emissions calculations and periodic emissions compliance tests.

Contour plots of the annual mean and 1-hour mean NO_2 concentrations for the modelled future operations scenario are shown in Figure 4 and Figure 5.

For short-term CO concentrations at both human receptor locations and the modelled off-site locations, the respective PCs are less than 10% of the relevant short-term EQS and the impacts are considered 'insignificant'.

Table 5-1: Dispersion modelling results – Maximum NO_2 and CO concentrations at human receptors for existing operations

Pollutant	Averaging period	Assessment location	Maximum receptor	EQS (µg/m^3)	Baseline air quality level (µg/m^3)	PC (µg/m^3)	PEC (µg/m^3)	PC / EQS (%)	PEC / EQS (%)	PC as a percentage of headroom (%)
CO	Maximum 8-hour running mean	Sensitive locations	R14	10,000	202	42.2	244.7	0.4%	2.4%	0.4%
	Maximum 1-hour mean	Maximum off-site	-	30,000	202	236.8	438.4	0.8%	1.5%	0.8%
		Sensitive locations	R28	30,000	202	202.4	404.0	0.7%	1.3%	0.7%
NO_2	Annual mean	Sensitive locations	R5	40	7.7	4.8	12.5	11.9%	31.1%	-
	1-hour mean (99.79th percentile)	Maximum off-site	-	200	15.4	102.2	117.5	51.1%	58.8%	55.3%
		Sensitive locations	R29	200	15.4	102.2	117.5	51.1%	58.8%	55.3%

Table 5-2: Dispersion modelling results – Maximum NO_2 and CO concentrations at human receptors for proposed future operations

Pollutant	Averaging period	Assessment location	Maximum receptor	EQS (µg/m^3)	Baseline air quality level (µg/m^3)	PC (µg/m^3)	PEC (µg/m^3)	PC / EQS (%)	PEC / EQS (%)	PC as a percentage of headroom (%)
CO	Maximum 8-hour running mean	Sensitive locations	R17	10,000	203	22.7	226.1	0.2%	2.3%	0.2%
	Maximum 1-hour mean	Maximum off-site	-	30,000	202	124.0	325.6	0.4%	1.1%	0.4%
		Sensitive locations	R28	30,000	202	119.2	320.8	0.4%	1.1%	0.4%
NO_2	Annual mean	Sensitive locations	R4	40	7.7	0.5	8.2	1.2%	20.4%	-
	1-hour mean (99.79th percentile)	Maximum off-site	-	200	15.4	52.9	68.2	26.4%	34.1%	28.6%
		Sensitive locations	R29	200	15.4	52.5	67.8	26.2%	33.9%	28.4%

5.2 Ecological Receptors

5.2.1 Assessment Against Critical Levels

The environmental effects of releases from the site at the assessed ecological receptors has been determined by comparing predicted concentrations of released substances with the EQSs for the protection of vegetation (critical levels) (see Section 3.3). The results of the detailed modelling at the ecological receptors are shown in Table 5-3 to Table 5-6. The results presented are the maximum predicted concentrations at the maximum SSSI and the maximum local nature site for the five years of meteorological data used in the study. The predicted concentrations at all other SSSIs and local natures sites would be less than those presented in Table 5-3 to Table 5-6.

5.2.1.1 Existing operations

The dispersion modelling results at ecological receptors for the existing operations scenario are set out in Table 5-3 and Table 5-4.

Table 5-3: Dispersion modelling results – Maximum annual mean NOx concentrations at ecological receptors for existing operations

Ref	Ecological Receptor	EQS (µg/m^3)	Baseline air quality level (µg/m^3)	PC (µg/m^3)	PEC (µg/m^3)	PC / EQS (%)	PEC / EQS (%)
H11	Bardney Limewoods, Lincolnshire SSSI and Bardney Limewoods NNR	30	9.5	0.8	10.3	2.8%	34.4%
H19	Sotby Wood LWS		9.4	3.4	12.7	11.2%	42.4%

Table 5-4: Dispersion modelling results – Maximum 24-hour mean NOx concentrations at ecological receptors for existing operations

Ref	Ecological Receptor	EQS (µg/m^3)	Baseline air quality level (µg/m^3)	PC (µg/m^3)	PEC (µg/m^3)	PC / EQS (%)	PEC / EQS (%)
H11	Bardney Limewoods, Lincolnshire SSSI and Bardney Limewoods NNR	75	18.9	15.9	34.9	21.2%	46.5%
H19	Sotby Wood LWS		18.8	19.6	38.3	26.1%	51.1%

The results in Table 5-3 and Table 5-4 indicate that for the maximum SSSI (Bardney Limewoods, Lincolnshire SSSI and Bardney Limewoods NNR) and local nature site (Sotby Wood LWS), the annual mean and maximum 24-hour mean PECs are less than 100% of the critical level.

5.2.1.2 Proposed future operations

The dispersion modelling results at ecological receptors for the proposed future operations scenario are set out in Table 5-5 and Table 5-6.

Table 5-5: Dispersion modelling results – Maximum annual mean NOx concentrations at ecological receptors for proposed future operations

Ref	Ecological Receptor	EQS ($\mu g/m^3$)	Baseline air quality level ($\mu g/m^3$)	PC ($\mu g/m^3$)	PEC ($\mu g/m^3$)	PC / EQS (%)	PEC / EQS (%)
H11	Bardney Limewoods, Lincolnshire SSSI and Bardney Limewoods NNR	30	9.5	0.1	9.6	0.4%	31.9%
H19	Sotby Wood LWS		9.4	0.4	9.7	1.2%	32.4%

Table 5-6: Dispersion modelling results – Maximum 24-hour mean NOx concentrations at ecological receptors for proposed future operations

Ref	Ecological Receptor	EQS ($\mu g/m^3$)	Baseline air quality level ($\mu g/m^3$)	PC ($\mu g/m^3$)	PEC ($\mu g/m^3$)	PC / EQS (%)	PEC / EQS (%)
H11	Bardney Limewoods, Lincolnshire SSSI and Bardney Limewoods NNR	75	18.9	9.1	28.1	12.2%	37.4%
H19	Sotby Wood LWS		18.8	11.5	30.3	15.4%	40.4%

The results in Table 5-5 indicate that for the maximum SSSI (Bardney Limewoods, Lincolnshire SSSI and Bardney Limewoods NNR), the maximum annual mean NOx PC is less than 1% of the relevant critical level and can be classed as 'insignificant' as per Environment Agency guidance (Environment Agency, 2022). For the maximum local nature site (Sotby Wood LWS), the PC is less than 100% of the critical level and therefore can be described as 'insignificant'.

The results in Table 5-6 indicate that for the maximum SSSI (Bardney Limewoods, Lincolnshire SSSI and Bardney Limewoods NNR), the maximum short-term NOx PC is greater than 10% of the critical level. However, the PEC is well within the critical level and, therefore, considered as 'not significant.' For the maximum local nature site (Sotby Wood LWS), the PC is less than 100% of the critical load and can be described as 'insignificant'.

Comparison of the worst-case concentrations between the existing (Table 5-3 and Table 5-4) and proposed future operations (Table 5-5 and Table 5-6) scenarios show that there is predicted to be a decrease in concentrations of NOx due to the implementation of the proposed changes.

5.2.2 Assessment Against Critical Loads

The rate of deposition of acidic compounds and nitrogen containing species have been predicted at the assessed ecological receptors. This allows the potential for adverse effects to be evaluated by comparison with the relevant critical loads.

Critical load functions for acid deposition are specified on the basis of both nitrogen-derived acid and sulphur-derived acid. This information, including existing deposition levels at habitat sites, is available from APIS (Centre for Ecology and Hydrology, 2022). Further information on the assessment criteria for deposition is provided in Section 3.3. The dispersion modelling results for the maximum SSSI and local nature site are set out in Table 5-7 to Table 5-10.

Table 5-7: Dispersion modelling results – maximum acid deposition at ecological receptors for existing operations

Rec ref	Protected conservation area	Vegetation type (for deposition velocity)	Critical Load (CL) (kEqH+/ha/year)			Acid deposition (kEqH+/ha/year)					
			CLMaxS	CLMinN	CL MaxN	Existing deposition (N)	Existing deposition (S)	PC	PEC	PC/CL (%)	PEC/CL (%)
H11	Bardney Limewoods, Lincolnshire SSSI and Bardney Limewoods NNR	Tall	8.2	0.4	8.6	2.9	0.2	0.0121	3.1	0.1%	35.6%
H19	Sotby Wood LWS	Short	4.0	1.1	5.1	1.7	0.1	0.0241	1.9	0.5%	36.8%
		Tall	8.3	0.4	8.6	2.9	0.2	0.0481	3.1	0.6%	36.3%

Table 5-8: Dispersion modelling results – maximum nitrogen deposition at ecological receptors for existing operations

Rec ref	Protected conservation area	Vegetation type (for deposition velocity)	Minimum Critical Load (CL) (kgN/ha/year)	Nitrogen deposition (kgN/ha/year)				
				Existing deposition	PC	PEC	PC/CL (%)	PEC/CL (%)
H11	Bardney Limewoods, Lincolnshire SSSI and Bardney Limewoods NNR	Tall	10	40.3	0.170	40.4	1.7%	404
H19	Sotby Wood LWS	Short	10	23.8	0.337	24.1	3.4%	241
		Tall	5	40.7	0.675	41.4	13.5%	828

Table 5-9: Dispersion modelling results – maximum acid deposition at ecological receptors for proposed future operations

Rec ref	Protected conservation area	Vegetation type (for deposition velocity)	Critical Load (CL) (kEqH+/ha/year)			Acid deposition (kEqH+/ha/year)					
			CLMaxS	CLMinN	CL MaxN	Existing deposition (N)	Existing deposition (S)	PC	PEC	PC/CL (%)	PEC/CL (%)
H11	Bardney Limewoods, Lincolnshire SSSI and Bardney Limewoods NNR	Tall	8.2	0.4	8.6	2.9	0.2	0.0016	3.0	0.02%	35.5%
H19	Sotby Wood LWS	Short	4.0	1.1	5.1	1.7	0.1	0.0025	1.8	0.05%	36.3%
		Tall	8.3	0.4	8.6	2.9	0.2	0.0050	3.1	0.06%	35.8%

Table 5-10: Dispersion modelling results – maximum nitrogen deposition at ecological receptors for proposed future operations

Rec ref	Protected conservation area	Vegetation type (for deposition velocity)	Minimum Critical Load (CL) (kgN/ha/year)	Nitrogen deposition (kgN/ha/year)				
				Existing deposition	PC	PEC	PC/CL (%)	PEC/CL (%)
H11	Bardney Limewoods, Lincolnshire SSSI and Bardney Limewoods NNR	Tall	10	40.3	0.023	40.3	0.2%	403%
H19	Sotby Wood LWS	Short	10	23.8	0.035	23.8	0.3%	238%
		Tall	5	40.7	0.070	40.8	1.4%	816%

5.2.2.1 Existing operations

The results in Table 5-7 indicate that for the maximum SSSI (Bardney Limewoods, Lincolnshire SSSI and Bardney Limewoods NNR) and local nature site (Sotby Wood LWS), the acid deposition PC is less than 1% of the relevant critical load value.

The results in Table 5-8 indicate that for the maximum SSSI (Bardney Limewoods, Lincolnshire SSSI and Bardney Limewoods NNR), the nitrogen deposition PC is higher than 1%, where the PEC exceeds the critical load value. The nitrogen deposition PCs at the maximum local nature site are less than 100% of the critical loads.

It should be noted that nitrogen deposition rates currently exceed their relevant critical loads at the majority of the ecological receptors. However, this is a relatively common situation at designated sites across the UK due to the high baseline deposition rates.

5.2.2.2 Proposed future operations

The acid and nitrogen deposition results set out in Table 5-9 and Table 5-10, respectively, indicate that at the Bardney Limewoods, Lincolnshire SSSI and Bardney Limewoods NNR, the PC is less than 1% of the relevant critical load value for acid deposition and the impact can be described as 'insignificant' as per Environment Agency guidance (Environment Agency, 2022). For Sotby Wood LWS, the PCs are less than 100% of the critical load and are considered to be 'insignificant'.

Comparison of the worst-case deposition rates between the existing (Table 5-7 and Table 5-8) and proposed future operations (Table 5-9 and Table 5-10) worst case scenarios show that there is predicted to be a decrease in acid and nitrogen deposition PCs due to the implementation of the proposed development.

5.3 Stack Height Sensitivity Analysis

A study was undertaken to determine the effect of a range of possible stack heights (17m, 19m, 21m, 25m and 30m) for the proposed SGT-750 gas turbine. In summary, the modelling showed that there would not be any significant air quality effects at human or ecological receptors at any of the stack heights considered (i.e. a stack height of 17m would be acceptable from an air quality perspective). Further details of the modelling results for the range of stack heights considered are set out in Appendix D.

Although impacts are acceptable for the lowest of the stack heights considered, due to engineering considerations regarding compliance with Environment Agency guidance and a British Standard (BS EN 15259) on stack gas homogeneity, Siemens identified a minimum required stack height of 25m.

Given the results presented in in Section 5.1 and 5.2, no significant benefit would be achieved in adopting a stack height greater than the assessed 25m stack height. Increasing the stack height to 30m would result in further improvements in ground level concentrations and deposition rates, however, these incremental improvements are less marked than can be seen with stack height increases up to 25m, and would potentially contribute to increased landscape and visual effects associated with the proposed scheme. Having due regard to these considerations, planning permission has been granted for the development at the identified 25m stack height.

6. Conclusions

This report has addressed the potential air quality impacts associated with the proposed development at Hatton Compressor Station, arising from the emissions of NOx and CO. The predicted impacts were assessed against the relevant air quality standards and guidelines for the protection of human health and vegetation.

6.1 Human Receptors

The assessment of emissions from on-site combustion sources was carried out for two scenarios representing the existing and proposed worst case operations. Due to engineering considerations, a minimum stack height of 25m is required and this formed the basis of the proposed operation scenario. The results for a 25m stack height indicate that the predicted NO_2 and CO concentrations at sensitive human receptors do not exceed any relevant long-term or short-term EQSs and the overall air quality effect would be not significant.

6.2 Ecological Receptors

Even taking account of a number of worst case assumptions related to operating hours and loads for the proposed operations, the detailed assessment indicates that the predicted NOx concentrations and nitrogen and acid deposition at the SSSIs within 15km and other local nature sites within 2km would be not significant.

6.3 Summary

Based on the above assessment, it is concluded that the operation of the assessed combustion plant for the future proposed operations scenario are acceptable from an air quality perspective.

The assessment also showed that the proposed operations represent an improvement compared to the currently permitted operations, based on a comparison of the worst case scenarios. It should be noted that the stated worst case scenarios represent a very significant overestimate of running hours and load, assuming that the proposed new unit operates continuously and the retained RB211 operates for the maximum legally permitted 500 hours per year. The retained RB211 represents a greater potential source of pollution than the new unit and would only be utilised if operationally essential due to its emergency use (500 hour) status; operational preference would be given to operating the SGT-750 and / or VSD (Unit D) in normal circumstances.

7. References

ADM Ltd (2005). Assessment of Effects on Air Quality of Emissions to Atmosphere from the Hatton Gas Pumping Station, P0504, 22nd April 2005.

ADM Ltd (2020). Hourly sequential meteorological data for Waddington meteorological station 2016-2020 [online] Further information available at: http://www.aboutair.com/met-data.htm.

Air Quality Technical Advisory Group (AQTAG) (2014). AQTAG 06 Technical Guidance on Detailed Modelling Approach for an Appropriate Assessment for Emissions to Air, updated version approved March 2014.

Centre for Ecology and Hydrology (CEH) (2022). Air Pollution Information System [online] Available at: http://www.apis.ac.uk [Accessed November 2022].

Department for Environment, Food and Rural Affairs (Defra) and the Devolved Administrations (2007). The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. Vol 1. London: Defra.

Department for Environment, Food and Rural Affairs (Defra) (2021). Environmental open-data applications and datasets. [online] Available at: http://uk-air.defra.gov.uk [Accessed May 2021].

Department for Environment, Food and Rural Affairs (Defra) (2022). UK Air Information Resource. [online] Available at: https://uk-air.defra.gov.uk/data/laqm-background-home [Accessed November 2022].

Environment Agency (2021) Environmental permitting: air dispersion modelling report. [online] Available at: https://www.gov.uk/guidance/environmental-permitting-air-dispersion-modelling-reports [Accessed January 2021].

Environment Agency (2022). Air emissions risk assessment for your environmental permit. [online] Available at: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit [Accessed November 2022].

Grid Reference Finder (2021). Available at https://gridreferencefinder.com/ [Accessed April 2021].

National Gas Transmission (2021). Data and information provided to Jacobs via email communications, April 2021.

Siemens (2021). Data and information provided to Jacobs via email communications, April 2021.

8. Figures

Figure 1: Approximate site fenceline, modelled buildings and modelled stack locations

Figure 2: Land ownership boundary, modelled stack locations, extent of modelled grid and sensitive human receptor locations

Figure 3: Protected conservation areas

Figure 4: Proposed operations – annual mean nitrogen dioxide process contributions, 2020 meteorological data

Figure 5: Proposed operations – 1-hour mean (99.79th percentile) nitrogen dioxide process contributions, 2020 meteorological data

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Appendix A. Dispersion Model Input Parameters

A.1 Emission Parameters

The emissions data used to represent the site for the existing operations (RB211 Unit A and B) and proposed future scenario (SGT-750 and RB211 Unit A) described in Section 1.2 are set out in Table A-1.

Table A-1. Dispersion modelling parameters

Parameters		Unit	New Siemens SGT-750 gas turbine (101.5 MW_{th})	RB211 Unit A Gas turbine (70.6 MW_{th})	RB211 Unit B Gas turbine (70.6 MW_{th})
Fuel		-	Natural gas	Natural gas	Natural gas
Emission point		-	A46	A1	A2
Assessed annual operation hours	Existing scenario	Hours	N/A	8,760	8,760
	Future scenario		8,760	500	N/A
Stack location		m	[redacted]	[redacted]	[redacted]
Stack height		m	25	19	19
Stack diameter		m	2.8	3.5	3.5
Flue gas temperature		°C	438	446	446
Efflux velocity		m/s	36.3	13.7	13.7
Moisture content of exhaust gas		%	6.2		
Oxygen content of exhaust gas (dry)		%	15.6		
Volumetric flow rate (actual)		m^3/s	223.6	132	132
Volumetric flow rate (normal)[1]		Nm^3/s	72.4	40	40
NOx emission concentration[1],		mg/Nm^3	40	239	239
NOx emission rate		g/s	2.894	9.560	9.560
CO emission concentration[1]		mg/Nm^3	40	139	139
CO emission rate		g/s	2. 894	5.560	5.560

Note 1: Normalised flows and concentrations presented at 273 K, 101.3 kPa, dry gas and oxygen content of 15%

A.2 Dispersion Model Inputs

A.2.1 Structural influences on dispersion

The main structures within the site which have been included in the model to reflect the existing site layout are identified within Table A-2.

Table A-2. Building parameters

Building	Modelled building shapes	Length (m)	Width / diameter (m)	Height (m)	Angle of length to north	Centre point co-ordinates	
						Easting	Northing
Building 1 (SGT-750)	Rectangular	27.2	12.0	13.9	86.3	[redacted]	[redacted]
Building 2 (RB211)	Rectangular	21.9	4.4	7	358	[redacted]	[redacted]
Building 3 (RB211)	Rectangular	21.9	4.4	7	358	[redacted]	[redacted]
Building 4 (RB211)	Rectangular	21.9	4.4	7	358	[redacted]	[redacted]

A.3 Other model inputs

Other model input parameters are presented in Table A-3.

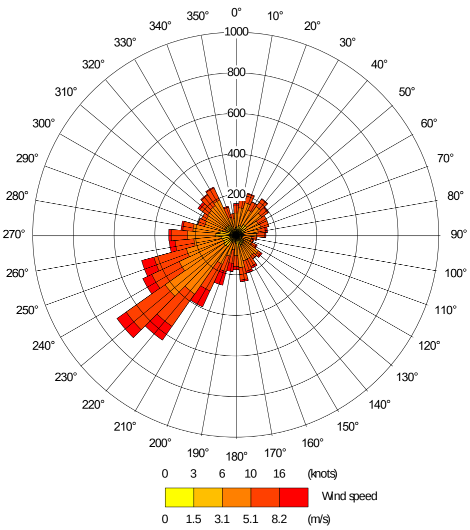
Table A-3. Other model inputs

Parameter	Value used	Comments
Surface roughness length for dispersion site	0.2 m	This is appropriate for the dispersion site which is area where the local land-is agricultural in nature.
Surface roughness length at meteorological station site	0.4 m	This is appropriate for an area where the local land-is a mixture of agricultural and built-up area such as village of Waddington.
Minimum Monin-Obukhov Length	1 m	Typical values for the dispersion site
Surface Albedo	0.23 m	Typical values for the dispersion site
Priestley-Taylor Parameter	1 m	Typical values for the dispersion site
Terrain	Not included	Guidance for the use of the ADMS model suggests that terrain is normally incorporated within a modelling study when the gradient exceeds 1:10. As the gradient in the vicinity of the site does not exceed 1:10, a terrain file was not included in the modelling.
Meteorological data	Waddington meteorological station, 2016 - 2020	Waddington meteorological station is located approximately 22.1 km southwest of the site and is considered the closest most representative meteorological monitoring station to the site.

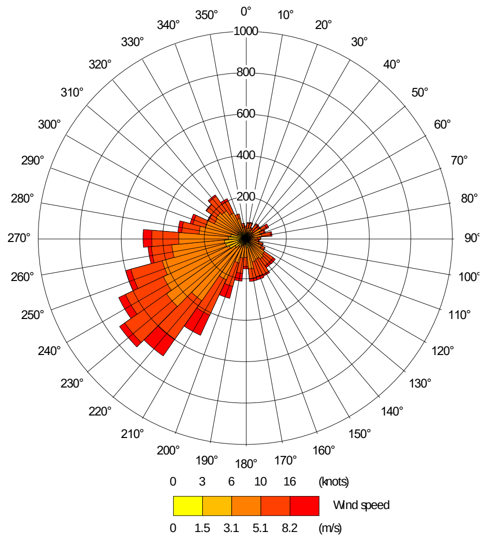
A.4 Meteorological Data

The wind roses for each year of meteorological data utilised in the assessment, obtained from ADM Ltd (ADM, 2021) are shown below.

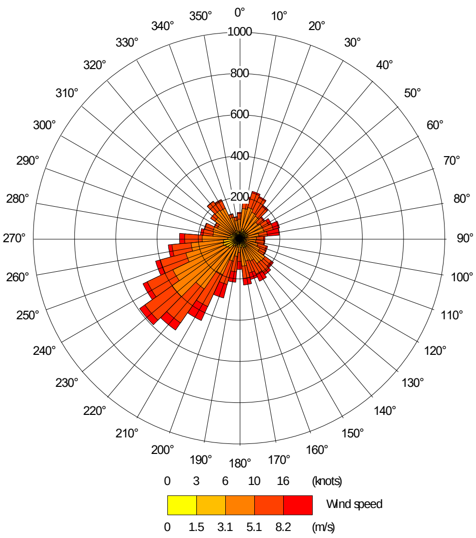
Waddington meteorological data, 2016



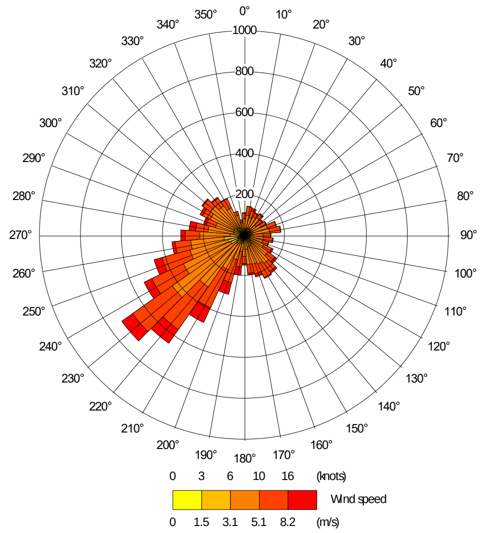
Waddington meteorological data, 2017



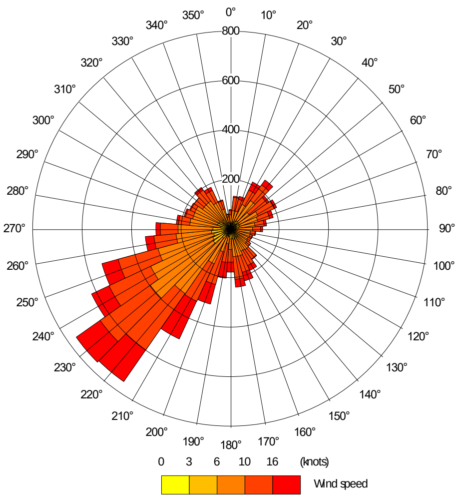
Waddington meteorological data, 2018



Waddington meteorological data, 2019



Waddington meteorological data, 2020



A.5 Model Domain/Study Area

The ADMS model calculates the predicted concentrations based on a user defined grid system. Generally, the larger the study area, the greater the distance between the grid calculation points and the lower the resolution of the dispersion model predictions. This is to be offset against the need to encompass an appropriately wide area within the dispersion modelling study to capture the dispersion of the stack emissions.

The modelled grid was specified as a 1.5 km x 1.5 km grid with calculation points every 10 m (i.e. 151 points along each grid axis) with a grid height of 1.5 m. This size of grid was selected to provide a good grid resolution and also encompass a sufficient area so that the maximum predicted concentrations would be determined. The area within the site boundary was excluded from the modelled grid as it is not accessible to the general public. The modelled grid parameters are presented in Table A-4 and the extent of the grid is shown on Figure 2.

Table A-4. Modelled grid parameters

	Start	Finish	Number of grid points	Grid spacing (m)
Easting	[redacted]	[redacted]	151	10
Northing	[redacted]	[redacted]	151	10
Grid height	1.5	1.5	1	-

As well as the modelled grid, the potential impact at 32 sensitive human receptors (e.g. exposure locations such as residential properties, PRoW and minor roads where people may walk) and 25 ecological receptors within the required study area were assessed. The receptor locations are shown in Figure 2 and Figure 3 and further details of the human receptor and ecological receptor locations are provided in Table A-5 and Table A-6, respectively.

Table A-5. Assessed human receptors

Receptor	Description	Grid reference		Distance from the SGT-750 stack location (km)	Direction from the site
		Easting	Northing		
R1	Residential property on Panton Road	[redacted]	[redacted]	[redacted]	NNE
R2	Residential property on Panton Road	[redacted]	[redacted]	[redacted]	NE
R3	Residential property on Panton Road	[redacted]	[redacted]	[redacted]	NE
R4	Residential property on Panton Road	[redacted]	[redacted]	[redacted]	NE
R5	Residential property on Sturton Road	[redacted]	[redacted]	[redacted]	ENE
R6	Residential property on Sturton Road	[redacted]	[redacted]	[redacted]	ENE
R7	Residential property on Sturton Road	[redacted]	[redacted]	[redacted]	ENE
R8	Residential property on Sturton Road	[redacted]	[redacted]	[redacted]	E
R9	Residential property on Lincoln Road	[redacted]	[redacted]	[redacted]	ESE
R10	Residential property on Main Road	[redacted]	[redacted]	[redacted]	SE
R11	Residential property on Main Road	[redacted]	[redacted]	[redacted]	SE

Receptor	Description	Grid reference		Distance from the SGT-750 stack location (km)	Direction from the site
		Easting	Northing		
R12	Residential property on Main Road	[redacted]	[redacted]	[redacted]	SE
R13	Residential property on Main Road	[redacted]	[redacted]	[redacted]	SSE
R14	Residential property on Main Road	[redacted]	[redacted]	[redacted]	SSW
R15	Residential property on Main Road	[redacted]	[redacted]	[redacted]	SSW
R16	Residential property on Main Road	[redacted]	[redacted]	[redacted]	WSW
R17	Residential property on Main Road	[redacted]	[redacted]	[redacted]	W
R18	Residential property on Main Road	[redacted]	[redacted]	[redacted]	W
R19	Residential property on Main Road	[redacted]	[redacted]	[redacted]	W
R20	Residential property on Main Road	[redacted]	[redacted]	[redacted]	W
R21	Residential property on Horncastle Road	[redacted]	[redacted]	[redacted]	WNW
R22	Residential property on Walk Lane	[redacted]	[redacted]	[redacted]	NW
R23	Residential property on Panton Road	[redacted]	[redacted]	[redacted]	NNW
R24	PRoW (short-term only)	[redacted]	[redacted]	[redacted]	E
R25	PRoW (short-term only)	[redacted]	[redacted]	[redacted]	ESE
R26	PRoW (short-term only)	[redacted]	[redacted]	[redacted]	ESE
R27	Minor road (short-term only)	[redacted]	[redacted]	[redacted]	NNE
R28	Minor road (short-term only)	[redacted]	[redacted]	[redacted]	ENE
R29	Minor road (short-term only)	[redacted]	[redacted]	[redacted]	ENE
R30	Minor road (short-term only)	[redacted]	[redacted]	[redacted]	ENE
R31	Minor road (short-term only)	[redacted]	[redacted]	[redacted]	ENE
R32	Minor road (short-term only)	[redacted]	[redacted]	[redacted]	E

Table A-6. Assessed nature conservation sites

Receptor	Description	Grid reference		Distance from the SGT-750 stack location (km)	Direction from the site
		Easting	Northing		
H1	Hainton Sheepwalk SSSI	[redacted]	[redacted]	[redacted]	N
H2	Withcall and South Willingham Tunnels SSSI	[redacted]	[redacted]	[redacted]	NNE
H3	Benniworth Haven Cuttings SSSI	[redacted]	[redacted]	[redacted]	NE
H4	Red Hill SSSI	[redacted]	[redacted]	[redacted]	ENE
H5	Silverines Meadows SSSI	[redacted]	[redacted]	[redacted]	ENE
H6	Sotby Meadows SSSI	[redacted]	[redacted]	[redacted]	ENE
H7	High Barn, Oxcombe SSSI	[redacted]	[redacted]	[redacted]	E
H8	Woodhall Spa Golf course SSSI	[redacted]	[redacted]	[redacted]	SSE
H9	Moor Farm SSSI	[redacted]	[redacted]	[redacted]	SSE
H10	Kirkby Moor SSSI	[redacted]	[redacted]	[redacted]	SSE
H11	Bardney Limewoods, Lincolnshire SSSI and Bardney Limewoods NNR	[redacted]	[redacted]	[redacted]	SSW
H12	Potterhanworth Wood SSSI	[redacted]	[redacted]	[redacted]	SW
H13	Little Scrubbs Meadow SSSI	[redacted]	[redacted]	[redacted]	SW
H14	Gosling's Corner SSSI and Gosling's Corner Ancient Woodland (ID 1115503)	[redacted]	[redacted]	[redacted]	WSW
H15	Wickenby Wood SSSI	[redacted]	[redacted]	[redacted]	NW
H16	Linwood Warren SSSI	[redacted]	[redacted]	[redacted]	NNW
H17	Hatton Wood Ancient Woodland (ID 1115511)	[redacted]	[redacted]	[redacted]	SW
H18	Hatton Wood Ancient Replanted Woodland (ID 1115511)	[redacted]	[redacted]	[redacted]	SW
H19	Sotby Wood LWS	[redacted]	[redacted]	[redacted]	ENE
H20	Hatton Meadows LWS	[redacted]	[redacted]	[redacted]	SSW
H21	Chambers Plantation LWS	[redacted]	[redacted]	[redacted]	SW
H22	Minting Wood LWS	[redacted]	[redacted]	[redacted]	SSW
H23	Coultas Wood LWS	[redacted]	[redacted]	[redacted]	WSW
H24	Hoop Lane Road Verges LWS	[redacted]	[redacted]	[redacted]	WNW
H25	Withcall Meadow LWS	[redacted]	[redacted]	[redacted]	WNW

A.6 Treatment of oxides of nitrogen

It was assumed that 70% of NOx emitted from the assessed combustion plant will be converted to NO_2 at ground level in the vicinity of the site, for determination of the annual mean NO_2 concentrations, and 35% of emitted NOx will be converted to NO_2 for determination of the hourly mean NO_2 concentrations, in line with guidance provided by the Environment Agency (Environment Agency, 2021). This approach is likely to overestimate the annual mean NO_2 concentrations considerably at the most relevant assessment locations close to the site.

A.7 Calculation of PECs

In the case of long-term mean concentrations, it is relatively straightforward to combine modelled process contributions with baseline air quality levels, as long-term mean concentrations due to plant emissions could be added directly to long-term mean baseline concentrations.

It is not possible to add short-period peak baseline and process concentrations directly. This is because the conditions which give rise to peak ground-level concentrations of substances emitted from an elevated source at a particular location and time are likely to be different to the conditions which give rise to peak concentrations due to emissions from other sources.

As described in the Environment Agency guidance (Environment Agency, 2022), for most substances the short-term peak PC values are added to twice the long-term mean baseline concentration to provide a reasonable estimate of peak concentrations due to emissions from all assessed sources.

A.8 Modelling Uncertainty

There are always uncertainties in dispersion models, in common with any environmental modelling study, because a dispersion model is an approximation of the complex processes which take place in the atmosphere. Some of the key factors which lead to uncertainty in atmospheric dispersion modelling are as follows.

- The quality of the model output depends on the accuracy of the input data enter the model. Where model input data are a less reliable representation of the true situation, the results are likely to be less accurate.
- The meteorological data sets used in the model are not likely to be completely representative of the meteorological conditions at the site. However, the most suitable available meteorological data was chosen for the assessment.
- Models are generally designed on the basis of data obtained for large scale point sources and may be less well validated for modelling emissions from smaller scale sources.
- The dispersion of pollutants around buildings is a complex scenario to replicate. Dispersion models can take account of the effects of buildings on dispersion; however, there will be greater uncertainty in the model results when buildings are included in the model (although in the case of the buildings and structures at the site, these are relatively small-scale and uncertainty would be limited).
- Modelling does not specifically take into account individual small-scale features such as vegetation, local terrain variations and off-site buildings. The roughness length (zo) selected is suitable to take general account of the typical size of these local features within the model domain.

To take account of these uncertainties and to ensure the predictions are more likely to be over-estimates than under-estimates, the conservative assumptions described below have been used for this assessment.

A.9 Conservative assumption

The conservative assumptions adopted in this study are summarised below.

- The SGT-750 gas turbine was assumed to operate for 8,760 hours each calendar year at the process condition which would lead to the highest environmental concentrations of pollutants, but in practice, it will only operate at this process condition for a relatively small proportion of the year (approximately 10%). Other process conditions would lead to lower environmental concentrations and there would extended periods during the year when the SGT-750 would not operate. For the existing scenario, the two RB211 units were also assumed to operate for 8,760 hours each calendar year, which would not occur in practice.
- The existing RB211 gas turbine was assumed to operate in conjunction with the SGT-750 operating at its maximum process condition. This would not occur in practice as this combined operation would only occur when the SGT-750 is at a lower power output. For determination of annual mean concentrations the RB211 was assumed to operate for 500 hours each calendar year (the maximum permitted) and for short-term means, it was assumed to operate continuously for the full year.
- The study is based on emissions being continuously at the specified emission limits or guaranteed emission concentrations.
- The maximum predicted concentrations at any residential areas as well as off-site locations were considered for the assessment of short-term concentrations and the maximum predicted concentrations

at any residential areas were considered for assessment of annual mean concentrations within the air quality study area. Concentrations at other locations will be less than the maximum values presented.

- The highest predicted concentrations obtained using any of the five different years of meteorological data have been used in this assessment. During a typical year the ground level concentrations are likely to be lower.
- It was assumed the vegetation type selected for the respective designated sites is present at the specific modelled location where the highest PC was predicted.

Appendix B. Calculating Acid and Nitrogen Deposition

Nitrogen and deposition have been predicted using the methodologies presented in the Air Quality Technical Advisory Group (AQTAG) guidance note: AQTAG 06 "Technical Guidance on Detailed Modelling Approach for an Appropriate Assessment for Emissions to Air" (AQTAG, 2014).

When assessing the deposition of nitrogen, it is important to consider the different deposition properties of nitric oxide and nitrogen dioxide. It is generally accepted that there is no wet or dry deposition arising from nitric oxide in the atmosphere. Thus, it is normally necessary to distinguish between nitric oxide (NO) and nitrogen dioxide in a deposition assessment. In this case, the conservative assumption that 70% of the oxides of nitrogen are in the form of nitrogen dioxide was adopted.

Information on the existing nitrogen and acid deposition was obtained from the APIS database (Centre for Ecology and Hydrology, 2022). Information on the deposition critical loads for the SSSI and local nature sites were also obtained from the APIS database using the Site Relevant Critical Load function and Search by Location function, respectively.

The annual dry deposition flux can be obtained from the modelled annual average ground level concentration via use of the formula:

Dry deposition flux (μg/m^2/s) = ground level concentration (μg/m^3) x deposition velocity (m/s)

(where μg refers to μg of the chemical species under consideration).

The deposition velocities for various chemical species recommended for use (AQTAG, 2014) are shown below in Table B-1.

Table B-1. Recommended dry deposition velocities

Chemical species	Recommended deposition velocity (m/s)	
NO_2	Grassland (short)	0.0015
	Forest (tall)	0.003

To convert the dry deposition flux from units of μg/m^2/s (where μg refers to μg of the chemical species) to units of kg N/ha/yr (where kg refers to kg of nitrogen) multiply the dry deposition flux by the conversion factors shown in Table B-2. To convert dry deposition flux to acid deposition multiply by factors shown in Table B-3.

Table B-2. Dry deposition flux conversion factors for nutrient nitrogen deposition

μg/m^2/s of species	Conversion factor to kg N/ha/yr
NO_2	95.9

Table B-3. Dry deposition flux conversion factors for acidification

μg/m^2/s of species	Conversion factor to keq/ha/yr
NO_2	6.84

Appendix C. Results at Human and Ecological Receptors

Table C-1. Results of detailed assessment at sensitive human receptor locations for maximum 8-hour mean and 1-hour mean CO predicted concentrations

Receptor ID	Baseline air quality level (µg/m^3)	Maximum 8-hour running mean					Maximum 1-hour mean				
		EQS (µg/m^3)	PC (µg/m^3)	PEC (µg/m^3)	PC/EQS (%)	PEC/EQS (%)	EQS (µg/m^3)	PC (µg/m^3)	PEC (µg/m^3)	PC/EQS (%)	PEC/EQS (%)
R1	202	10,000	16.0	218	0.2	2.2	30,000	17.7	219	0.1	0.7
R2	202		18.5	220	0.2	2.2		20.5	222	0.1	0.7
R3	202		21.3	223	0.2	2.2		22.5	224	0.1	0.7
R4	202		22.3	224	0.2	2.2		23.6	225	0.1	0.8
R5	202		20.5	222	0.2	2.2		23.8	225	0.1	0.8
R6	202		15.7	217	0.2	2.2		18.4	220	0.1	0.7
R7	202		12.1	214	0.1	2.1		13.2	215	<0.1	0.7
R8	202		9.9	212	0.1	2.1		12.1	214	<0.1	0.7
R9	202		10.4	213	0.1	2.1		12.5	215	<0.1	0.7
R10	202		18.0	220	0.2	2.2		21.3	224	0.1	0.7
R11	202		18.8	221	0.2	2.2		21.6	224	0.1	0.7
R12	202		19.2	222	0.2	2.2		22.1	225	0.1	0.7
R13	202		12.2	215	0.1	2.1		15.2	218	0.1	0.7
R14	202		21.1	224	0.2	2.2		25.7	228	0.1	0.8
R15	202		18.9	221	0.2	2.2		23.9	226	0.1	0.8
R16	203		22.4	226	0.2	2.3		23.7	227	0.1	0.8
R17	203		22.7	226	0.2	2.3		24.2	228	0.1	0.8
R18	203		19.0	222	0.2	2.2		25.5	229	0.1	0.8
R19	203		17.1	221	0.2	2.2		21.2	225	0.1	0.7
R20	203		15.1	218	0.2	2.2		19.7	223	0.1	0.7
R21	203		12.9	216	0.1	2.2		17.1	220	0.1	0.7
R22	204		4.6	209	<0.1	2.1		6.2	210	<0.1	0.7
R23	202		8.1	210	0.1	2.1		9.0	211	<0.1	0.7
R24	202		*35.5*	*237*	*0.4*	*2.4*		44.4	246	0.1	0.8

Receptor ID	Baseline air quality level (µg/m³)	Maximum 8-hour running mean					Maximum 1-hour mean				
		EQS (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)	EQS (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
R25	202		*31.1*	*233*	*0.3*	*2.3*		39.2	241	0.1	0.8
R26	202		*26.1*	*229*	*0.3*	*2.3*		31.1	234	0.1	0.8
R27	202		*44.2*	*246*	*0.4*	*2.5*		86.8	288	0.3	1.0
R28	202		*47.5*	*249*	*0.5*	*2.5*		119.2	321	0.4	1.1
R29	202		*86.8*	*288*	*0.9*	*2.9*		97.3	299	0.3	1.0
R30	202		*56.3*	*258*	*0.6*	*2.6*		57.2	259	0.2	0.9
R31	202		*34.6*	*236*	*0.3*	*2.4*		40.4	242	0.1	0.8
R32	202		*41.3*	*243*	*0.4*	*2.4*		50.0	252	0.2	0.8

Table C-2. Results of detailed assessment at sensitive human receptor locations for annual mean NO_2 and 1-hour mean (99.79th percentile) NO_2 predicted concentrations

Receptor ID	Baseline air quality level (µg/m³)	Annual mean					99.79th percentile of 1-hour mean					
		EQS (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)	EQS (µg/m³)	Baseline air quality level (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
R1	7.7	40	0.29	8.0	0.7	19.9	200	15.4	9.8	25.1	4.9	12.6
R2	7.7		0.41	8.1	1.0	20.2		15.4	11.5	26.8	5.7	13.4
R3	7.7		0.48	8.2	1.2	20.4		15.4	12.7	28.0	6.3	14.0
R4	7.7		0.48	8.2	1.2	20.4		15.4	13.3	28.6	6.6	14.3
R5	7.7		0.41	8.1	1.0	20.2		15.4	13.1	28.4	6.5	14.2
R6	7.3		0.25	7.5	0.6	18.9		14.6	9.8	24.4	4.9	12.2
R7	7.3		0.17	7.5	0.4	18.7		14.6	7.0	21.5	3.5	10.8
R8	7.3		0.15	7.4	0.4	18.6		14.6	6.2	20.7	3.1	10.4
R9	7.4		0.09	7.5	0.2	18.8		14.8	6.1	20.9	3.0	10.5
R10	7.5		0.11	7.6	0.3	19.0		14.9	10.5	25.5	5.3	12.7

Receptor ID	Baseline air quality level (µg/m³)	Annual mean					99.79th percentile of 1-hour mean					
		EQS (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)	EQS (µg/m³)	Baseline air quality level (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
R11	7.5		0.11	7.6	0.3	19.0		14.9	10.4	25.4	5.2	12.7
R12	7.5		0.12	7.6	0.3	19.0		14.9	10.9	25.9	5.5	12.9
R13	7.5		0.08	7.5	0.2	18.9		14.9	7.2	22.2	3.6	11.1
R14	7.5		0.12	7.6	0.3	19.0		14.9	13.3	28.3	6.7	14.1
R15	7.5		0.14	7.6	0.3	19.0		14.9	12.0	26.9	6.0	13.5
R16	7.8		0.12	8.0	0.3	19.9		15.7	12.1	27.8	6.1	13.9
R17	7.8		0.12	8.0	0.3	19.9		15.7	12.1	27.8	6.1	13.9
R18	7.8		0.09	7.9	0.2	19.8		15.7	11.1	26.8	5.6	13.4
R19	7.8		0.08	7.9	0.2	19.8		15.7	9.5	25.1	4.7	12.6
R20	7.8		0.07	7.9	0.2	19.8		15.7	8.6	24.3	4.3	12.1
R21	7.8		0.06	7.9	0.1	19.8		15.7	7.6	23.3	3.8	11.6
R22	7.3		0.03	7.4	0.1	18.4		14.7	3.0	17.7	1.5	8.8
R23	7.5		0.08	7.5	0.2	18.8		14.9	4.7	19.6	2.4	9.8
R24	7.7		*0.21*	*7.9*	*0.5*	*19.7*		15.4	20.9	36.3	10.4	18.1
R25	7.7		*0.14*	*7.8*	*0.3*	*19.6*		15.4	17.1	32.4	8.5	16.2
R26	7.5		*0.11*	*7.6*	*0.3*	*19.0*		14.9	11.9	26.8	5.9	13.4
R27	7.7		*0.05*	*7.7*	*0.1*	*19.3*		15.4	14.5	29.9	7.3	14.9
R28	7.7		*0.18*	*7.9*	*0.4*	*19.6*		15.4	25.8	41.2	12.9	20.6
R29	7.7		*0.41*	*8.1*	*1.0*	*20.2*		15.4	52.5	67.8	26.2	33.9
R30	7.7		*0.53*	*8.2*	*1.3*	*20.5*		15.4	32.8	48.1	16.4	24.1
R31	7.7		*0.43*	*8.1*	*1.1*	*20.3*		15.4	22.1	37.5	11.1	18.8
R32	7.7		*0.26*	*7.9*	*0.6*	*19.9*		15.4	22.7	38.1	11.3	19.0

Table C-3. Results of detailed assessment at assessed protected conservation site for annual mean NOx and 24-hour mean NOx concentrations

Receptor ID	Annual mean						Daily mean					
	Baseline air quality level (μg/m^3)	EQS (μg/m^3)	PC (μg/m^3)	PEC (μg/m^3)	PC/EQS (%)	PEC/EQS (%)	EQS (μg/m^3)	Baseline air quality level (μg/m^3)	PC (μg/m^3)	PEC (μg/m^3)	PC/EQS (%)	PEC/EQS (%)
H1	9.0	30	0.01	9.0	<0.1	29.9	75	17.9	0.5	18.4	0.6	24.5
H2	9.3		0.02	9.3	0.1	31.1		18.6	0.8	19.4	1.1	25.9
H3	9.2		0.04	9.3	0.1	30.9		18.5	0.9	19.4	1.2	25.8
H4	9.3		0.03	9.3	0.1	31.1		18.6	0.8	19.4	1.1	25.9
H5	9.4		0.03	9.4	0.1	31.4		18.8	0.8	19.6	1.1	26.1
H6	9.3		0.08	9.4	0.3	31.4		18.7	2.2	20.9	3.0	27.9
H7	9.4		0.01	9.4	<0.1	31.4		18.8	0.8	19.6	1.0	26.1
H8	9.4		0.01	9.4	<0.1	31.4		18.8	0.4	19.2	0.6	25.7
H9	9.4		0.01	9.4	<0.1	31.3		18.8	0.8	19.5	1.0	26.0
H10	9.4		<0.01	9.4	<0.1	31.2		18.7	0.4	19.1	0.6	25.5
H11	9.5		0.11	9.6	0.4	31.9		18.9	9.1	28.1	12.2	37.4
H12	9.8		0.01	9.8	<0.1	32.8		19.7	0.4	20.1	0.5	26.8
H13	9.0		0.03	9.0	0.1	30.0		18.0	2.5	20.4	3.3	27.2
H14	9.1		0.03	9.1	0.1	30.3		18.1	2.5	20.6	3.4	27.5
H15	9.7		0.01	9.7	<0.1	32.3		19.4	0.5	19.9	0.6	26.5
H16	9.0		0.01	9.0	<0.1	29.9		17.9	0.9	18.8	1.2	25.1
H17	9.5		0.09	9.6	0.3	31.8		18.9	6.5	25.5	8.7	34.0
H18	9.2		0.06	9.2	0.2	30.7		18.3	4.6	22.9	6.1	30.5
H19	9.4		0.35	9.7	1.2	32.4		18.8	11.5	30.3	15.4	40.4
H20	9.5		0.14	9.6	0.5	32.0		18.9	11.1	30.0	14.8	40.0
H21	9.5		0.09	9.6	0.3	31.8		18.9	6.9	25.8	9.2	34.4
H22	9.2		0.05	9.2	0.2	30.7		18.3	3.6	21.9	4.7	29.2
H23	9.3		0.05	9.3	0.2	31.1		18.6	4.4	23.0	5.9	30.7

Receptor ID	Annual mean						Daily mean					
	Baseline air quality level ($\mu g/m^3$)	EQS ($\mu g/m^3$)	PC ($\mu g/m^3$)	PEC ($\mu g/m^3$)	PC/EQS (%)	PEC/EQS (%)	EQS ($\mu g/m^3$)	Baseline air quality level ($\mu g/m^3$)	PC ($\mu g/m^3$)	PEC ($\mu g/m^3$)	PC/EQS (%)	PEC/EQS (%)
H24	9.5		0.04	9.6	0.1	32.0		19.1	5.6	24.7	7.5	32.9
H25	10.1		0.05	10.2	0.2	34.0		20.3	6.3	26.6	8.4	35.5

Table C-4. Modelled acid deposition at assessed ecological receptors

Ref	Ecological receptor	Vegetation type (for deposition velocity)	Critical load (CL) ($kEqH^+/ha/year$)			Acid deposition ($kEqH^+/ha/year$)					
			CLMaxS	CLMinN	CLMaxN	Existing deposition (N)	Existing deposition (S)	PC	PEC	PC/CL (%)	PEC/CL (%)
H1	Hainton Sheepwalk SSSI	Short	1.600	0.438	2.038	1.7	0.2	0.0001	1.8	<0.01	90.0
H2	Withcall and South Willingham Tunnels SSSI	Not assessed – no critical load data available									
H3	Benniworth Haven Cuttings SSSI	Not assessed – no critical load data available									
H4	Red Hill SSSI	Short	4.000	0.856	4.856	1.6	0.2	0.0002	1.8	<0.01	37.0
H5	Silverines Meadows SSSI	Short	0.830	0.223	1.053	1.7	0.2	0.0002	1.8	0.02	172.4
H6	Sotby Meadows SSSI	Short	4.000	1.071	5.071	1.7	0.1	0.0006	1.8	0.01	36.0
H7	High Barn, Oxcombe SSSI	Short	4.000	0.856	4.856	1.8	0.2	0.0001	2.0	<0.01	41.1
H8	Woodhall Spa Golf course SSSI	Short	0.820	0.714	1.534	1.6	0.1	<0.0001	1.8	<0.01	115.4
H9	Moor Farm SSSI	Short	0.145	0.321	0.466	1.6	0.1	<0.0001	1.8	0.01	379.4
H10	Kirkby Moor SSSI	Short	0.420	0.714	1.134	1.6	0.1	<0.0001	1.8	<0.01	154.5
H11	Bardney Limewoods, Lincolnshire SSSI and Bardney Limewoods NNR	Tall	8.245	0.357	8.602	2.9	0.2	0.0016	3.0	0.02	35.5
H12	Potterhanworth Wood SSSI	Tall	2.224	0.357	2.581	2.8	0.2	0.0001	3.0	<0.01	116.8

Ref	Ecological receptor	Vegetation type (for deposition velocity)	Critical load (CL) ($kEqH^+/ha/year$)			Acid deposition ($kEqH^+/ha/year$)					
			CLMaxS	CLMinN	CLMaxN	Existing deposition (N)	Existing deposition (S)	PC	PEC	PC/CL (%)	PEC/CL (%)
H13	Little Scrubbs Meadow SSSI	Short	4.000	1.071	5.071	1.7	0.1	0.0002	1.8	<0.01	35.6
H14	Gosling's Corner SSSI and Gosling's Corner Ancient Woodland (ID 1115503)	Tall	2.263	0.357	2.620	2.9	0.2	0.0004	3.0	0.02	116.2
H15	Wickenby Wood SSSI	Tall	2.291	0.357	2.648	2.6	0.2	0.0001	2.8	<0.01	104.4
H16	Linwood Warren SSSI	Tall	0.704	0.285	0.989	2.6	0.2	0.0001	2.8	0.01	285.2
H17	Hatton Wood Ancient Woodland (ID 1115511)	Tall	8.245	0.357	8.602	2.9	0.2	0.0012	3.1	0.01	35.8
H18	Hatton Wood Ancient Replanted Woodland (ID 1115511)	Tall	8.216	0.357	8.573	2.8	0.2	0.0009	3.0	0.01	35.0
H19	Sotby Wood LWS	Short	4.000	1.071	5.071	1.7	0.1	0.0025	1.8	0.05	36.3
		Tall	8.258	0.357	8.615	2.9	0.2	0.0050	3.1	0.06	35.8
H20	Hatton Meadows LWS	Short	4.000	1.071	5.071	1.7	0.1	0.0010	1.8	0.02	36.3
H21	Chambers Plantation LWS	Short	4.000	1.071	5.071	1.7	0.1	0.0006	1.8	0.01	36.3
		Tall	8.245	0.357	8.602	2.9	0.2	0.0013	3.1	0.01	35.8
H22	Minting Wood LWS	Short	4.000	1.071	5.071	1.6	0.1	0.0004	1.8	0.01	34.7
		Tall	8.216	0.357	8.573	2.8	0.2	0.0008	3.0	0.01	35.0
H23	Coultas Wood LWS	Short	4.000	1.071	5.071	1.7	0.1	0.0004	1.8	0.01	36.3
		Tall	8.241	0.357	8.598	2.9	0.2	0.0007	3.1	0.01	35.8
H24	Hoop Lane Road Verges LWS	Short	4.000	1.071	5.071	1.7	0.1	0.0003	1.8	0.01	36.3
		Tall	2.249	0.357	2.606	2.9	0.2	0.0006	3.1	0.02	118.2
H25	Withcall Meadow LWS	Short	4.000	1.071	5.071	1.7	0.1	0.0003	1.8	0.01	36.3

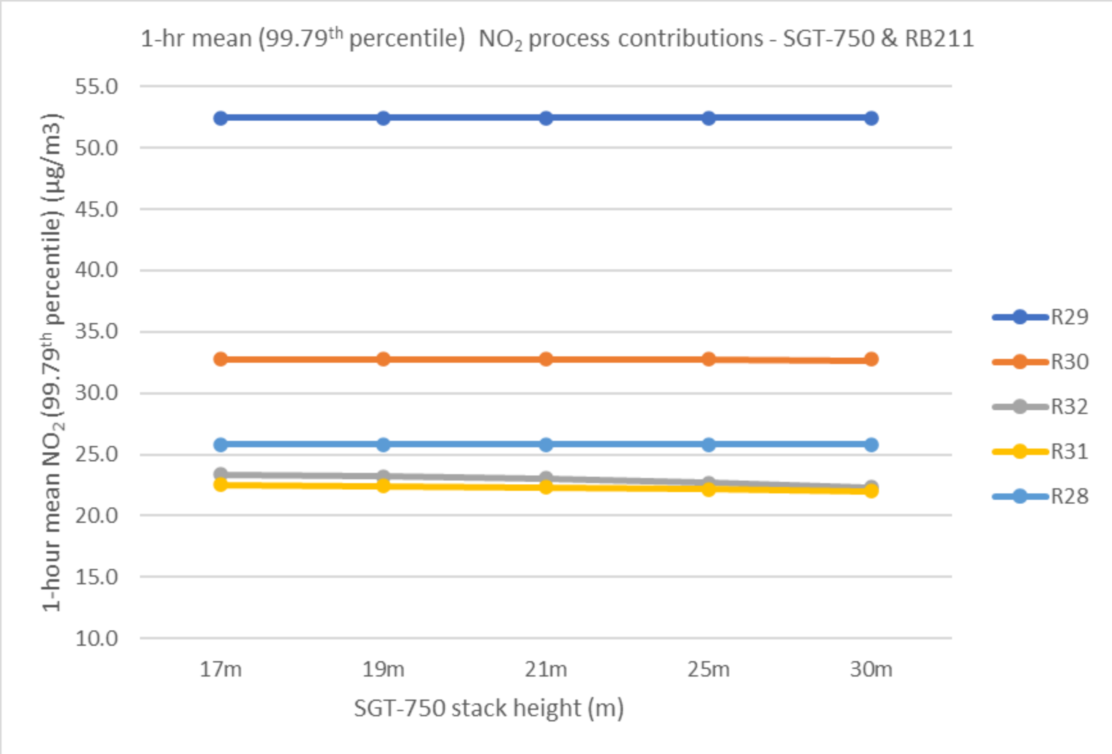
Table C-5. Modelled nitrogen deposition at assessed ecological receptors

Ref	Ecological receptor	Vegetation type (for deposition velocity)	Critical load (CL) (kgN/ha/year)	Nitrogen deposition (kgN/ha/year)				
				Existing deposition (N)	PC	PEC	PC/CL (%)	PEC/CL (%)
H1	Hainton Sheepwalk SSSI	Short	8	23.5	0.001	23.5	<0.01	293.6
H2	Withcall and South Willingham Tunnels SSSI	Not assessed – no critical load data available						
H3	Benniworth Haven Cuttings SSSI	Not assessed – no critical load data available						
H4	Red Hill SSSI	Short	15	23.0	0.003	23.0	0.02	153.4
H5	Silverines Meadows SSSI	Short	8	23.3	0.003	23.3	0.04	291.0
H6	Sotby Meadows SSSI	Short	20	23.5	0.008	23.5	0.04	117.7
H7	High Barn, Oxcombe SSSI	Short	15	25.7	0.001	25.7	0.01	171.3
H8	Woodhall Spa Golf course SSSI	Short	10	22.9	0.001	22.9	0.01	229.2
H9	Moor Farm SSSI	Short	5	22.8	0.001	22.8	0.01	456.9
H10	Kirkby Moor SSSI	Short	10	22.7	<0.0001	22.7	<0.01	226.6
H11	Bardney Limewoods, Lincolnshire SSSI and Bardney Limewoods NNR	Tall	10	40.3	0.023	40.3	0.23	402.8
H12	Potterhanworth Wood SSSI	Tall	15	39.9	0.001	39.9	0.01	265.9
H13	Little Scrubbs Meadow SSSI	Short	20	23.2	0.003	23.2	0.02	115.8
H14	Gosling's Corner SSSI and Gosling's Corner Ancient Woodland (ID 1115503)	Tall	15	40.1	0.006	40.1	0.04	267.3
H15	Wickenby Wood SSSI	Tall	15	36.4	0.001	36.4	0.01	242.6
H16	Linwood Warren SSSI	Tall	10	36.9	0.002	36.9	0.02	369.4
H17	Hatton Wood Ancient Woodland (ID 1115511)	Tall	10	40.7	0.017	40.8	0.17	407.6
H18	Hatton Wood Ancient Replanted Woodland (ID 1115511)	Tall	10	39.8	0.012	39.8	0.12	397.7
H19	Sotby Wood LWS	Short	10	23.8	0.035	23.8	0.35	238.3
		Tall	5	40.7	0.070	40.8	1.40	816.2
H20	Hatton Meadows LWS	Short	10	23.8	0.014	23.8	0.14	238.1
H21	Chambers Plantation LWS	Short	10	23.8	0.009	23.8	0.09	238.1
		Tall	5	40.7	0.018	40.8	0.35	815.2

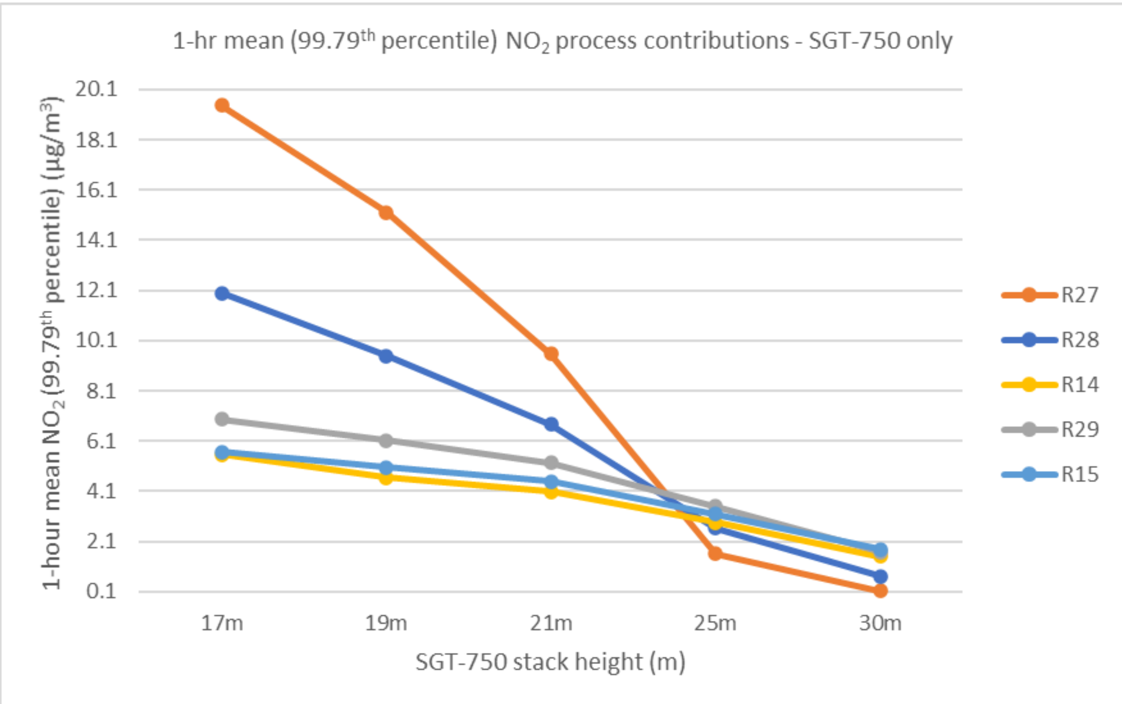
Ref	Ecological receptor	Vegetation type (for deposition velocity)	Critical load (CL) (kgN/ha/year)	Nitrogen deposition (kgN/ha/year)				
				Existing deposition (N)	PC	PEC	PC/CL (%)	PEC/CL (%)
H22	Minting Wood LWS	Short	10	22.8	0.005	22.8	0.05	228.3
		Tall	5	39.8	0.011	39.8	0.21	795.4
H23	Coultas Wood LWS	Short	10	23.8	0.005	23.8	0.05	238.0
		Tall	5	40.7	0.010	40.7	0.20	815.0
H24	Hoop Lane Road Verges LWS	Short	5	23.8	0.004	23.8	0.08	476.1
		Tall	10	40.7	0.008	40.7	0.08	407.5
H25	Withcall Meadow LWS	Short	10	23.8	0.005	23.8	0.05	238.0

Appendix D. Stack Height Sensitivity Analysis

Graph 1: Predicted 1-hour mean NO_2 concentrations (PC) for SGT-750 and RB211

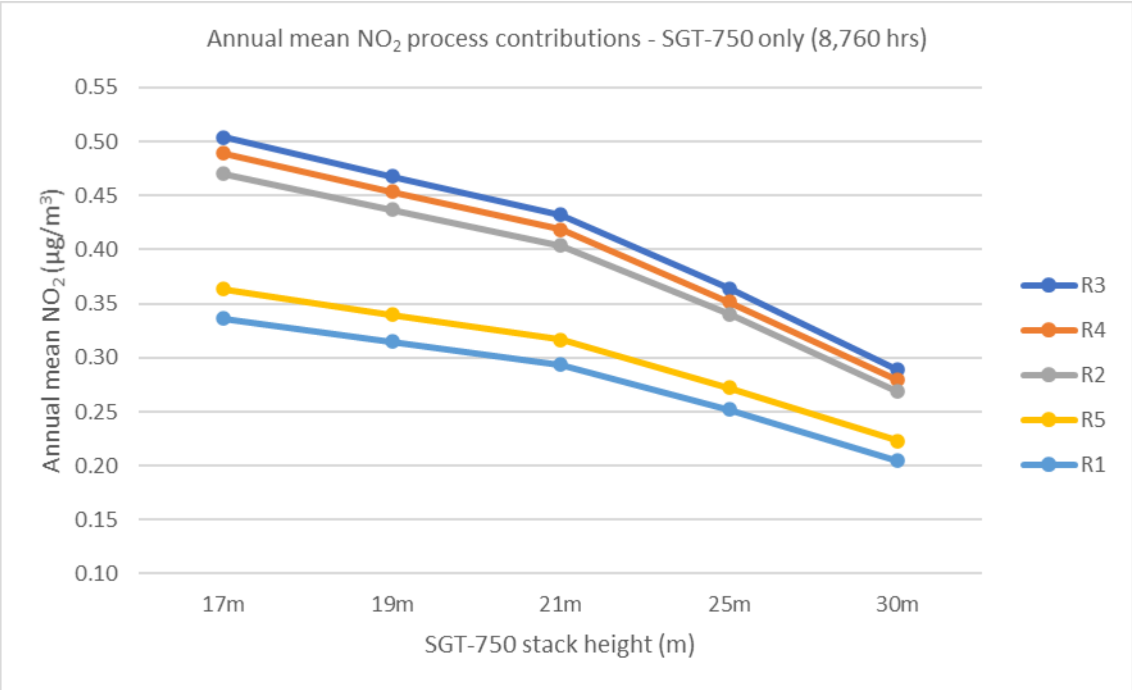


Graph 2: Predicted 1-hour mean NO_2 concentrations (PC) for SGT-750



Graph 3: Predicted annual mean NO_2 concentrations (PC) for SGT-750 and RB211

Graph 4: Predicted annual mean NO_2 concentrations (PC) for SGT-750



Graph 1 and Graph 2 shows the results of the dispersion modelling study for stack heights between 17 m and 30 m for the PCs of 1-hour mean NO_2 (99.79th percentile) at the top 5 receptor locations. Graph 1 shows that the highest ground level concentrations are influenced by the existing RB211 emissions as there is very little decrease observed for increases in the SGT-750 gas turbine stack height. Graph 2 demonstrates the improvement in ground level concentrations when increasing the stack height for the SGT-750 gas turbine, when considered in isolation.

Graph 3 and Graph 4 shows the results of the dispersion modelling study for stack heights between 17 m and 30 m for the PCs of annual mean NO_2 at the top 5 receptor locations. As the RB211 has less influence on annual mean concentrations due to the limit of 500 hours operation, a similar pattern of decreasing concentrations is observed with the SGT-750 gas turbine operating in isolation and with the RB211.

Appendix 6: Compressor machinery BAT assessment

Author's Note – Hatton BAT assessments

This appendix presents the Best Available Techniques (BAT) assessments carried out in support of the selection of the new compressor machinery train at Hatton. The process adopted the National Gas Transmission BAT assessment methodology as defined in specification procedure T/SP/ENV/21. This process was developed in liaison with the Environment Agency (EA) and Scottish Environment Protection Agency (SEPA) and has been in use for the selection of all new or modified compressor machinery since 2013.

The BAT assessment was carried out in a staged process, commencing with the high level selection of options in a pre-call off BAT assessment. Following liaison with the EA and Ofgem[1] on the stage findings a subsequent market call off BAT assessment was carried out; this incorporate feedback from the early EA and Ofgem liaison. This was reported in June 2019 and comprises the first document in this appendix namely 'Hatton Compressor Upgrade BAT Assessment, National Grid Gas plc.'

The findings of this paper, which identified several candidate BAT options for Hatton, were subject to Ofgem and EA review. Ofgem directed National Gas Transmission (then National Grid Gas Transmission) that they would only approve funding for a single new machine, in line with the principles of the RIIO[2] price control process. On this basis National Gas Transmission went back to market with a reduced list of lots, each being a valid candidate BAT option, to determine the preferred BAT solution for a single new machine. This was reported in December 2020 and is presented as the second document in this appendix, namely 'Hatton Compressor Upgrade: Revised Lot 2B call off BAT assessment, National Grid Gas plc.'

This final stage assessment lead to the selection of chosen Siemens SGT-750 package option as the BAT solution for the Hatton upgrade. There then followed a series of internal and external governance exercises which led to the award of the contract.

These two papers should be read sequentially in order to understand the development of the BAT selection process which was carried out in a consultative manner with all key skateholders over a period of three years.

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[1] National Gas Transmission's financial regulator that must approve all network investments

[2] RIIO or 'Revenue = Incentives + Innovation + Outputs' is an Ofgem framework to ensure that energy transmission and distribution companies (including National Gas Transmission) provide a safe and reliable service, delivery value for money, maximise performance, operate efficiently, innovate and ensure the resilience of their networks for current and future customers.

Hatton Compressor Upgrade BAT Assessment

National Grid Gas plc

June 2019

FINAL – PUBLIC REGISTER REVISION

Project Environmental Solutions

www.peslconsulting.com

Quality control sheet

Project details

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Contents

1 Introduction

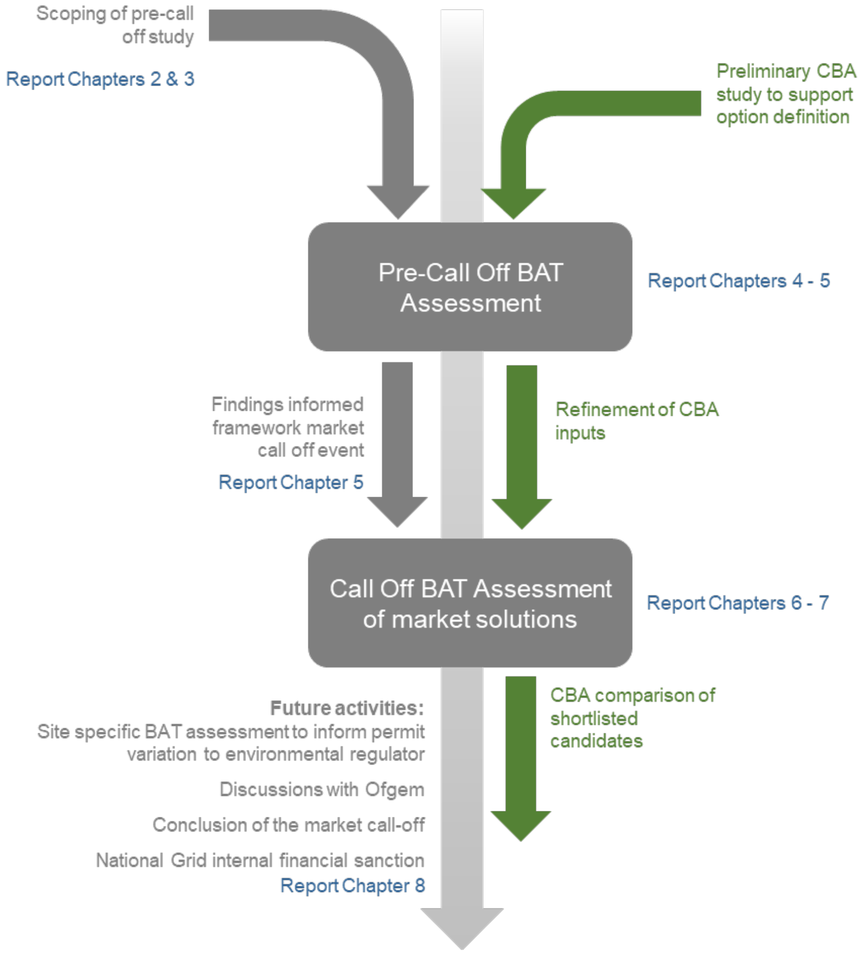
National Grid Gas plc (National Grid) commissioned Project Environmental Solutions Ltd (PESL) to support the Best Available Technique (BAT) assessment conducted to determine the most appropriate compressor machinery train upgrade options for the Hatton Gas Compressor Station (hereafter Hatton), to meet the requirements of the Environment Agency (EA) in respect of the site's Environmental Permit (EP) and Ofgem[1], in respect of National Grid's gas transporter licence obligations.

1.1 Study approach and reporting

This report describes the assessment of BAT carried out in respect of the proposed Hatton gas compressor upgrade project. The assessment was carried out in two stages, a 'Pre-call off Preliminary BAT Assessment' to provide indicative results and test key assessment assumptions, followed by a 'Call off BAT Assessment' undertaken on market derived candidate solutions offered by participants on National Grid's Gas Pipeline Compressor Machinery Train Package Framework (hereafter 'the framework'). The assessment has been carried out in parallel using National Grid's internal Cost Benefit Analysis (CBA) tool.

At the time of writing (June 2019), the call off event is still ongoing, thus the findings reported are interim conclusions based on the initial candidate shortlisting steps (referred to as Call Off Stage 1 (COS1)). The preliminary conclusions have been reviewed by EA[2] and will be subject to discussion with Ofgem.

Figure 1 Study and report overview



[1] Ofgem - The Office of Gas and Electricity Markets, the government regulator for gas and electricity markets in Great Britain.
[2] Network Review meeting presentation, 09.05.2019

1.2 Report structure

The remainder of this report sets out:

- The project drivers and site overview in Chapter 2.
- An overview of the BAT process in Chapter 3.
- The pre-call off BAT assessment methodology and findings are discussed in Chapters 4 and 5, respectively.
- The call off BAT assessment methodology and findings are discussed in Chapters 6 and 7, respectively.
- Key conclusions, together with study limitations and future activities are discussed in Chapter 8.

Information Boxes

At key points in the document information boxes are provided which present additional information for the benefit of the reader. These boxes are designed to reflect the different levels of familiarity amongst the audience of the topics in question; the remaining report text outside of these boxes is designed to provide key elements of the study and its findings for the reader familiar with the principal issues that are being addressed.

2 Project drivers and site overview

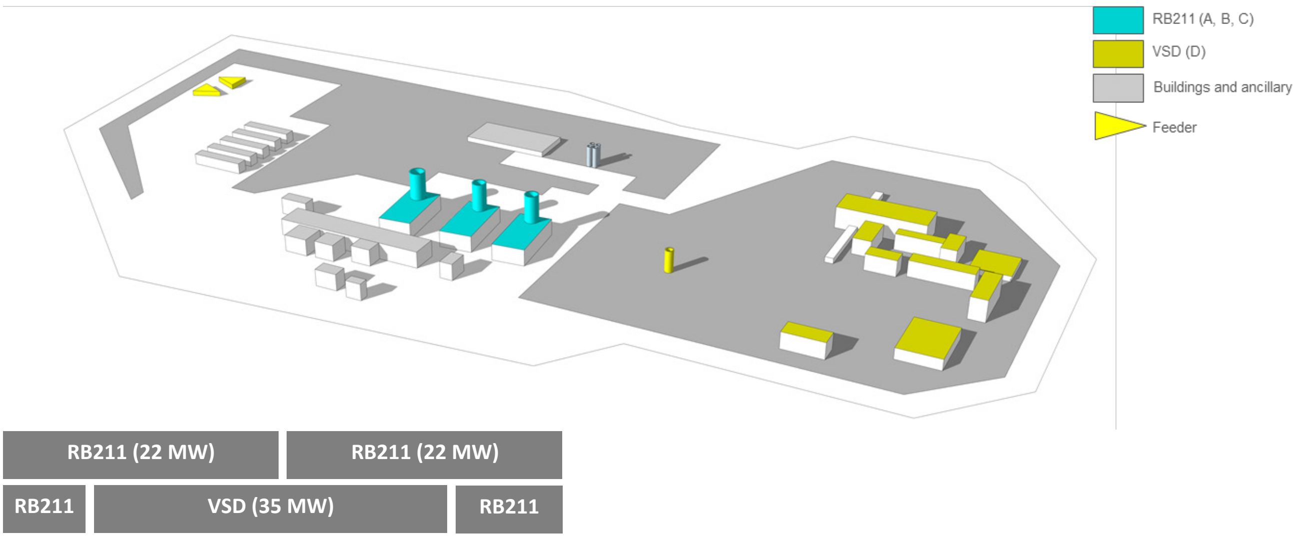
This chapter provides a contextual overview of National Grid's Hatton site and explains the key drivers behind the proposed compressor upgrade project.

2.1 Hatton site overview

National Grid's Hatton site is a key compressor installation that has historically seen high levels of duty; its purpose is to compress gas, increasing flows and pressures in the network for onward transmission to the wider network and ultimately customers. Existing equipment comprises three legacy gas turbine driven compressors (Units A, B and C) installed in the 1980s, and a single modern electric Variable Speed Drive (VSD) compressor (Unit D) installed in the mid-2000s. The site PPC permit dictates that the BAT VSD unit is used, when operationally available, in preference to the legacy gas turbine driven compressors.

Key plant is illustrated on the site schematic below, the table underneath shows the modular way in which existing units can be combined to accommodate the full range of site power requirements (as megawatts (MW)).

Figure 2 Hatton schematic



2.2 Project Background

Gas turbine back-up to the electric VSD must be maintained into the future to provide security of supply, the site is already at its maximum acceptable reliance on third party energy supplies in using the VSD for bulk compression. As such, no further investment in electric drives can be made at the site; instead compression upgrades must utilise low emission gas turbine driven units.

There are three primary drivers for the proposed gas turbine compressor upgrade project:

- **Tightening environmental regulatory requirements associated with legacy gas turbines.** The existing Large Combustion Plant[3] (LCP) at the site comprising three Rolls-Royce RB211-24C gas turbine driven compressor sets (hereafter RB211s) are not capable of meeting existing plant emissions limits as set out in the Industrial Emissions Directive[4] (IED). As such, National Grid elected to place Unit A onto the 500 hours 'emergency use' derogation, this being the maximum hours the unit can run per year for the remainder of its operational life. Units B and C were placed under Limited Life Derogation (LLD) whereby they must be retired on the sooner of 17,500 run hours from derogation or 31/12/2023. Associated Emissions Levels (AELs) contained in the Large Combustion Plant BAT Reference (BREF) documents[5] also drive future compliance standards for the site, as may emission limit values set out in the Medium Combustion Plant[6] (MCP) Directive (depending on the size of any new combustion plant installed).
- **Mass emissions reduction.** National Grid is required to regularly review network wide environmental emissions performance with the Environment Agency (EA), Scottish Environment Protection Agency (SEPA) and Natural Resources Wales (NRW); this is called the Network Review, annual updates of which are set by a condition in all the sites' permits. This process, carried out in discussion with the environmental regulators, involves the review of options to make material improvements to site mass emissions of NOx (as well as improvements in CO emission concentrations). The improvements focus on those sites with higher running hours and older gas turbine compressor machinery; although Hatton was subject to an earlier phase of the Emissions Reduction Programme (ERP), when the VSD was installed, the remaining usage of the RB211 units makes the site a Network Review priority despite lead duty being preferentially met by the BAT compliant electric VSD compressor.
- **Asset Health.** There are a number of asset health issues associated with the compressor machinery at Hatton due to age and high utilisation.

[3] Plant with an individual thermal input in excess of 50MW
[4] Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control)
[5] Best Available Techniques (BAT) Reference Document for the Large Combustion Plants Industrial Emissions Directive 2010/75/EU (Integrated Pollution Prevention and Control) JOINT RESEARCH CENTRE. European IPPC Bureau. (December 2017) and Commission Implementing Decision (EU) 2017/1442 of 31 July 2017 establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for large combustion plants (August 2017).
[6] Directive (EU) 2015/2193 of the European Parliament and of the Council of 25 November 2015 on the limitation of emissions of certain pollutants into the air from medium combustion plants

3 BAT process overview

This chapter provides an overview of the principles of BAT and its application by National Grid to compressor machinery train selection. These principles are common to the pre-call off and market led call off BAT assessments, with only detailed aspects of the methodology varying with the stage of work.

3.1 Defining BAT

The principle of BAT underpins the IED regime; it can be defined as follows:

- **Best** means the most effective techniques for achieving a high general level of protection for the environment as a whole.
- **Available** means techniques developed on a scale which allows implementation in the relevant industrial sector under economically and technically viable conditions, taking into consideration the cost and advantages, whether or not the techniques are used or produced in the United Kingdom as long as they are reasonably accessible to the operator.
- **Techniques** includes both technology and the way the installation is designed, built, maintained, operated and decommissioned.

This definition can be distilled to its key expectation, namely that of a cost benefit analysis:

> *"The selection of techniques and practices to protect the environment should achieve an appropriate balance between benefits to the environment as a whole and the costs incurred by the operator"*

Inherent in this process is the requirement to consider whole life cost, together with drivers towards sustainable, low emissions, high efficiency and flexible technology; these demands are consistent with the objectives of RIIO[7] and will drive customer benefit.

3.2 The National Grid approach to the assessment of BAT

National Grid is legally bound under the IED to comply[8] with the requirements of BAT in respect of its compressor installations operating gas turbine driven compressor plant. Beyond this, National Grid made a policy decision in 2013 that BAT would be the primary selection mechanism for all new and substantially modified compressor machinery trains. This approach is consistent with National Grid's corporate objective to demonstrate Whole Life Value for its internal and external stakeholders. Other key requirements e.g. health and safety and system integration are addressed via compliance with National Grid's engineering standards.

A BAT assessment methodology has been developed by National Grid in discussion with the EA[9] and SEPA, based on an approach defined by the UK environmental regulators (See Information Box 1).

By following the principles of the regulators' approach, the National Grid method takes full account of the required considerations under sites' environmental permits, but in addition also seeks to:

- Ensure that the company's legal obligations with regard to procurement legislation and rules can be met, as the method is designed to be used as part of a live procurement event.
- Take account of primary operational criteria essential to the management of a critical national infrastructure asset, where its operator is subject to stringent legal gas supply obligations.

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7 RIIO. Revenue=Incentives+Innovation+Outputs, Ofgem's performance-based framework to set network price controls

8 Legally binding implementation is through site Environmental Permits in England and Wales and Pollution Prevention and Control (PPC) permits in Scotland

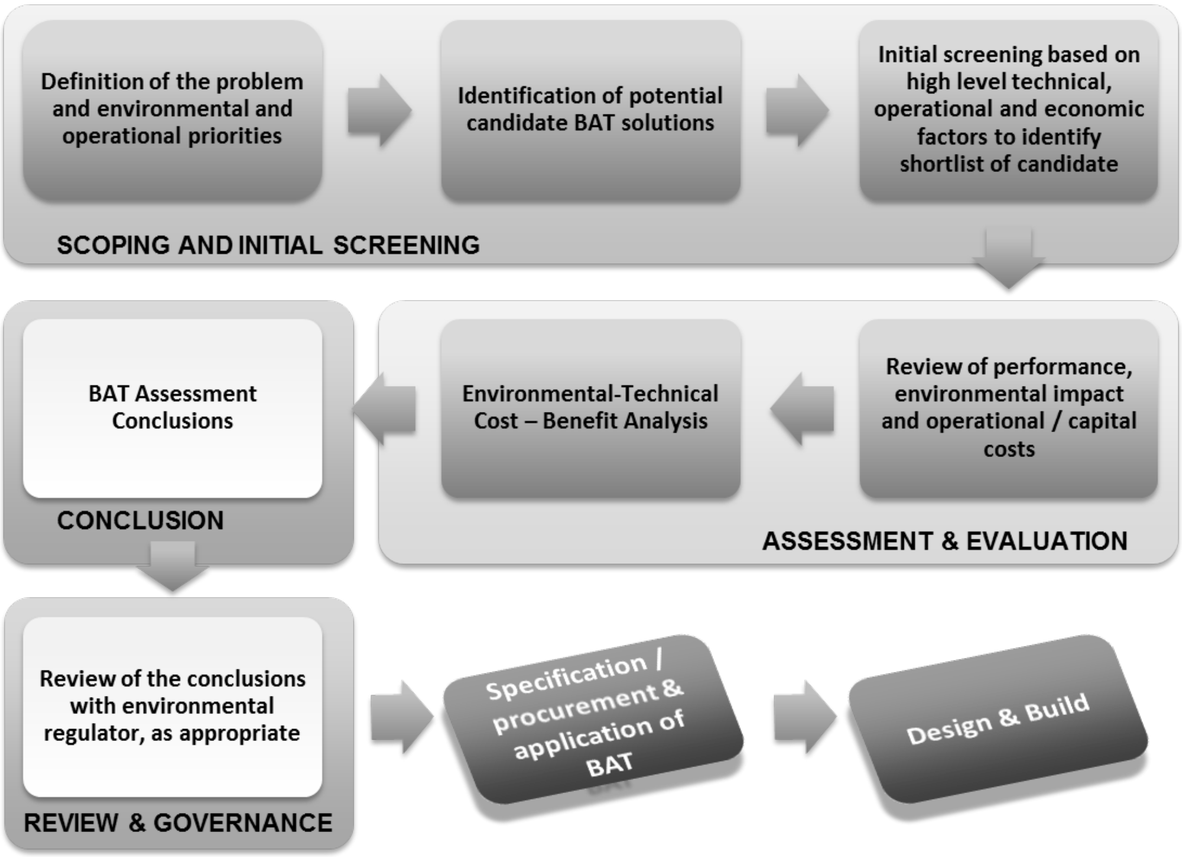
9 Consultation on the BAT methodology commenced prior to the separation of the EA and NRW

- Support the achievement of the company's wider sustainability obligations, in particular carbon dioxide reduction targets under its 'Our climate commitment' initiative[10].
- Align with OFGEM's expectations under the RIIO-T1 price control review[11].

The National Grid BAT assessment approach is a stepwise process (Figure 3), underpinned by a novel environmental-technical cost benefit analysis methodology which draws together the environmental and operational priorities that inform a particular decision relating to compressor machinery selection or modification. It is a decision support tool not a decision-making tool, professional environmental assessment and engineering judgement remains a key part of the process.

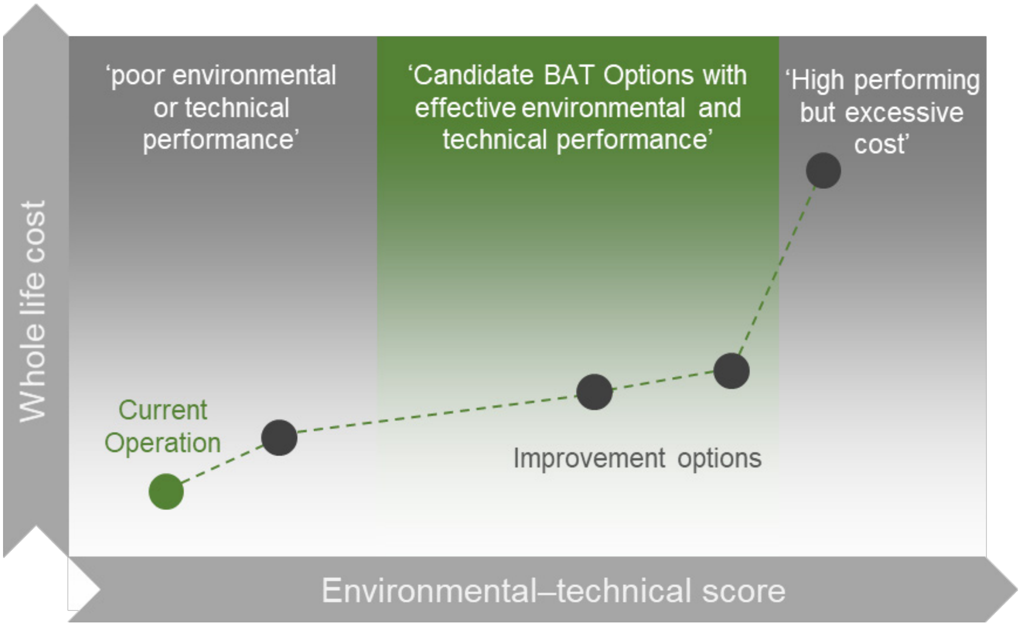
Due to the multiple drivers (comprising regulatory and commercial factors), the process brings technical / commercial / environmental evaluation criteria into a common assessment, rather than separate evaluations, and uses whole life cost rather than capital cost, reflecting that operating cost (fuel) is the greater proportion over a 20-40 years design life for compressor machinery. The approach uses spreadsheet models and delivers graphical outputs (Figure 4) and is formalised in National Grid Specification Procedure T/SP/ENV/21.

Figure 3 Principles of the National Grid BAT assessment process



[10] https://www.nationalgrid.com/group/responsibility-and-sustainability/environmental-sustainability/our-climate-commitment
[11] RIIO-T1, price control period 2013 – 2021.

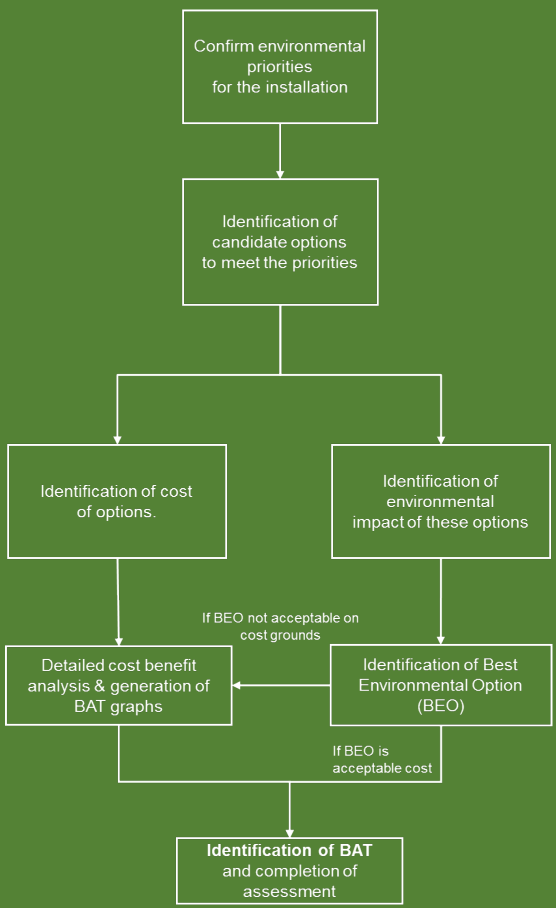
Figure 4 Conceptual illustration of graphical outputs from BAT model



Information Box 1: Principles of approach to BAT defined by UK environmental regulators

The assessment of BAT is a stepwise process following an established approach set out by the UK environmental regulators: the EA, SEPA and NRW. This method forms the basis for the National Grid BAT assessment approach.

Stepwise Regulator's BAT Model



- Given the adoption of BAT assessment as the primary selection method for new and substantially modified gas compressor machinery train, National Grid has defined additional primary operating criteria to be considered in the BAT assessment.

  These additional parameters, such as reliability, versatility, ownership, and constructability are all consistent with the principles of BAT and relate to the way the installation is "designed, built, maintained, operated and decommissioned."

3.3 BAT assessment and the CBA tool

In parallel to the BAT assessment process, National Grid has developed another Cost Benefit Analysis model (referred to as ‘the CBA Tool’). This is used to support need case approval for investment funding both internally within National Grid and externally with Ofgem.

There is much in common between the BAT assessment and CBA process, and the two tools share many common inputs. The principles differences relate to:

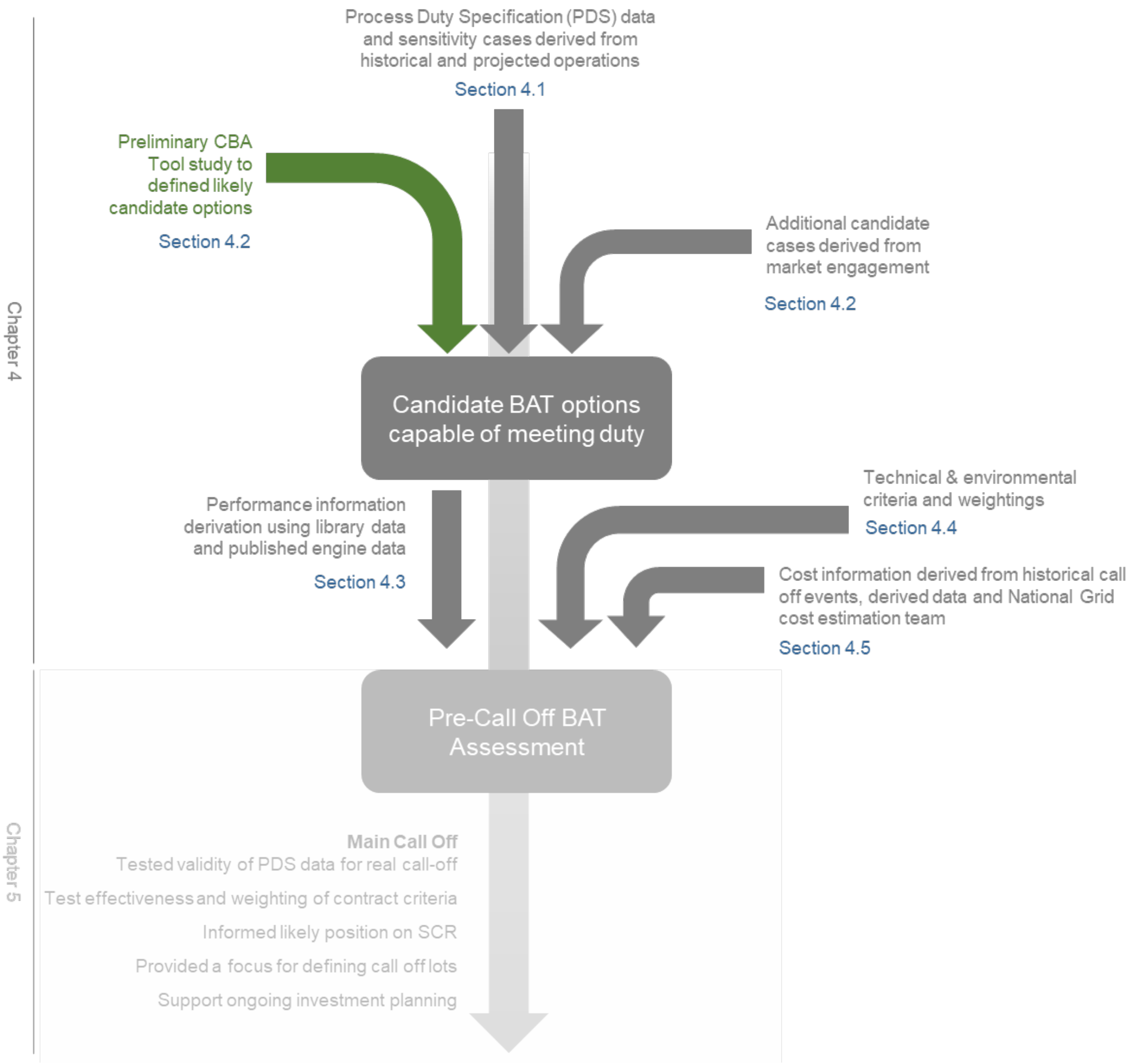
- Monetising of externalities in CBA tool (such as emission of NOx), which are addressed as scores in the BAT tool.
- Qualitative scoring of operational factors in the BAT tool (such as emissions limits compliance); such factors are only included within the CBA Tool if they bring a monetised constraint cost risk.
- The CBA tool considers wider network interactions, such as the availability of other network stations, whereas the BAT tool is site specific.

A tabular presentation of the inputs and key assessment principles associated with the BAT model and CBA tool are presented in Appendix 1 to provide further guidance to the reader.

4 Pre-call off BAT assessment (methodology)

The first stage of the BAT assessment process was to conduct a pre-call off initial assessment to consider overall options for the proposed compression upgrade at Hatton. This provided a 'sandpit' environment in which to define and test Process Duty Specification (PDS) points (i.e. the likely operating conditions expected at the site) and assess possible options from the market (including the viability of Selective Catalytic Reduction (SCR) emissions abatement). It also allowed the evaluation team to rehearse key decision criteria and explore operational aspects inherent in Hatton operations, prior to formal market testing via call off. Chapter 5 presents the findings of the pre-call off BAT assessment.

Figure 5 Overview of pre-call off BAT process



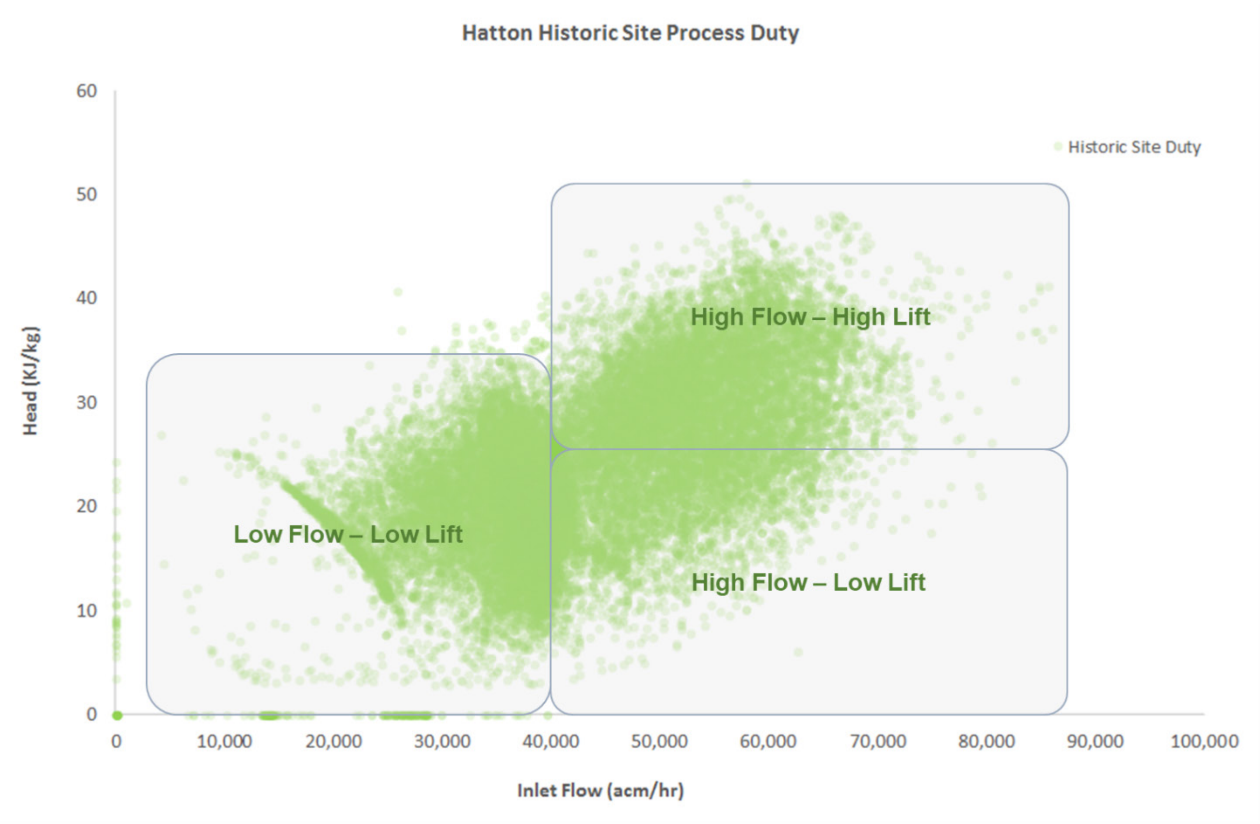
4.1 Process Duty Specifications (PDS) and Sensitivity Cases

The PDS defines a series of likely operating points for the station, each reflecting a snapshot of a given gas flow and pressure lift that would be expected of the station to meet its operating requirements. Whilst the exact combination of process flow and lift conditions experienced by the station are almost without limit, operations tend to cluster around areas of the site operating 'envelope' (see Information Box 3).

Representative points are selected by National Grid network analysts and rotating machinery engineers to represent typical and boundary PDS points; respectively these explore where the bulk of the site duty is seen and where extremes of duty (such as peak winter demand) can reasonably be predicted. Each PDS point is attributed with a 'frequency' value which can be translated into the number of hours that running at that point is likely to be required in any given year.

Hatton operating conditions can be variable, with three characteristic operating zones: low flow low lift; high flow low lift; and high flow high lift. These are illustrated in Figure 6 below against a backdrop of historical running points at the site in the years 2008-2018 (indicated by the green scatter plot).

Figure 6 Characteristic flow / lift zones at Hatton

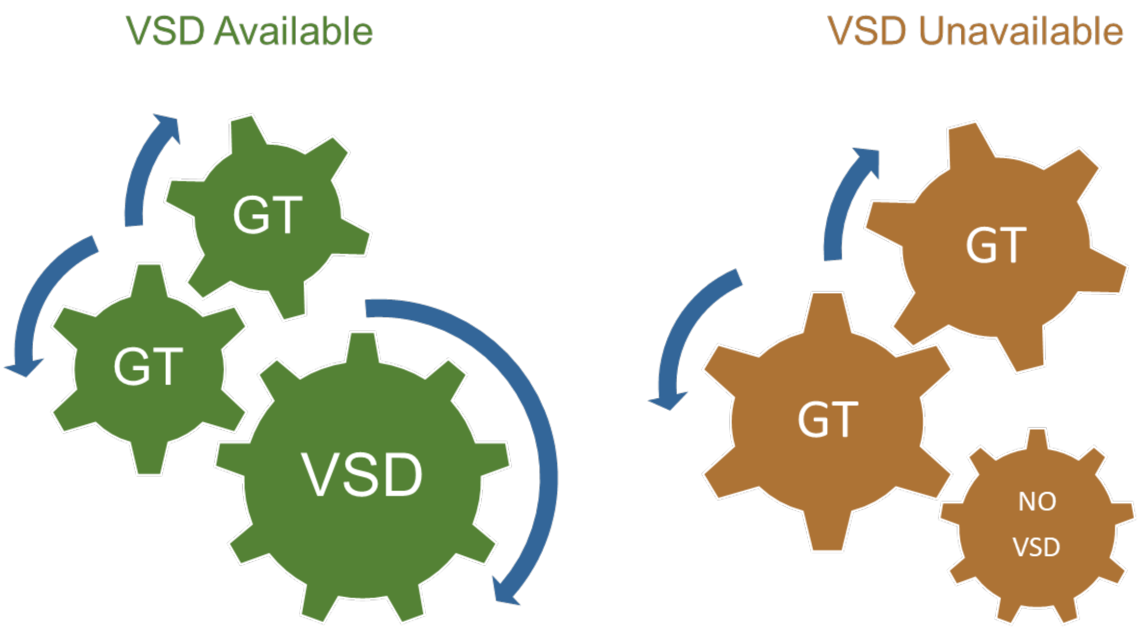


These require single or multiple machinery train in parallel to deliver the site duty:

- Low flow – low lift duty is currently fulfilled by a single RB211 (as the VSD cannot turn-down sufficiently);
- The transitional zone from low flow to high flow is met by a single VSD;
- Medium to high flow-high lift scenarios are met with two RB211s in parallel; and
- High flow – low lift and high flow – high lift requireds the VSD operating in parallel with an RB211.

The primary sensitivity for Hatton relates to the availability, or otherwise, of the VSD unit as this materially changes the unit selection process to meet site duty requirements.

Figure 7 Primary sensitivities at Hatton



Information Box 3: Envelopes and compressor matching

The envelope is the area of available operations constrained by the physical characteristics of the installed compressors, either operating individually or in parallel with other units on site.

Any compressor machinery package of broadly the right size will be suited to a specific site's duty points to a greater or lesser extent; manufacturers will look to match standard drivers and pipeline compressors / compressor impellers to those site duty points. A well matched compressor will be able to deliver the required flow or lift conditions, in efficient areas of the compressor map, avoiding poor flow (surge) or excess speed (choke) conditions.

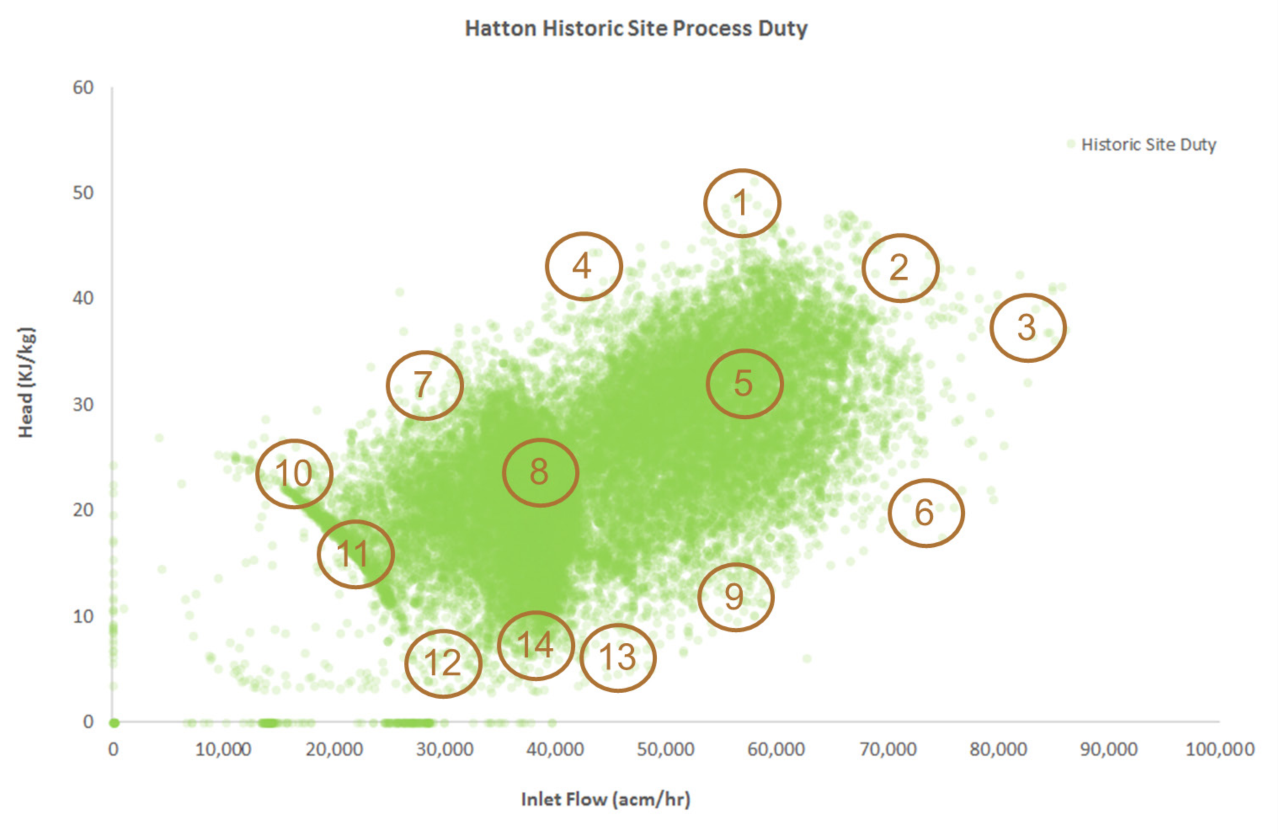
The situation is further complicated as the driver (gas turbine) must be well matched to the compressor, as if the engine load falls outside of the predetermined Dry Low Emission (DLE) power range, emissions can rapidly increase.

A series of 14 PDS points were derived to represent the likely process flow and lift conditions; the likely occurrence (or otherwise) of these PDS points were mapped against the sensitivity cases (VSD available and VSD not available). These PDS points, illustrated in Figure 8, and the associated VSD availability sensitivity cases allowed the study to robustly test overall site BAT. The selected PDS points were designed to test peripheral (boundary) conditions and central operating points. PDS points 13, 6 and 3 were selected, in particular, to provide challenging boundary conditions.

Two further sensitivity combinations were applied, to test utilisation (hours) and PDS point variance. These are summarised below in comparison to the base case, referred to as 'Basis of Design'

- Basis of design represents base case, equating to 6,600 site hours per annum using the core PDS points derived for the pre-call off BAT assessment.
- Scenario S1 is an envelope sensitivity, also assuming 6,600 site hours per annum, however increased hours were assigned to higher flow and head points, as seen in more recent running years at Hatton.
- Scenario S2 is an hours sensitivity, which assumes same PDS points as the basis of design case, however lower overall running site hours were assumed (3,300 per annum). This sensitivity was designed to test the robustness of the conclusions to possible future changes in duty pattern.

Figure 8 Indicative pre-call off BAT assessment PDS points



4.2 Derivation of candidate options

A series of candidate BAT options were identified based on new units available on the OEM framework, and also arising from issue of a market 'Request for Information' (RFI) issued to National Grid's main compressor suppliers. SCR (NOx reduction) /Oxycat (CO reduction) emissions abatement systems were also considered as a 'major plant retrofit' (i.e. the re-lifing of all major system components as well as the installation of emissions control systems). The options were selected in order to facilitate:

a) development of a robust regulatory BAT assessment for the EA

b) full consideration of other cases which the market may offer.

A maximum of three new/retrofit units were defined per candidate option (due to space and need case constraints) to encompass new Dry Low Emission (DLE) gas turbine plant and / or SCR/Oxycat[12] with major overhaul (LCP units), or SCR with major overhaul (MCP units). Additional VSD electric compressor plant was scoped out, due to risk associated with further extending reliance on off-site third-party energy suppliers to meet bulk compression duty.

The following sources of data provided candidate options:

- Current units on the NTS
- Recent National Grid project experience (Oxycat installation at Aylesbury Compressor Station)
- Previous tender returns associated with the Emissions Reduction Programme (ERP)
- Internal National Grid analyses using the CBA Tool
- The Network Innovation Allowance SCR feasibility study[13]
- Market information gathering and supplier engagement.

The final candidate options for the pre-call off BAT assessment are presented in the table below. The configuration column indicates the assumed order of preference for running these units for the purpose of the BAT assessment. In all cases the VSD remains the unit of first preference; when unavailable (as illustrated in the selection of sensitivity cases described previously) the remaining options would be brought into service in preference order (subject to availability). Reference to 'RB211 500' relates to the potential continued usage of Unit A under the IED emergency usage derogation.

Configuration ('>' indicates downward hierarchy of operational preference)
1 x VSD > 2 x RB211 > 1 x RB211 500
1 x VSD > 2 x RB211 CAT > 1 x RB211 500
1 x VSD > 2 x New GT large > 1 x RB211 500
1 x VSD > 3 x New GT Medium > 1 x RB211 500
1 x VSD > 3 x New GT Small > 1 x RB211 500
1 x VSD > 1 x New GT Medium > 1 x New GT V Large > 1 x RB211 500
1 x VSD > 1 x New GT Small > 1 x New GT V Large > 1 x RB211 500

4.3 Derivation of performance information

A specialist National Grid rotating machinery engineer undertook an exercise to match the candidate machinery options to the PDS points and sensitivity cases. In doing so, and via a number of modelling assumptions and engineering calculations, performance information for each candidate unit at each PDS point for each sensitivity case was derived. This included the following key performance parameters, for each PDS point, per machine:

- MW thermal input to achieve the required duty
- Associated mass emissions of NOx and CO at each PDS point.

These data formed the key values required to complete the input sheets for the T/SP/ENV/21 BAT model and were supplemented with derived data to complete the remaining input parameters. A number of sources were utilised to obtain the required information:

- Historical data (including in-house emissions tests) from current units on the NTS
- Previous project analyses carried out in-house by National Grid or by their engineering contractors

[12] Oxycat – passive oxidation catalyst system for the abatement of CO
[13] NIA project reference: NIA_NGGT0087

- Previous tender returns associated with the Emissions Reduction Programme (ERP)
- The Network Innovation Allowance SCR feasibility study
- Market information gathering, including an RFI.

Information Box 4: Catalytic emissions reduction

National Grid has extensively investigated the application of catalytic emissions control to legacy gas turbine compressors on the NTS. Oxidation catalysts have been installed on two Avon gas compressors at Aylesbury compressor station to reduce emissions of CO, and a broad ranging environmental and technical feasibility study has been completed in respect of NOx reduction catalyst technology (specifically Selective Catalytic Reduction (SCR) (reference: NIA_NGGT0087)). These works have indicated that catalytic solutions are potential candidate BAT options in certain instances, and thus should be considered as 'in scope' at least for the purpose of pre-call off BAT assessment.

Conceptual illustration of SCR installed on an NTS compressor station

4.4 Technical and environmental criteria and weightings

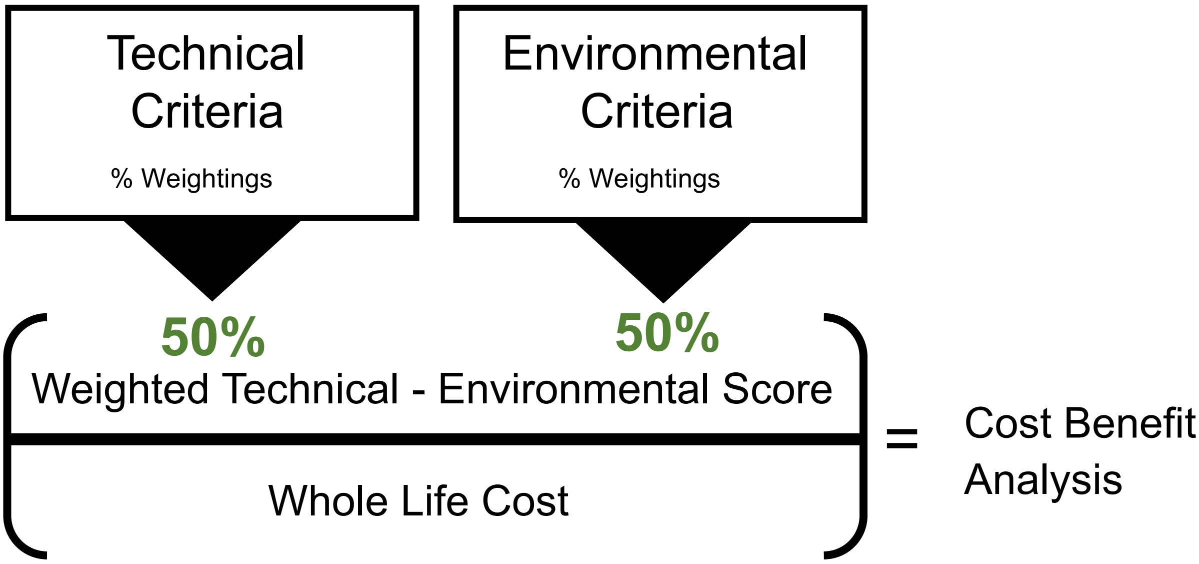
The T/SP/ENV/21 BAT model requires that the technical and environmental criteria relevant to the decision are defined and weighted in accordance with their relative importance in any given decision, taking account of site, unit and project specific issues. This aspect of the model, which is inherently subjective, was peer reviewed with key National Grid stakeholders to validate assumptions and decisions made.

This chapter presents the chosen criteria and weightings used in the assessment. The individual scored outcomes and combined BAT assessment results are presented later in the report in Chapter 5.

4.4.1 Model structure and overall technical and environmental weighting

The overall model structure and weightings defined reflected that this assessment was driven by environmental *and* technical (operational) requirements. The model requires a weighting to be set between technical and environmental criteria; following peer review a relative weighting of 50% technical to 50% environmental was selected for the pre-call off BAT assessment. Environmental improvements are an important part of any investment, especially for high running hours sites such as Hatton, therefore it should be noted that certain elements of the technical criteria, discussed in the following sub-section, include key environmental considerations e.g. emissions compliant envelope versatility and future proofing (emissions headroom) and are thus considered as part of the technical criteria in the BAT model.

Figure 9 Hatton BAT model structure and high-level weightings



4.4.2 Technical criteria and weightings

Specific 'technical' evaluation criteria (operational and deliverability considerations) were developed to address the questions this assessment was seeking to inform. Qualitative technical evaluation is always based on engineering professional judgement, as in any decision-making process either formal or informal.

Evaluation criteria and scoring were prepared prior to the assessment (in a similar manner to how the T/SP/ENV/21 approach is applied in a live tender event, to maintain robustness). Evaluation criteria and scoring were reviewed by key National Grid project stakeholders in order to help balance subjectivity. The following key considerations were reflected in deriving the technical criteria and associated weightings:

- Technical evaluation criteria were developed to address the questions this assessment was seeking to inform, and were used to develop working draft contract award criteria (CAC), ahead of the future tender event.
- Whilst technical criteria are operational and deliverability considerations, they are consistent with the principles of BAT (which include requirements to consider how a permitted installation is operated as well as designed).
- Qualitative technical evaluation is always based on engineering professional judgement, however, to maintain robustness the evaluation criteria and scoring were prepared prior to the assessment (in a similar approach to a live tender event).
- A VSD is already in place, therefore the focus was on gas turbine specific considerations / criteria.
- Reliability (betterment over minimum standards) was not adopted as a technical criterion for this pre-call off BAT assessment. It was considered that the reliability requirements embedded in the underlying framework qualifying criteria would be a more effective way to meet National Grid requirements. Reliability of compressor machinery is essential for National Grid, however, OEM supplied information on reliability performance over and above the minimum (usually as MTTR, MTBF[14]) has historically proven very difficult to meaningfully score in a call off event due to differences in source, calculation method, and in defining comparable plant
- It is important to note that similar considerations to many of the technical criteria also apply when qualifying OEMs to the compressor machinery framework i.e. criteria such as ownership. For the evaluation criteria it represents betterment of minimum allowable standards, hence has a lower apparent weighting than may be expected if were being assessed as an absolute measure.

[14] MTTR / MTBF – Mean time to repair / mean time between failure

Criteria[15]	Target achievement for candidate options (maximum score)	Weighing
T8. Emission compliant versatility	Broad unconstrained flexibility to operate at full range of expected process conditions offering a full turn down range from min-gov. Very well matched to duty profile.	20%
T9. Future proofing (emission limits)	Good emissions performance headroom compared to MCP / LCP ELV and BREF AELs for NOx / CO across required turndown range. Good potential to remain compliant if current ELVs are reduced.	15%
T10. Ownership (maintainability and operability)	Excellent serviceability; long term availability of spares (>20 years), machinery type proven in use and well understood; presents no unusual / complex maintenance requirements.	10%
T12. Constructability	Scale and impacts of construction on site, highest score would be where scheme is limited to swopping components or modular plant on a like for like basis.	5%
		=50%

4.4.3 Environmental criteria and weighting

Environmental performance criteria are a key part of any new machinery selection when applying the principles of BAT, and as discussed, it is a legal requirement for permitted installations. The T/SP/ENV/21 BAT model includes quantitative calculation of mass emission performance for the three primary pollutants associated with natural gas fired gas turbine operations, namely NOx, CO and CO_2. The calculated emissions are derived from unit performance and run hours; the base engine environmental performance data being derived as described in Section 4.3.

Hatton upgrade drivers are compliance (emission limit values) and emissions reduction (mass release), as outlined in Section 2.2. The weightings were selected on the basis that the UK environmental regulators' priority substance for control from the NTS fleet is NOx, however emissions of CO are also controlled via emission limit values in the site permits. While CO_2 emissions are important from an environmental and corporate perspective, they are primarily controlled from the compressor fleet via European Union Emission Trading System (EU-ETS) permits; CO_2 emissions in the context of BAT assessment is better viewed as a surrogate measure for engine and compressor efficiency and seal gas control. The follow key considerations were reflected in deriving the environmental criteria and associated weightings:

- High run hours would result in significant emissions reduction potential, this would be harmed by the need for any legacy unit running, and thus appropriately penalise options reliant on this.
- Ammonia slip associated with SCR was specifically excluded at this stage as impact is measured in relation to habitat sites and cannot be assessed without site specific air dispersion / deposition modelling. It was therefore determined that air dispersion modelling would be undertaken prior to market call off if an SCR based candidate option were identified as BAT.
- Also recognising the potential for candidate BAT solutions to include SCR, a criterion for environmental hazard was defined, to reflect that SCR systems require potentially hazardous reagents to be stored on site in material volumes.
- Noise was considered qualitatively at this stage on first principles only (i.e. on the number of parallel units running together). Noise cannot be assessed in detail without actual OEM performance predictions and site-specific assessment.

[15] Technical criteria T1 to T7 and T11 were other pre-call off test criteria explored outside of the BAT process

Criteria[16]	Target achievement for candidate options (maximum score)	Weighing
E6. Mass Emissions tNOx	Lowest mass emission of oxides of nitrogen (NOx) over 20 year period (arising from direct combustion of natural gas). Remains the environmental regulators' priority for control.	20%
E7. Mass Emissions tCO_2e	Lowest mass emission of carbon dioxide equivalent (CO_2e) over 20 year period (arising from direct combustion of natural gas and seal gas losses). Can be considered analogous for high machinery train efficiency and low resource (fossil fuel consumption).	10%
E8. Mass Emissions tCO	Lowest mass emission of carbon monoxide (CO) over 20 year period (arising from direct combustion of natural gas). Included within the site environmental permits, but historical assessments confirm that no significant 'real world' environmental impacts arise from NTS CO emissions.	5%
E9. Environmental Hazard	SCR systems introduce a new environmental hazard in the form of storage of reagent; risk is manageable but novel in the context of NTS operations. Qualitatively scored criteria.	5%
E10. Noise	Key compliance issue at Hatton due to local sensitivity. Can only assess on first principles without tender returns – number of parallel units. Qualitatively scored criteria.	10%
		=50%

4.5 Cost information

The T/SP/ENV/21 BAT model combines operating costs with capital costs to calculate an indicative whole life cost over a 20-year design life; this can be calculated as a Net Present Value (NPV) if required.

4.5.1 Model structure

The whole life cost calculation is derived from a series of user selected sub-components and calculations; the resulting sum is plotted against the weighted technical-environmental score described previously. Each of the cost components is presented in more detail over the following paragraphs; detailed cost data has not been provided in this report as it includes commercially sensitive information. This information is available on request from the National Grid Project Sponsor[17], as appropriate.

4.5.2 Maintenance data analysis

Scheduled maintenance interventions data provided by National Grid Engineering and Asset Management (EAM) was analysed for selected units in the legacy gas turbine fleet. Normal time-based interventions were identified (e.g. visual and functional inspection; calibration and test inspection; overhaul/major inspection). The highest 'normal' resource time input was identified for each intervention; this was combined with an estimated manpower cost (£/hr) provided by EAM in National Grid. The same intervention types and frequencies were assumed for new build DLE units as for legacy units; this is consistent with T/PM/MAINT/6. The major overhaul costs were adjusted to take account of the extra costs associated with DLE units, this was based on empirical evidence from existing DLE units operating on the NTS fleet. No maintenance costs were included for the VSD as data has not been calculated to same level of completeness as legacy/DLE units, but it was not considered a material differentiator.

4.5.3 Total target cost data

The National Grid Capital Delivery eHub cost estimation team provided target cost models for compressor upgrades (including estimates for Front End Engineering Design (FEED), Detailed Design, Build and

[16] Environmental criteria E1 to E5 were other pre-call off test criteria explored outside of the BAT process
[17] Phebion Mudoti, Senior Engineer - System Development, Gas Transmission.

Commission (DDBC), project services, and National Grid internal costs). These are a major component of any project and will generally be considerably higher than the OEM package costs. For consistency the same data basis was used as that supporting the Ofgem RIIO-T1 reopener discussions. As necessary other candidate option costs were derived transparently from the eHub data.

4.5.4 Whole life operating cost

The T/SP/ENV/21 BAT model includes a built-in estimator for operating cost, which uses National Grid Future Energy Scenario (FES) data for future gas and electricity prices. Operating costs combine estimated energy costs (based on unit gas and electrical power demand and FES cost data) with user input data on maintenance, consumables, etc. No weightings are applied in the cost calculations.

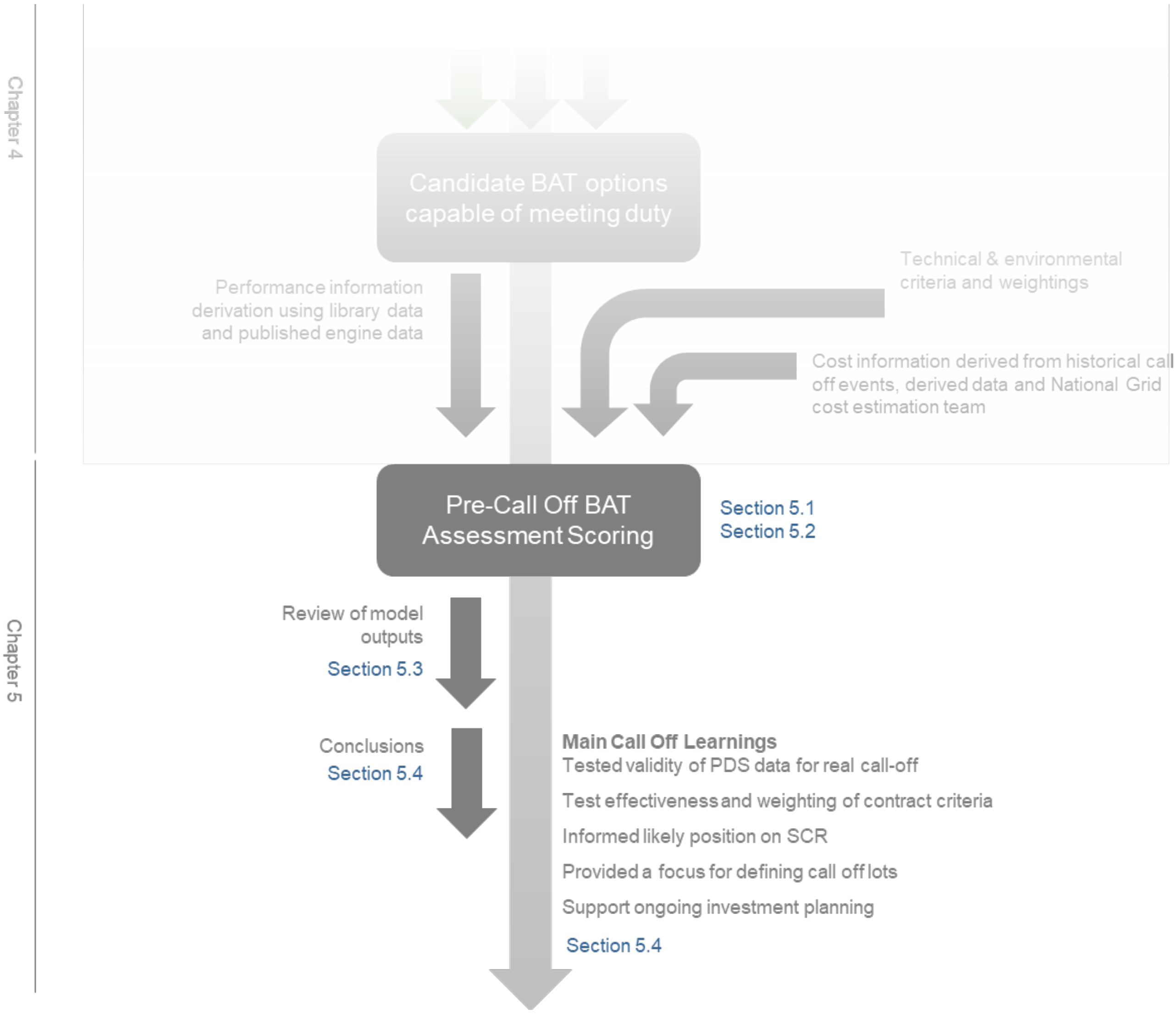
The T/SP/ENV/21 model derives the cost of an hour of operation based on engine MW input, then factors this up by the running hours over 20 years (for the base case and sensitivity running hours). It is important to note that no 20-year energy cost projection will be accurate. However, the FES data is published and is recognised within the National Grid business and more widely; it was therefore applied consistently to all the options under consideration. For catalyst solutions, additional running cost data associated with catalyst bed replacement and reagent purchase was derived from the NIA SCR environmental and technical feasibility study. No TNUoS[18] exposure was applied for VSD running, but a maximum availability standing charge was added to the cost base (£40k pcm). The model can also calculate present value of future expenditure, no NPV calculation sensitivity was undertaken at the pre-call off BAT assessment stage.

[18] TNUoS – electricity Transmission Network Use of System charges

5 Pre-call off BAT assessment (findings)

The findings of the pre-call off BAT assessment are presented in this chapter. The technical and environmental scores are summarised, after which key outcomes of the cost-benefit BAT assessment are presented. Key learnings from the pre-call off BAT assessment are then outlined in respect of designing the subsequent call off study, which is described in the following chapters.

Figure 10 Overview of pre-call off BAT process



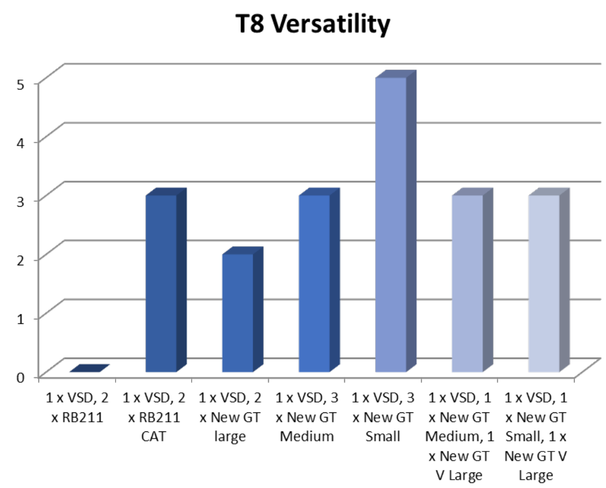
5.1 Technical scoring results

The candidate options for the pre-call off BAT assessment were scored against the technical evaluation criteria. This scoring was derived from a number of sources including experience of previous design and delivery projects, actual tender event scores for similar machinery, compressor envelopes from existing sites and from OEM suppliers, and network maintenance requirements for existing and new units. A workshop[19] meeting was held to review the scored outcomes with the key project stakeholders. The scores are presented graphically below, alongside key scoring themes.

[19] Held on 05.10.2018

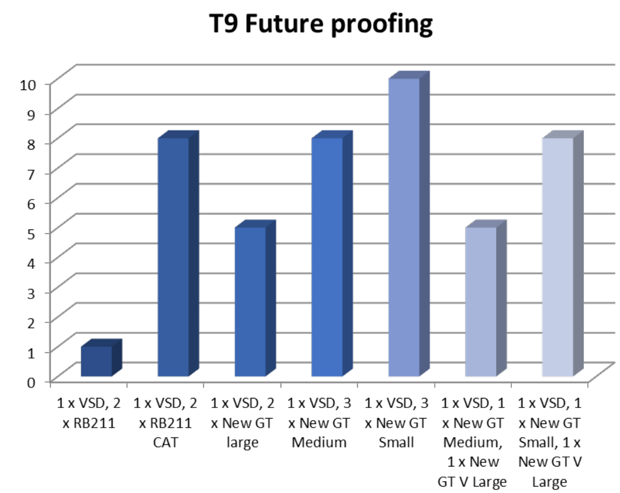
T8. Emission compliant versatility

- Three small units likely to offer greatest flexibility (but may have a possible high power deficit for certain 'top end' PDS points).
- There are several new unit sizing combinations that offer effective versatility. An RB211 catalyst would also offer similar, on the basis that it would not suffer from DLE turndown issues which can impact emissions compliant versatility.
- A very large DLE inevitably brings turndown constraints when operating standalone.



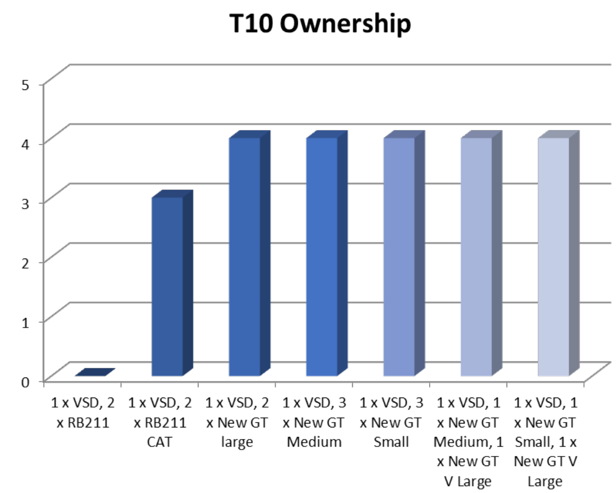
T9. Future proofing (emission limits)

- Options with DLE offer advantages in terms of future proofing, as high base thermal efficiency and potential for better CO control.
- Smaller machines tend to offer better performance guarantees than large.
- SCR gives good compliance over whole range (but unlikely to exceed AEEL[20] values. There is potential to enhance SCR future proofing through design (e.g. provision for additional catalyst beds).

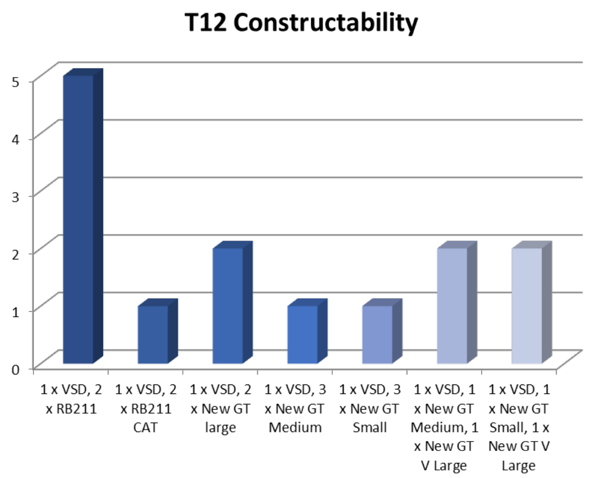


T10. Ownership (maintainability and operability)

- New supplied units considered to offer some advantage due to aftersales support and long-term spares supply.
- The maximum score of SCR was tempered due to newness of technology to National Grid.



[20] AEEL – Associated Energy Efficiency Level, as defined in the BAT Reference (BREF) conclusions

T12. Constructability		
• All options will represent major construction challenge. • Options based around two gas turbine packages scored more highly than those based on three GT packages. • SCR full re-life and new build were considered comparable in terms of effort for Hatton, as even SCR units would likely have to move from their current location due to safety constraints. 		

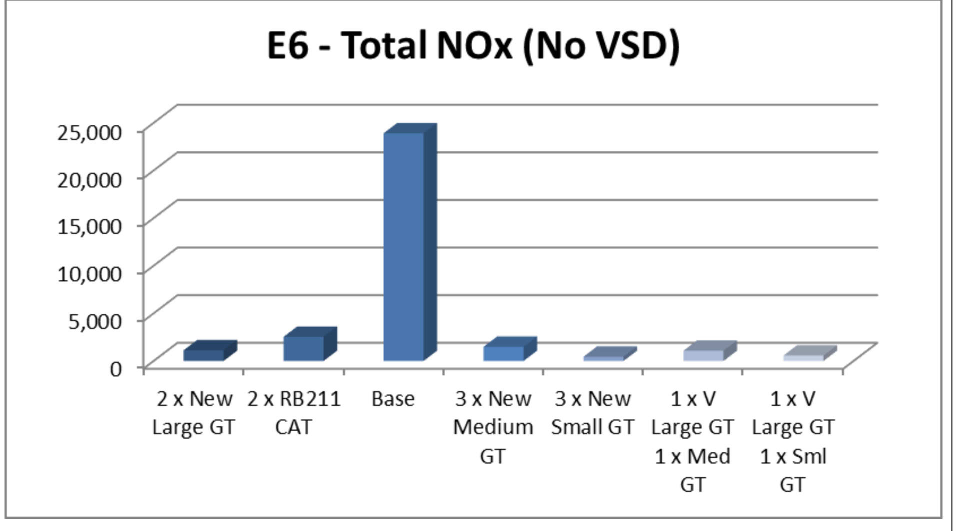
5.2 Environmental scoring results

For the calculated criteria E6 to E8, the T/SP/ENV/21 BAT model derives the estimated environmental performance for the candidate options, for each of the eight sensitivity cases. In respect of the criteria 'E9. Environmental Hazard', and 'E10. Noise' which was evaluated rather than calculated, the same approach was adopted as described in respect of the technical criteria (see section 4.4). The scores are presented graphically below, alongside key scoring themes. Selected results are presented to best illustrate the key discussion points; the VSD 'not available' sensitivity cases results are presented in order that the potential outcomes are clearly highlighted and not masked by 'business as usual' VSD running. VSD 'available' cases are also shown for comparison.

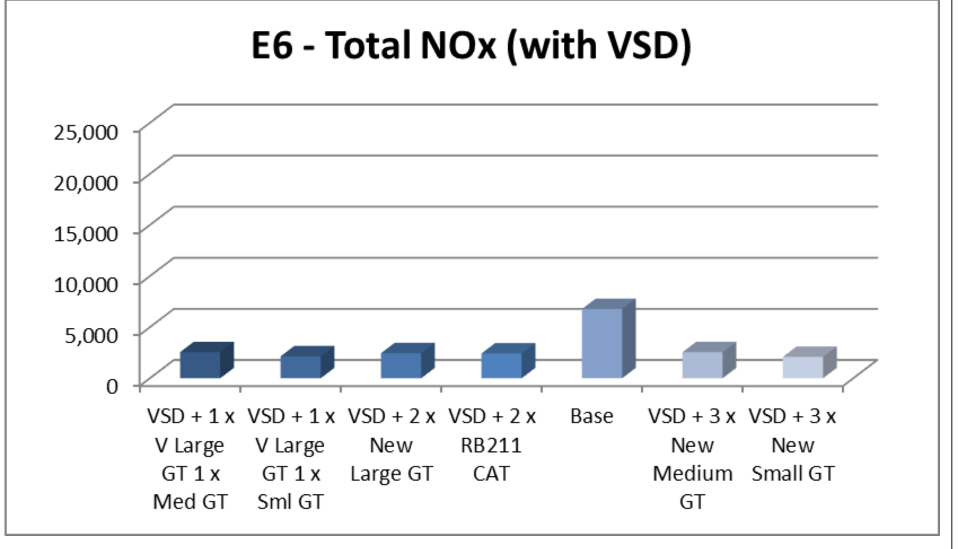
Environmental scoring results (tNOx)

- Graphs present tonnes of pollutant over the 20-year modelled life
- Theoretical maximum NOx reduction up 23,456 tonnes over 20 years.
- All improvement options offer similar NOx reduction, albeit the catalyst solution slightly less so.
- Small GT based options typically benefit from very good NOx emissions performance.
- Larger machines less good, based on historical tender data.
- High performing low emission gas turbines may result in lower NOx emissions overall, when compared to VSD usage (taking account of grid electricity NOx emission factors).

VSD Unavailable



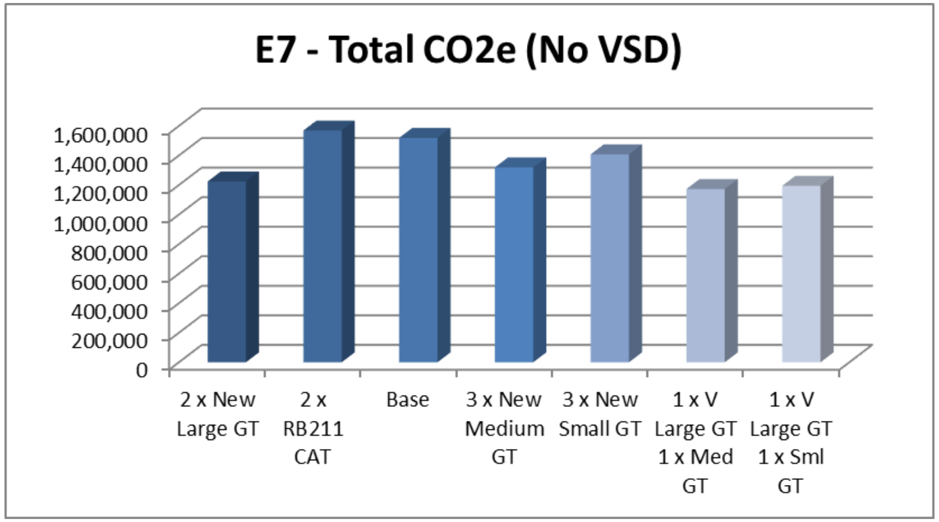
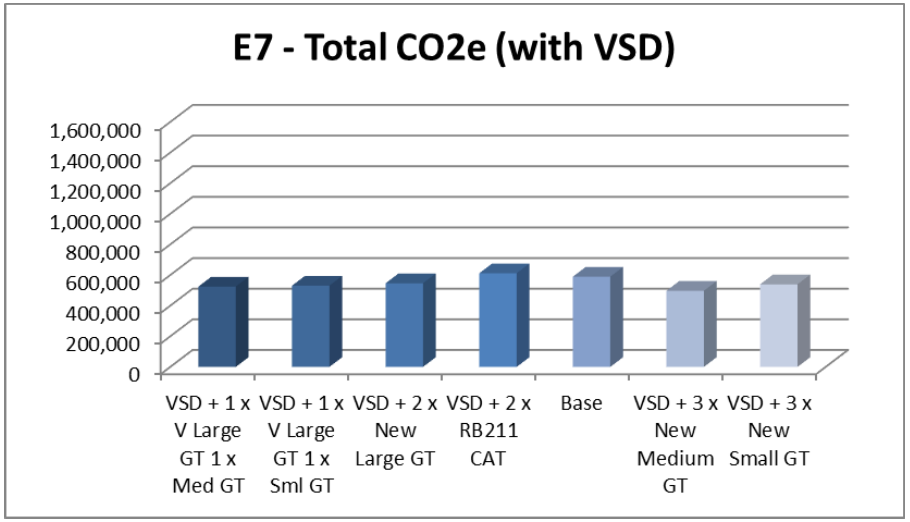
VSD Available



Note: Due to the method by which the BAT model processes named data input sheets, the candidates are presented in the graphs is a different order, case should be taken to read the x-axis labels

Environmental scoring results (tCO_2e)

- Graphs present tonnes of pollutant over the 20-year modelled life
- Reductions in tCO_2e are less marked.
- Surrogate for energy efficiency - limited real-world improvements in many cases.
- Conservative assumptions made on new compressor efficiency; plus DLE brings an efficiency penalty (advances in compressor efficiency have led to improvements >10%; thermal efficiency benefits (due to DLE) no greater than 5-8% for gas turbines).
- Inherent open cycle inefficiency of running 3 machines masks part load inefficiency of large machines.
- Machine matching is far more important than the impact of a few % point on design thermal efficiency.
- VSD usage demonstrates lower tCO_2e overall compared to gas turbine running due to greater energy conversion efficiency associated with centralised power generation.

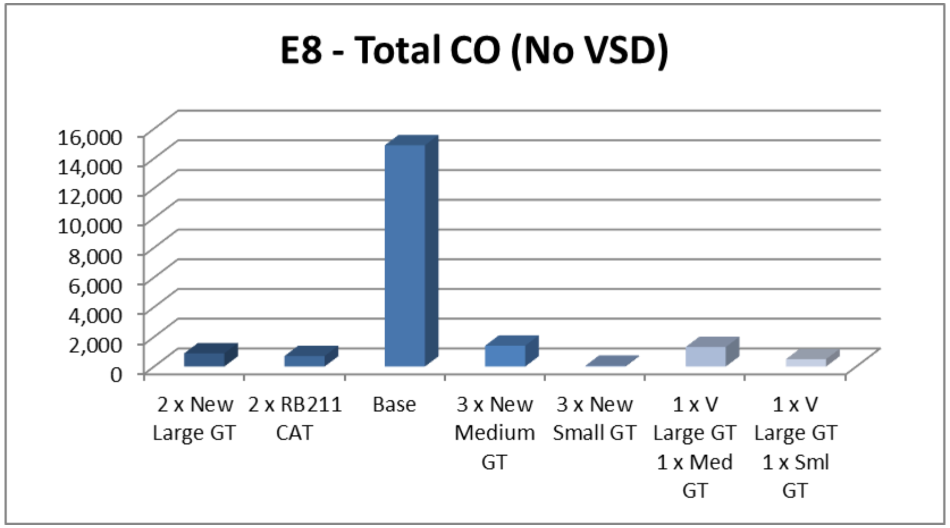
VSD Unavailable	VSD Available
	

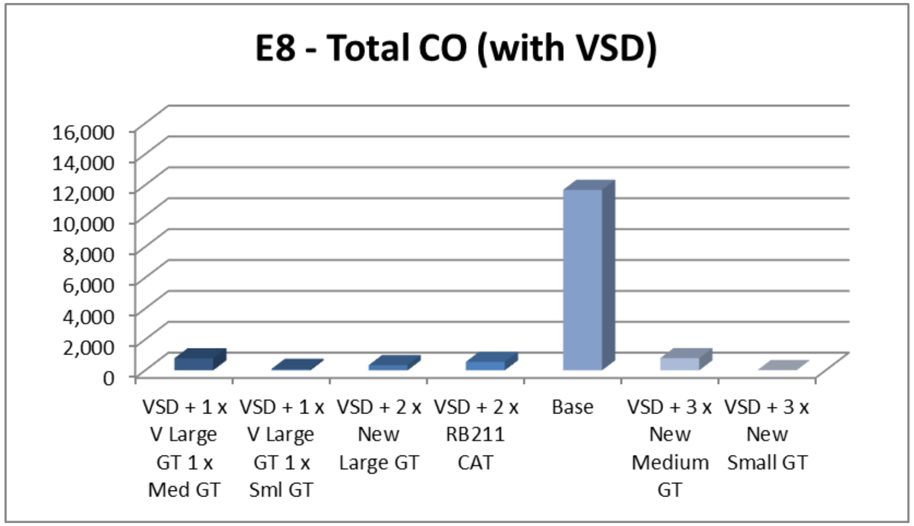
Note: Due to the method by which the BAT model processes named data input sheets, the candidates are presented in the graphs is a different order, case should be taken to read the x-axis labels

Environmental scoring results (tCO)

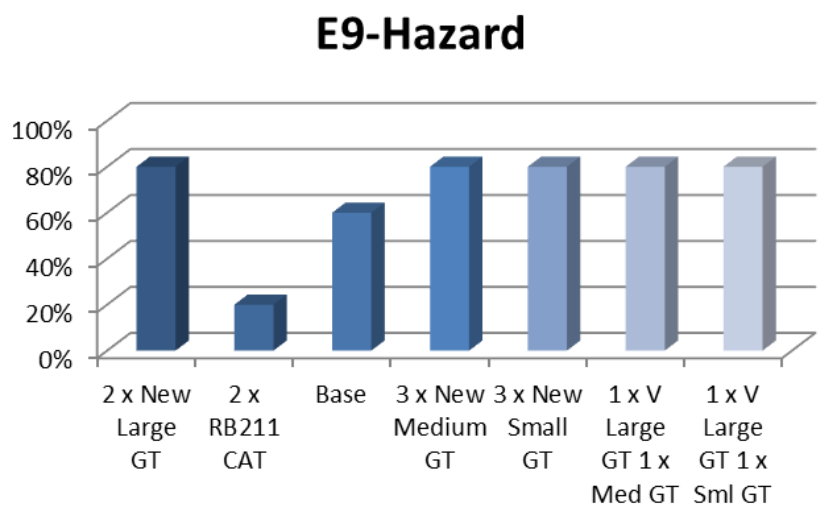
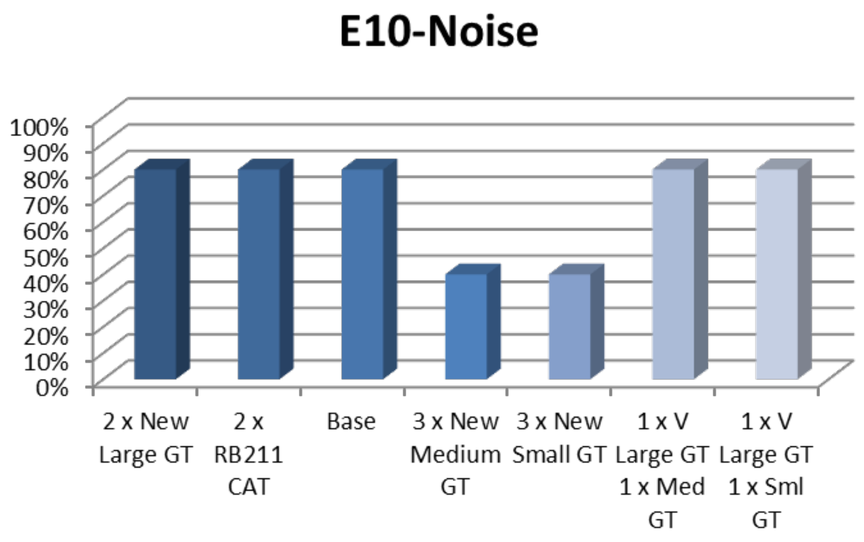
- Graphs present tonnes of pollutant over the 20-year modelled life
- All improvement options offer marked improvement in CO.
- Running lower down power curve, on edge of DLE regime results in increased CO emissions for medium new engine based solutions.
- VSD usage does not include indirect CO as no suitable emissions factors for grid electricity have been determined; in any event CO production associated with centralised power generation will be low as generation units are optimised for combustion efficiency (this cannot be achieved in mechanical drive applications due to varying load).

VSD Unavailable	VSD Available





Note: Due to the method by which the BAT model processes named data input sheets, the candidates are presented in the graphs is a different order, case should be taken to read the x-axis labels

E9. Environmental Hazard	E10. Noise
• All newly supplied units considered to offer some advantage in terms of environmental risk management. Base case will have slightly increased risk due to asset age. • SCR options considered inherently higher risk than non-SCR solutions, due to on-site storage of potentially hazardous materials.	• INDICATIVE ONLY - can only be theoretical for a conceptual BAT study. • General principle applied that cumulative noise from three parallel units will be greater than two.
VSD Unavailable / VSD Available	VSD Unavailable / VSD Available
	

5.3 Review of BAT model outputs

This section presents selected BAT results, showing the combined environmental-technical scores against the calculated whole life costs; graphical cost benefit charts are used with key themes highlighted in the accompanying commentary. The reader is reminded that at this stage the preliminary pre-call off BAT assessment was based on theoretical data and had not, at this point in the programme, been market tested. This was subsequently undertaken in the main call off BAT assessment presented in Chapters 6 and 7.

5.3.1 Overall results summary, basis of design duty

Two scenarios are highlighted to illustrate BAT conclusions associated with typical 'basis of design' duty estimates. The results are presented for the 'VSD available' scenario followed by the 'VSD unavailable' scenario.

Figure 11 VSD available, basis of design duty

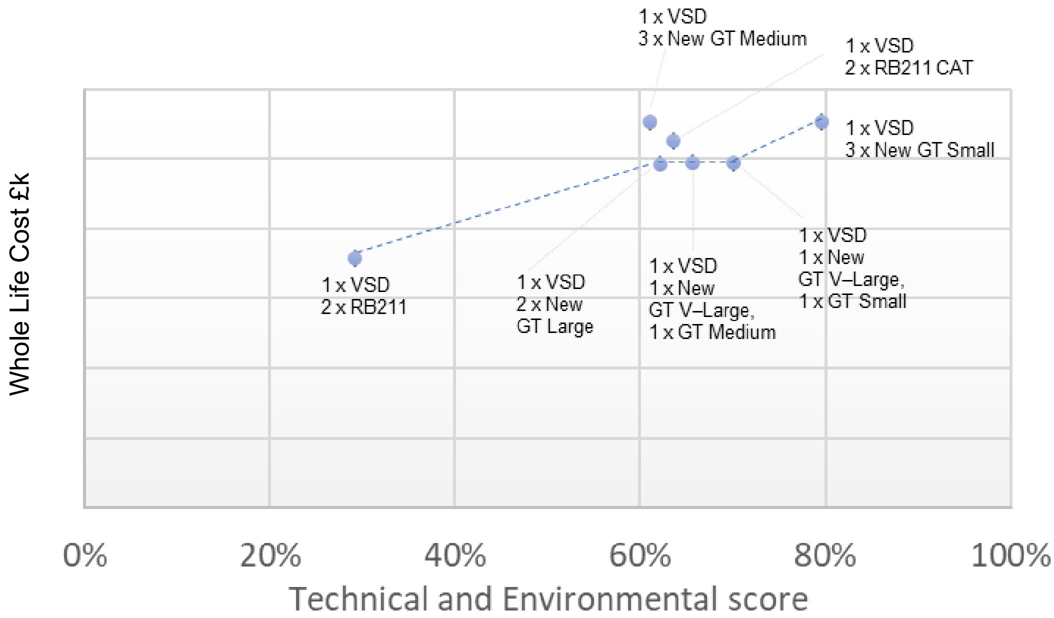
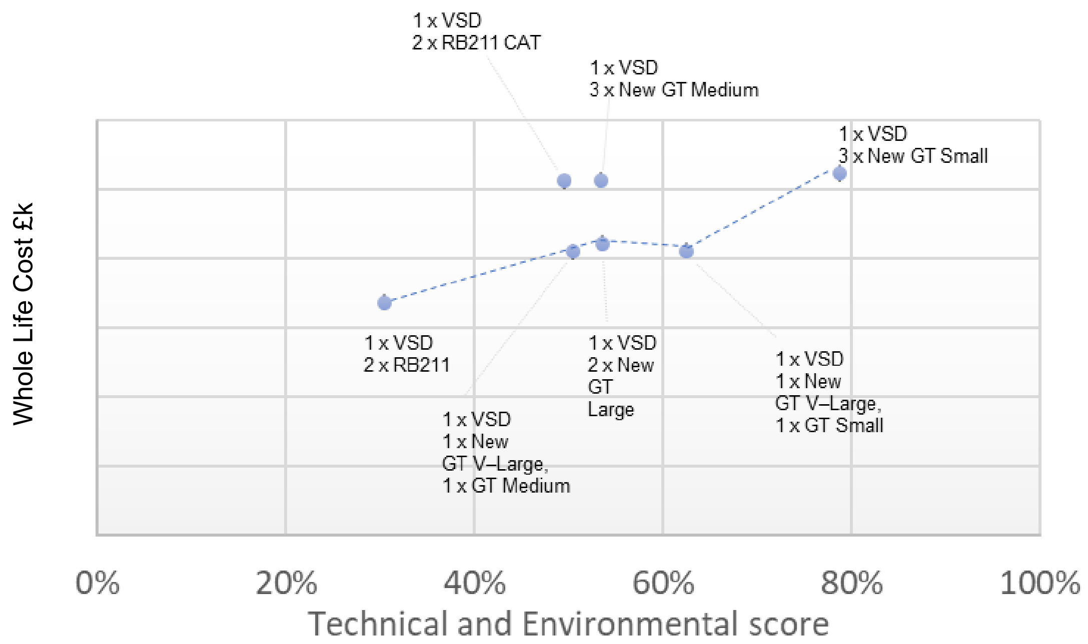


Figure 12 VSD unavailable, basis of design duty



The following observations are noted:

- Operating cost, in particular fuel, is the primary component of whole life cost for a high hours duty site over a 20 year modelled period.
- Increased run hours on the gas turbine (VSD unavailable) emphasises efficiency benefits between units but inherent inefficiency of running machines on open cycle masks individual unit gains and part load inefficiency, which can be associated with larger units.
- Due to future projections of gas vs electricity costs, the model indicates overall lower running costs associated with gas turbines vs VSDs.

Figure 13 VSD available, basis of design duty; exploration of outliers

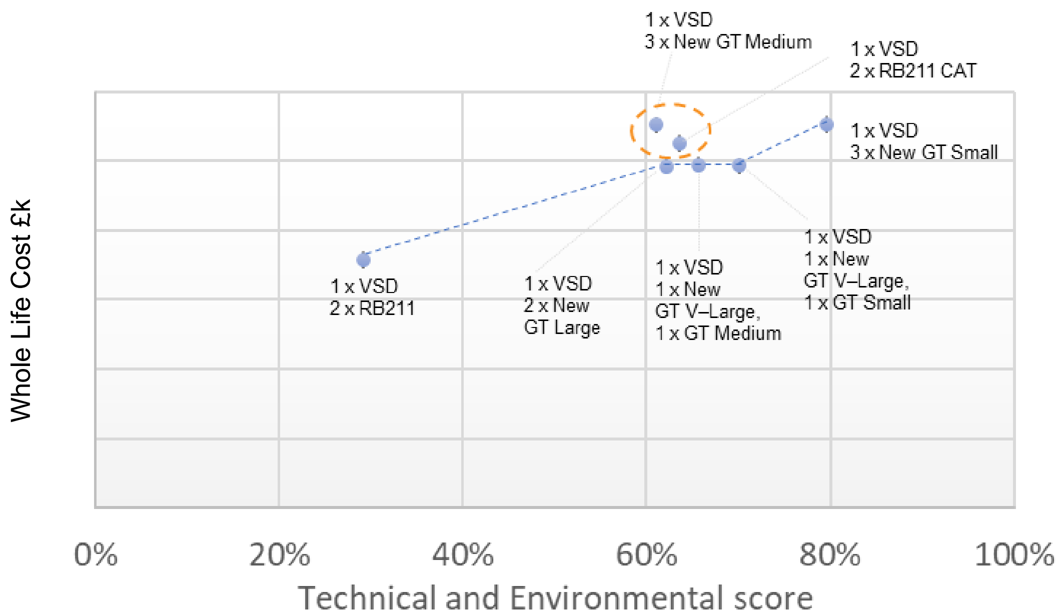
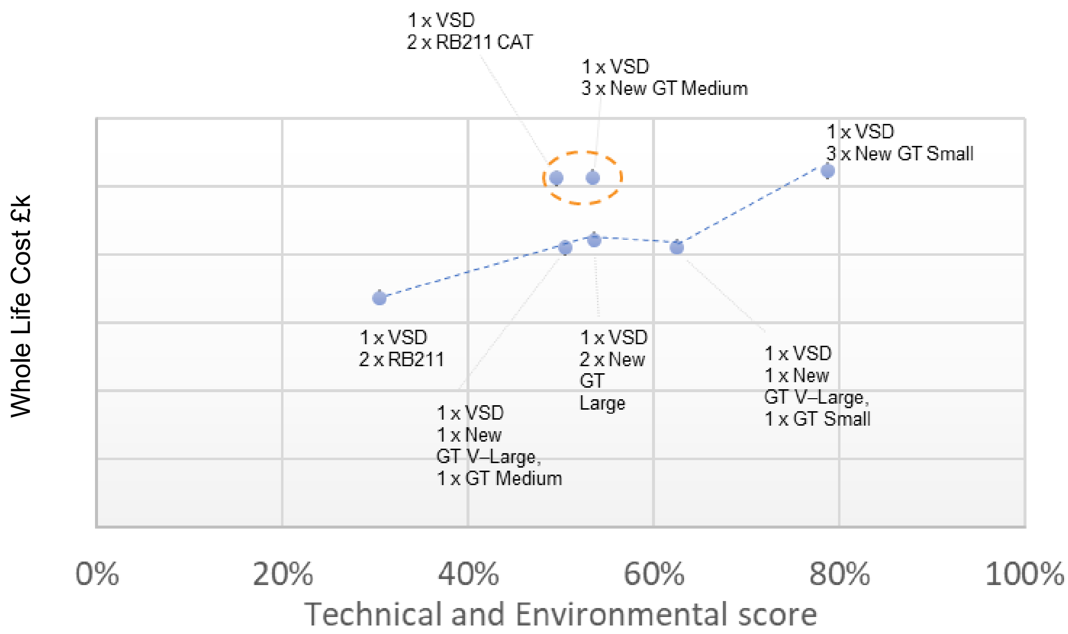


Figure 14 VSD unavailable, basis of design duty; exploration of outliers



The following observations are noted:

- Outlier groups are highlighted, in these cases it is possible to achieve the same or better environmental / technical performance but at a lower cost by selecting other options. Therefore, these do not offer a favourable cost benefit balance.
- The SCR based solution does not offer any financial advantage to match its environmental-technical performance, indicating that at the pre-call off indicative BAT stage SCR is not a candidate BAT solution at Hatton.

Figure 15 VSD available, basis of design duty; indicative BAT

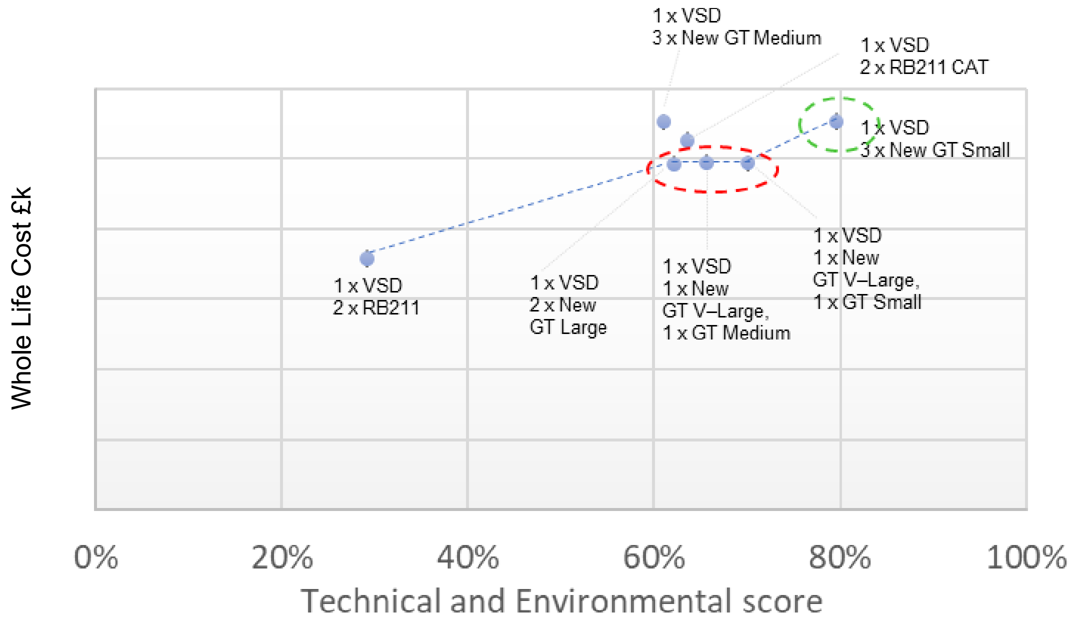
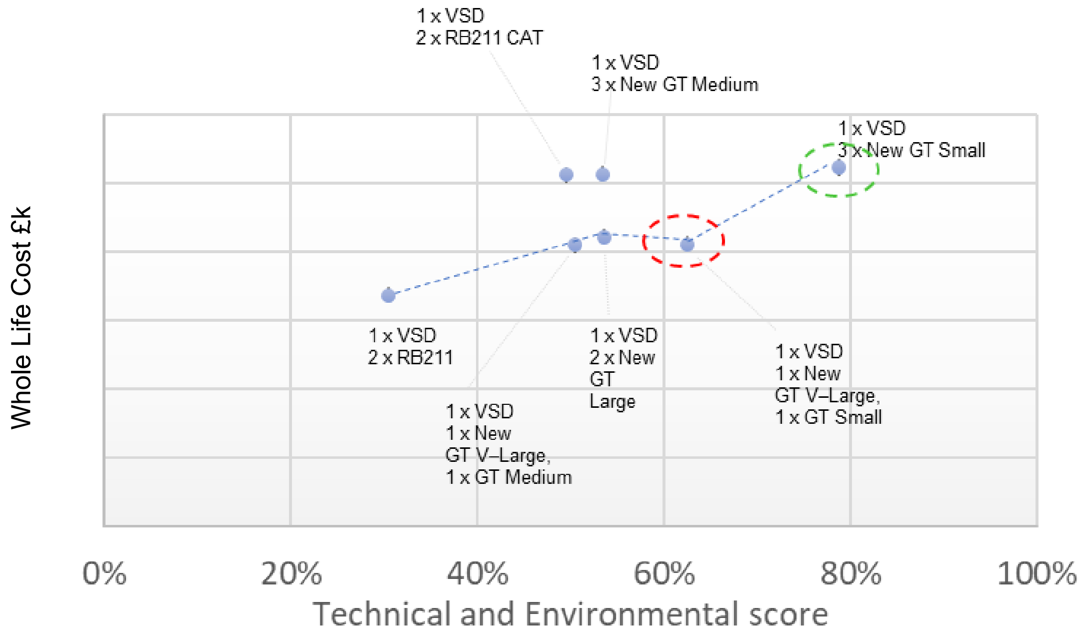


Figure 16 VSD unavailable, basis of design duty; indicative BAT



The following observations are noted:

- The 3 x Small Unit option (highlighted in green) offers the highest environmental and technical performance, in part due to good emissions headroom and good versatility, however this is at a £55m marginal cost for the VSD unavailable case. On this basis, at the indicative pre-call off BAT stage this was considered to represent excessive cost.
- There are considered to be a cluster of candidate BAT options (highlighted in red) for VSD available, this position becomes somewhat clearer for the VSD unavailable case. Given uncertainties in data inherent in an indicative BAT assessment, definitive conclusions are hard to draw. Overall it was considered that indicative BAT for both sensitivities would be a combination of two new units, at least one large or very large, the second either matched (large) or smaller in size (medium or small).

5.3.2 *Results summary, sensitivity case S1*

Scenario S1 is an envelope sensitivity, also assuming 6,600 hours per annum, however increased hours have been assigned to higher flow and head points, as seen in more recent running years at Hatton.

Figure 17 VSD unavailable, S1 duty

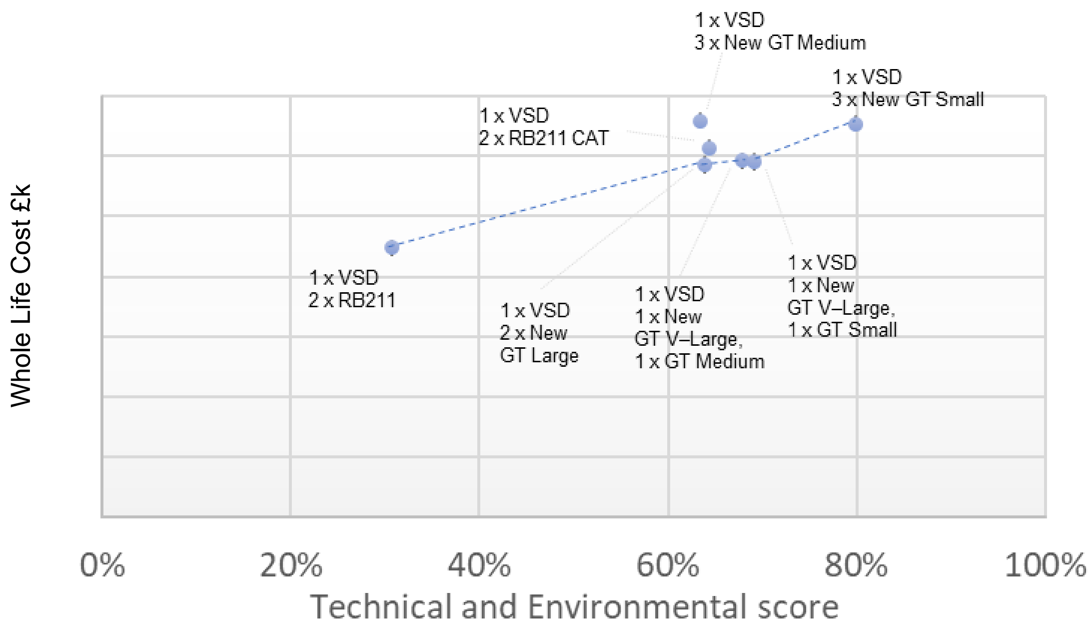
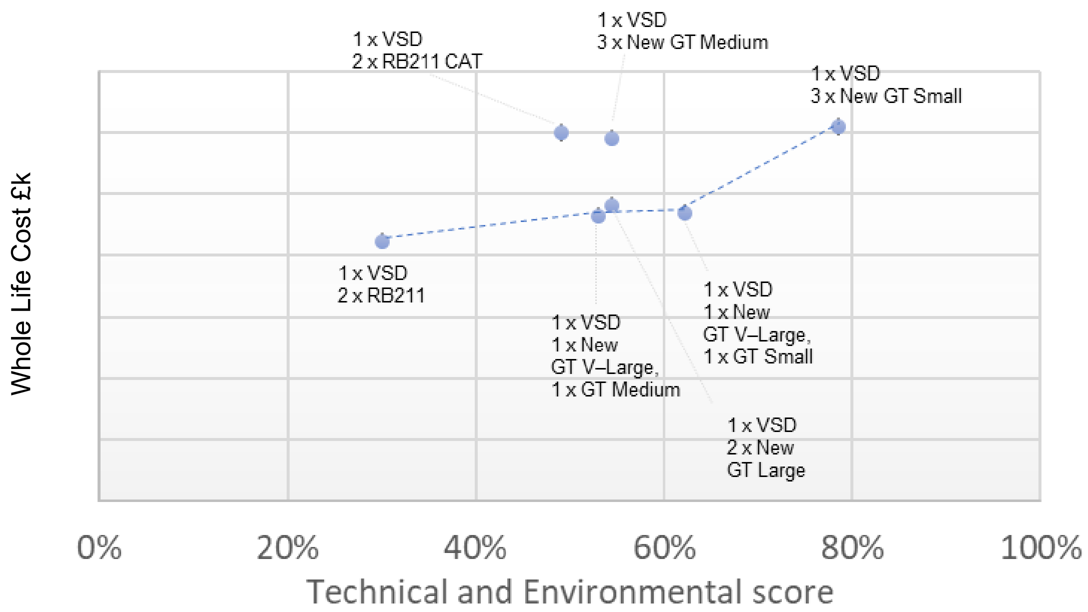


Figure 18 VSD available, S1 duty



The following observations are noted:

- Running costs are higher compared to the basis of design case.
- Overall, the results are consistent with the basis of design case; they illustrate further clustering of the candidate BAT options making identification of an overall conclusion difficult.
- It was considered that this sensitivity should form the basis for the call off PDS points.

5.3.3 *Results summary, sensitivity case S2*

Scenario S2 is an hours sensitivity, which assumes same PDS points as the basis of design case, however lower overall running hours were modelled (3,300 per annum). This sensitivity was designed to test the robustness of the conclusions to possible future changes in duty patterns.

Figure 19 VSD unavailable, S2 duty

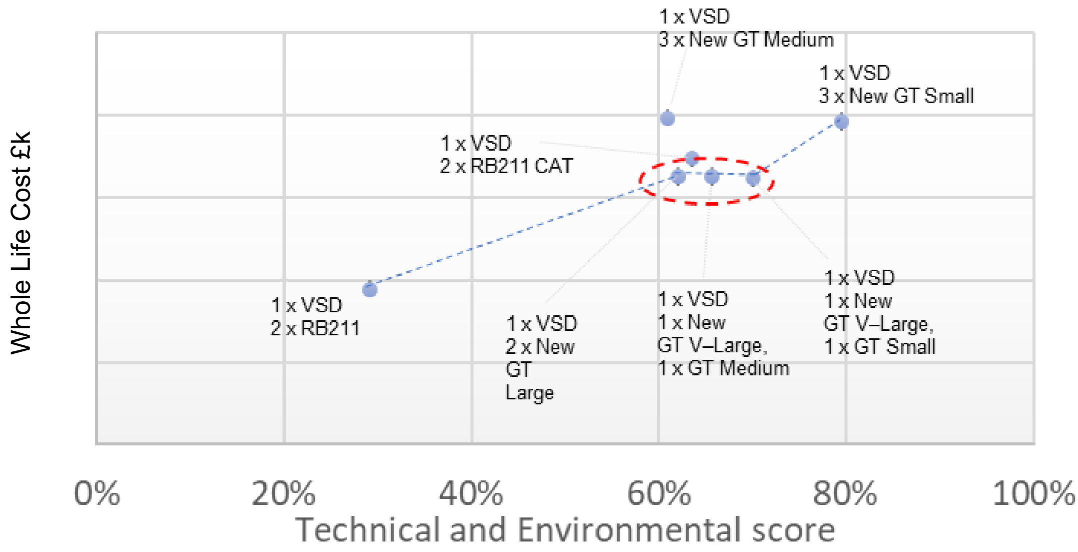
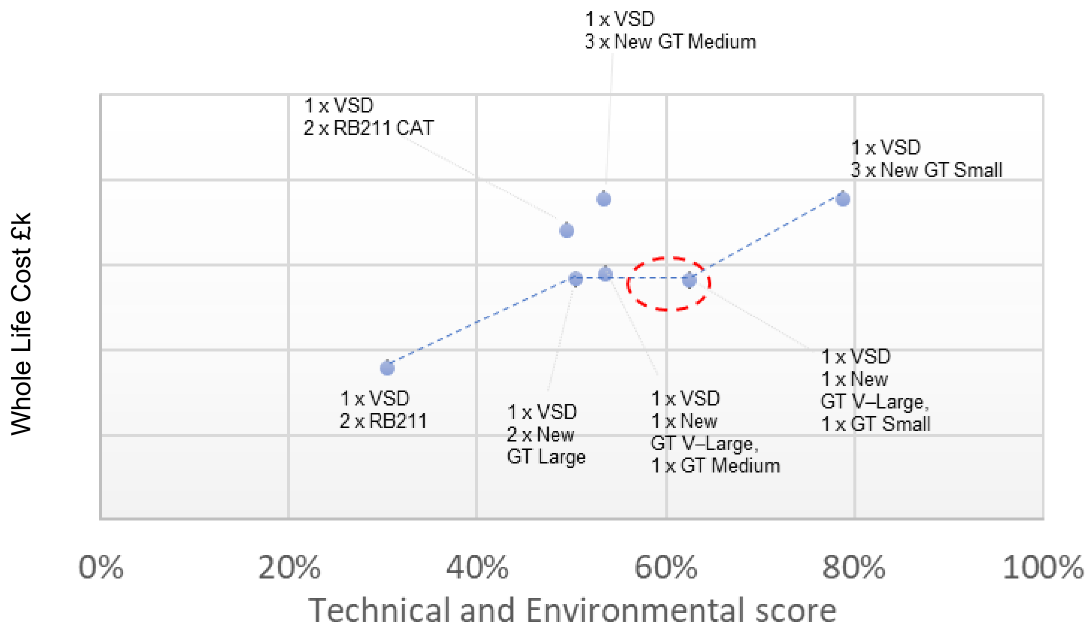


Figure 20 VSD available, S2 duty



The following observations are noted:

- This sensitivity illustrates that the indicative BAT conclusions are robust to varying run hours.
- The lower run hours increase the influence of the capital cost component of the whole life cost.

5.4 Conclusions and lessons learnt for the pre-call off

The following concluding observations can made in respect of the pre-call off indicative BAT:

- Indicative BAT for VSD available and unavailable sensitivities would be a combination of two new units, at least one large or very large, the second either matched (large) or smaller in size (medium or small).
- There is a cluster of potential candidate BAT options, an actual call off event will be required to fully test the BAT conclusions.
- SCR solutions are unlikely to represent BAT at Hatton.
- The S1 sensitivity PDS points should form the basis for the call off BAT assessment PDS.

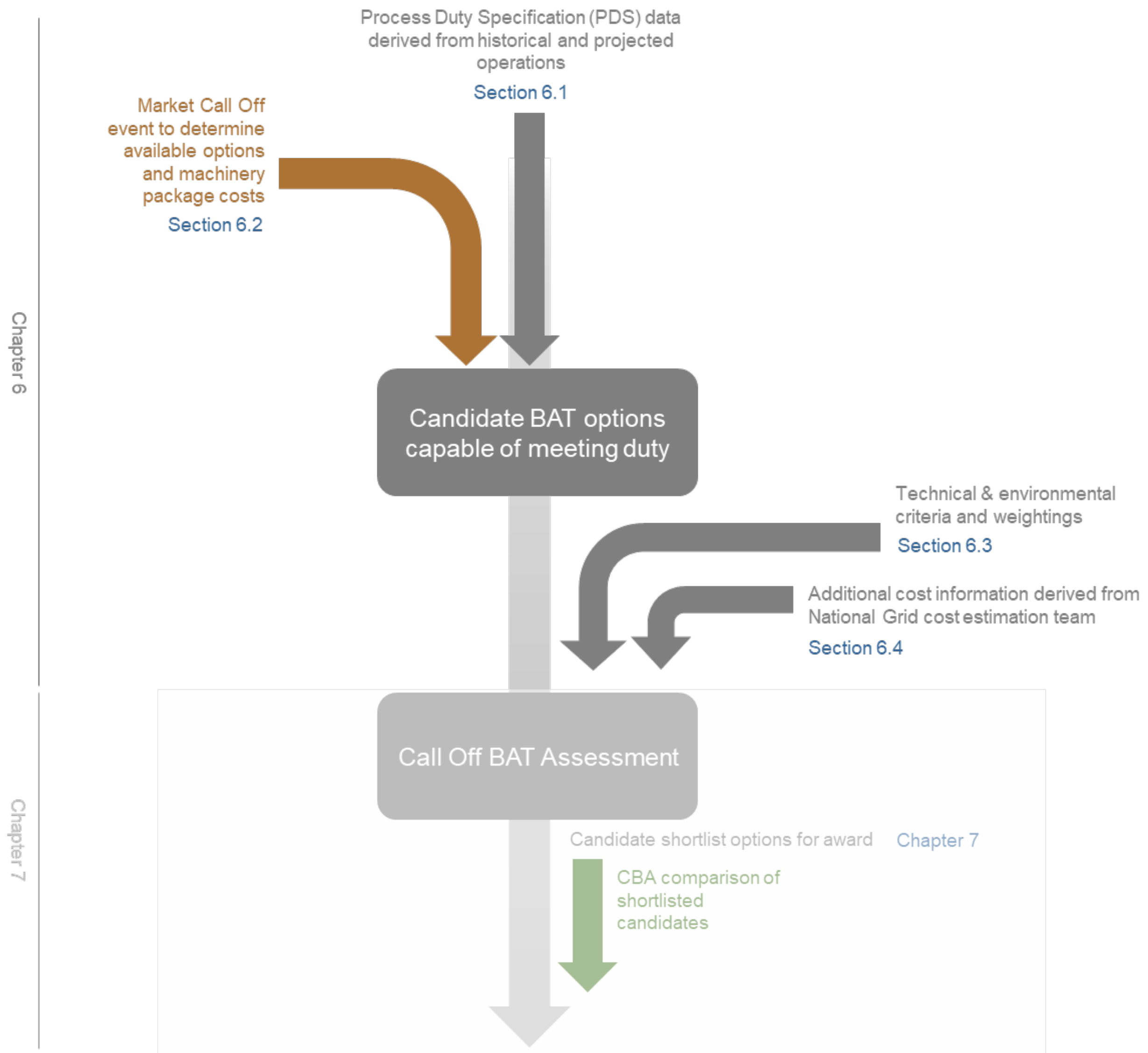
The pre-call off indicative BAT assessment allowed the following learnings to be fed into the development of the actual compressor machinery call off for Hatton:

- The PDS points selected were suitable to test the required site duty expectations and allow a good approximation of site wide BAT duty.
- It was apparent that SCR was not likely to be a candidate BAT option but that this conclusion could not be finally discounted without market testing.
- Single and multiple unit options should be considered in separate lots as the decision criteria between them could be different in actual technical scoring.
- The evaluation criteria and weightings were considered appropriate and (subject to minor revision and refinement) appropriate for the call off event.

6 Call off BAT assessment (methodology)

The second and final stage of the BAT assessment process was to conduct the call off assessment to define and test market ready options for the proposed compression upgrade at Hatton. This process was developed from the pre-call off BAT assessment described in the two previous chapters and was designed to support selection of suitable compressor machinery train for purchase. Due to similarities between the pre-call off and call off BAT assessment methodologies, this chapter describes the process carried out 'by difference' to that outlined in Chapter 4. Chapter 7 following presents the findings of the call off BAT assessment.

Figure 21 Overview of call off BAT process

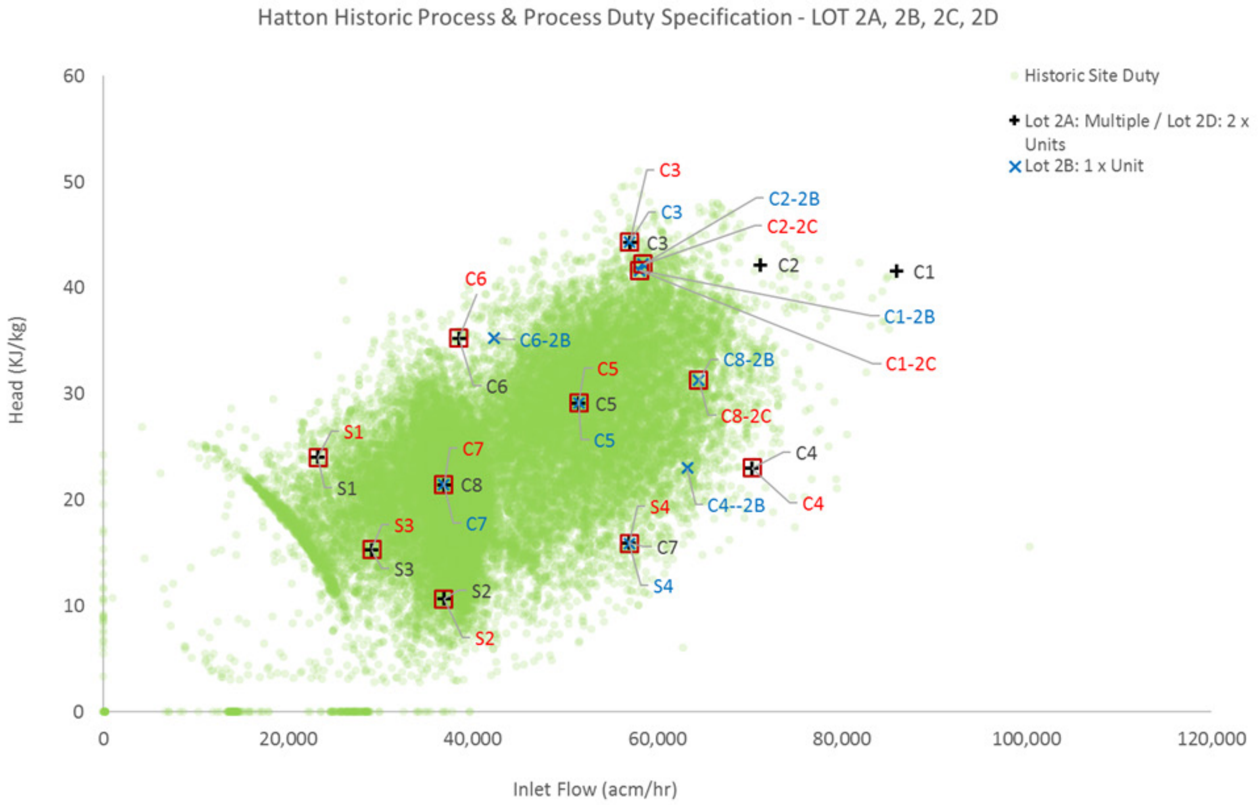


6.1 Process Duty Specifications (PDS) and call off lots

PDS points were defined for the market call off event, based on the pre-call off PDS points, and taking account of the lessons learnt through that process. Representative points were selected and refined by National Grid network analysts and rotating machinery engineers to represent typical and boundary PDS points.

A series of four lots were defined to test a range of scenarios matching the full range of flow and lift duties. Each was designed to test realistic boundary points for expected duty and bulk points in the middle of the envelope, as well as boundary points to test more extreme circumstances. C1, C2 and C4 were defined as particularly challenging points to test the suitability of candidate compressor machinery. BAT is therefore considered on a per Lot and site wide basis. The lots also aligned to 'unlimited' number of units, two unit and single unit solutions, by way of constraint on the bidding OEMs.

Figure 22 Hatton PDS points for call off



6.2 Market call off to determine available options and package costs

National Grid launched a call off in September 2018 for low emission gas turbine driven compressors. Initial responses were received from four global compressor suppliers; eight solutions were received across the four lots from three OEMs. Anonymity of bidders is preserved throughout this report using colours to represent each OEM. Small and very small units are analogous to MCP sized units (<50MW thermal input) and medium, large and very large units to LCP sized plant (>50MW, >70MW and >100MW thermal input, respectively). These also align conceptually to the range of current machinery at site (refer also to Chapter 2).

Lot 2A – Unspecified number of units outside existing boundary. Bids from:	
Purple:	3 x Small 'stick build' and preassembled unit (PAU) variants
Blue:	1 x Small and 1 x Large
Yellow:	3 x Small *
Yellow:	4 x Small *
Lot 2B – Single unit solution to meet medium power process duty (+ existing RB211 500 hours unit) outside existing boundary. Bids from:	
Blue:	1 x Very Large
Lot 2C – Two (2) unit solutions to meet Medium Power Process Duty (+ existing RB211 500 hours unit) outside existing boundary. Bids from:	
Purple:	1 x Small and 1 x Large 'stick build' and preassembled unit (PAU) variants
Yellow:	1 x Small and 1 x Medium
Lot 2D – Two (2) unit solutions to meet High Power Process Duty, outside existing boundary. Bids from:	
Blue:	1 x Small and 1 x Large (same technical solution as Lot 2A)

* Yellow options for Lot 2A failed on compliance / risk prior to the BAT assessment process

6.3 Technical and environmental criteria and weightings

As described previously, the T/SP/ENV/21 BAT model requires that the technical and environmental criteria relevant to the decision are defined and weighted in accordance with their relative importance in any given decision, taking account of site, unit and project specific issues. The call off technical and environmental criteria, and their associated weightings, were determined in a fully documented process supervised by National Grid Global Procurement[21] and subject to formal governance.

This chapter presents the chosen criteria and weightings used in the assessment. The individual scored outcomes and combined BAT assessment results are presented later in the report in Chapter 7.

6.3.1 Overall technical and environmental weighting

A relative weighting of 50% technical to 50% environmental was again selected for the call off BAT assessment; this represented a minor refinement compared to the pre-call off stage (Section 4.4) reflecting minor sub-criteria adjustments (described in the following sections).

6.3.2 Technical criteria and weightings

Specific 'technical' evaluation criteria (operational and deliverability considerations) were developed to meet the objectives of delivering an effective call off event to identify BAT from market available solutions; these were based largely on the pre-call off criteria, but incorporated lessons learnt and refinements.

The follow key considerations were reflected in deriving the technical criteria and associated weightings for the call off event:

- Emissions compliant versatility and future proofing (emissions limits) were retained as primary technical criteria, with similar weightings.
- Constructability was refined to focus more clearly on modular (pre-assembled unit (PAU)) approaches to construction, as this offered potential project deliverability and cost benefits for National Grid, and its weighting increased accordingly by 5% points.
- Ownership / maintenance complexity was retained with minor refinements focusing on potential areas of added value associated with the ownership proposition. At same time, a 5% point reduction in its weighting was applied, recognising the uncertainty over how material this factor would be in the evaluation.

[21] National Grid document: PAC3275-06-99-00-6011-NGG-0071-rev03.docx

- Technical criteria T1 through to T7 represented other evaluation criteria addressed outside of the BAT evaluation process[22].

Criteria	Target achievement for candidate option (maximum score)	Weighing
T8. Versatility (emissions compliant envelope)	Broad unconstrained flexibility to operate at full range of expected process conditions offering a full turn down range from min-gov. Very well matched to duty profile.	20%
T9. Future proofing (emission limits)	Good emissions performance headroom compared to MCP / LCP ELV and BREF AELs for NOx / CO across required turndown range. Good potential to remain compliant if current ELVs are reduced.	15%
T10. Operability / Maintenance Complexity	Excellent serviceability, market leading standards of ownership proposition, delivering added value.	5%
T11. Modular Build Approach	Solution capable of factory assembly with minimum site-based work to integrate component section during install.	10%
		=50%

6.3.3 Environmental criteria and weighting

Specific 'environmental' evaluation criteria (emissions and environmental performance considerations) were developed to meet the objectives of delivering an effective call off event to identify BAT from market available solutions; these were based largely on the pre-call off criteria but incorporated lessons learnt and refinements.

The follow key considerations were reflected in deriving the technical criteria and associated weightings for the call off event:

- The key emissions criteria (tNOx, tCO_2e and tCO) were retained as primary environmental criteria, with similar weightings.
- The overall environmental weighting was retained at 50%; however, environmental aspects associated with emissions levels, compliance and efficiency are also embedded in certain of the technical criteria, in particular T8 and T9 further increasing the importance placed on these key decision factors.
- Environmental hazard was retained, given the potential for the market to offer SCR based solutions.
- Noise (betterment over minimum / evidence to support) was refined, reflecting the importance of noise in the final site upgrade and to accommodate the fact that site and design specific information would be obtained during the course of the call off event.
- Environmental criteria E1 through to E5 represented other evaluation criteria addressed outside of the BAT evaluation process[23].

[22] National Grid document: PAC3275-06-99-00-6011-NGG-0071-rev03.docx
[23] National Grid document: PAC3275-06-99-00-6011-NGG-0071-rev03.docx

Criteria	Target achievement for candidate option (maximum score)	Weighing
E6. Mass Emissions tNOx	Lowest mass emission of oxides of nitrogen (NOx) over 20-year period (arising from direct combustion of natural gas). Remains the environmental regulators' priority for control.	20%
E7. Mass Emissions tCO_2e	Lowest mass emission of carbon dioxide equivalent (CO_2e) over 20-year period (arising from direct combustion of natural gas and seal gas losses). Can be considered analogous for high machinery train efficiency and low resource (fossil fuel consumption).	10%
E8. Mass Emissions tCO	Lowest mass emission of carbon monoxide (CO) over 20-year period (arising from direct combustion of natural gas). Included within the site environmental permits, but historical assessments confirm that no significant 'real world' environmental impacts arise from NTS CO emissions.	5%
E9. Environmental Hazard	Low risk to the water environment, (most sites connected to local surface water via drainage systems and can be unmanned for extended periods of time). Included primarily in case of SCR offers. Qualitatively scored criteria.	5%
E10. Noise, betterment / evidence to support	Betterment of minimum acceptable target noise level to provide headroom and de-risk, evidence-based submission addressing known issues (e.g. tonality).	10%
		=50%

6.4 Additional cost information

The cost components used in the call off event are summarised below. Detailed cost data has not been provided in this report as it includes commercially sensitive information. This information is available on request from the National Grid Project Sponsor[24], as appropriate.

6.4.1 Package cost

Package purchase costs were provided by the OEMs, including required optional extra items.

6.4.2 Maintenance data analysis

Scheduled maintenance interventions data (including major overhauls) were provided by the OEMs specific to their offered machinery packages and the duty hours, and conditions defined by PDS points. This was reviewed and risked by engineering specialists in National Grid.

National Grid internal maintenance costs were also utilised, as per the pre-call off event based on planned intervention requirements.

6.4.3 Total target cost data

The National Grid Capital Delivery eHub cost estimation team provided updated target cost models for compressor upgrades (including estimates for Front End Engineering Design (FEED), Detailed Design, Build and Commission (DDBC), project services, and National Grid internal costs).

[24] Phebion Mudoti, Senior Engineer - System Development, Gas Transmission.

6.4.4 Whole life operating cost

Whole life operating cost data was derived using the T/SP/ENV/21 BAT model built-in estimator, utilising National Grid FES data for future gas and electricity prices. The model can also calculate present value of future expenditure, however, no NPV calculation sensitivity was undertaken at the call off BAT assessment stage.

6.4.5 Normalising of scope and risk costs and options

Due to differences in supply capability between OEMs, the scope of equipment supply was normalised to ensure like for like comparison (e.g. if a particular equipment sub-component could not be supplied by the OEM, estimated costs for sourcing said item at the DDBC stage were added). Similarly, a range of technical and commercial project risks were monetised by engineering and procurement specialists in National Grid.

6.4.6 Asset health / failure data

Recognising that even newly installed equipment would age over the 20-year design life, an estimate was included for future asset health / failure costs. This was included on a per machinery train basis, not differentiating between OEM suppliers. Information derived from National Grid data[25] was interrogated to define a list of relevant interventions and an associated expenditure estimate (considering only those explicitly related to the compressor machinery train or enclosure related balance of plant, such as unit fire and gas systems).

The data was then categorised into ‘asset health’, ‘failure’ or ‘maintenance’ and an estimated ‘events in 20 years’ frequency value was assigned. The collated data and event frequency had previously been subjected to peer review in EAM.

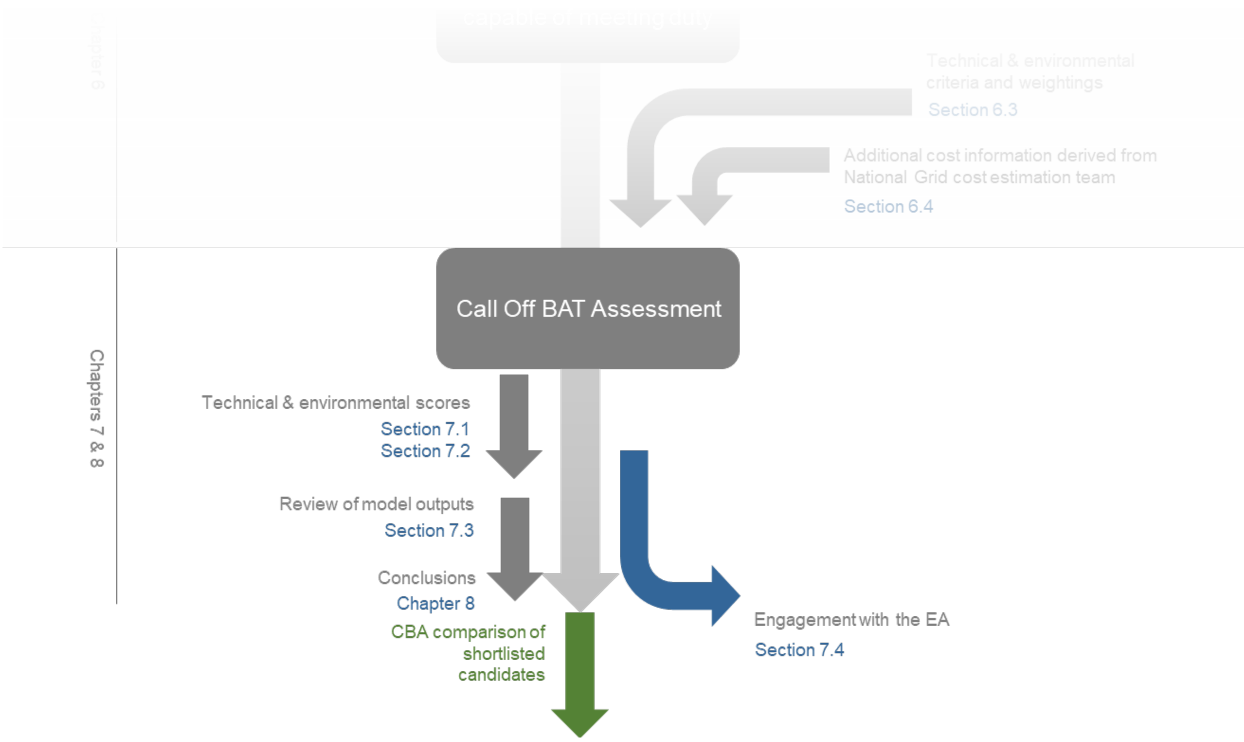
Failure cost data was calculated on the basis of a ‘weighted percentage probability of exposure’, e.g. a 1% failure probability of a £100k asset in any given year exposes the business to a weighted probability of a £1k cost in a year or a £20k cost over a 20 year period.

[25] 2017 Engineering and Asset Management Databook of asset health replacement and failure costs. The Databook provided a range of different degrees of complexity associated with failure interventions and also information on related failures that can extend beyond a single component to a wider assembly. As such, ‘medium’ complexity ratings were adopted and where single or multiple related systems interventions are identified, the worst case was selected.

7 Call off BAT assessment (findings)

The findings of the call off BAT assessment are presented in this chapter. The technical and environmental scores are summarised, after which key outcomes of the cost-benefit BAT assessment are presented. Overall conclusions are presented in Chapter 8.

Figure 23 Overview of call off BAT assessment process



7.1 Technical scoring results

The candidate options for the call off BAT assessment were scored against the technical evaluation criteria, in line with National Grid's approved evaluation methodology[26]. The scores are presented graphically below, alongside key scoring themes. Lot 2A results are coloured blue, Lot 2B yellow, Lot 2C orange and Lot 2D green.

[26] National Grid document: PAC3275-06-99-00-6011-NGG-0071-rev03.docx

<table>
<tr><th>T8. Emission compliant versatility</th><th>T9. Future proofing (emission limits)</th><th>T10. Ownership (maintenance complexity)</th></tr>
<tr><td>

One small and one medium unit from bidder Yellow was considered optimal for the two-unit Lot 2C, with large plus small units from Purple scoring second highest.
Three small units were considered to provide greater flexibility compared to the Blue small plus large combination.
The separate lots cannot be compared directly for criteria T8, as the options are scored within each Lot relative to the other options; they are illustrated here side by side for indicative purposes only.

</td><td>

The Blue solutions for Lot 2A scored well, with the offer of strong NOx and CO emission concentration guarantees.
Guarantee performance for the highest scoring units extended significantly below 70% MCR[27] to 40% or even 30% turndown.
Yellow solution for Lot 2C offered greater emissions future proofing compared to the Purple options.
The separate lots cannot be compared directly for criteria T9, as the options are scored within each Lot relative to the other options; they are illustrated here side by side for indicative purposes only.

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Across all lots Purple and Yellow scored higher in terms of future ownership proposition.

</td></tr>
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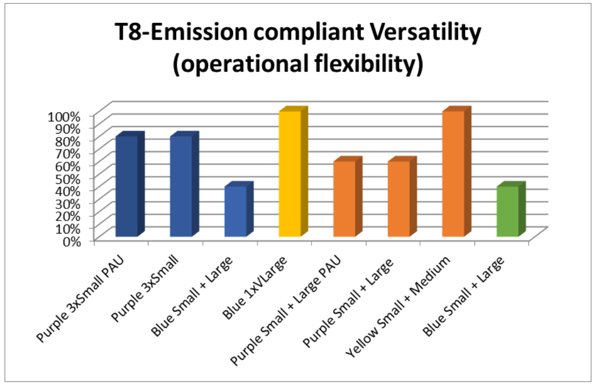

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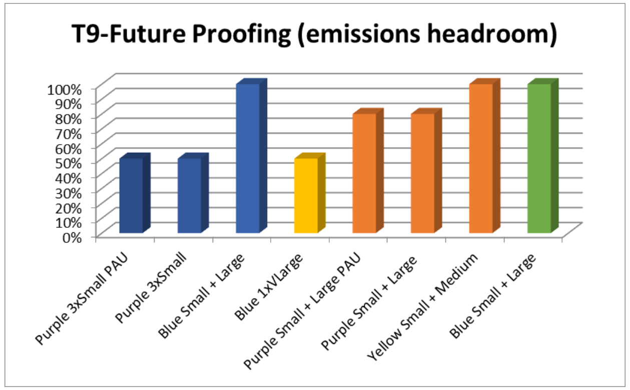

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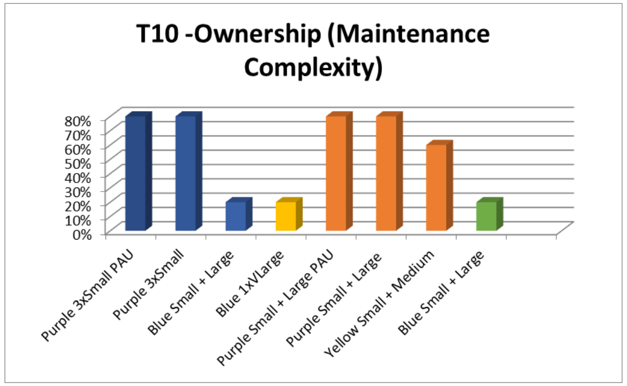
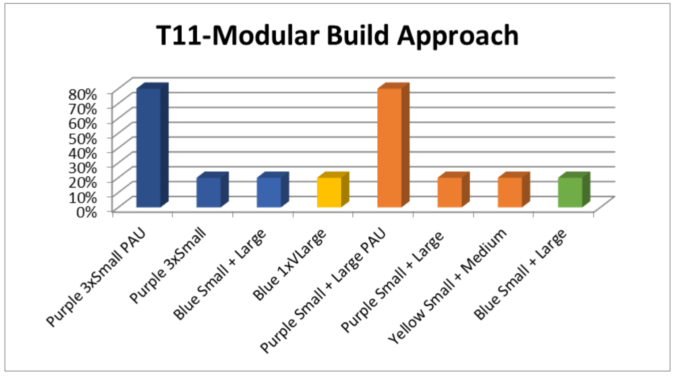


</td></tr>
</table>

27 MCR – maximum continuous rating

T11. Modular Build Approach		
• The only pre-assembled unit offer across both lots, from Purple, scored highest, the remainder scoring an equal, lower score. 		

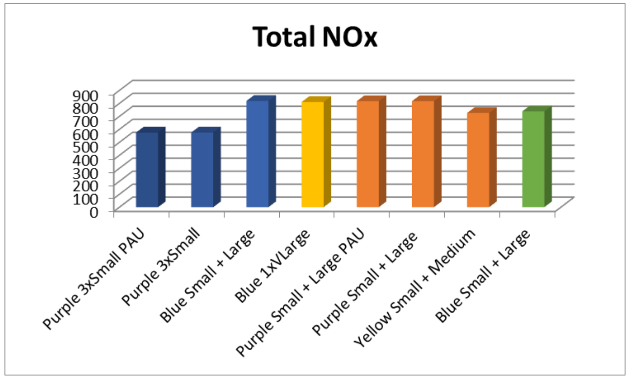
7.2 Environmental scoring results

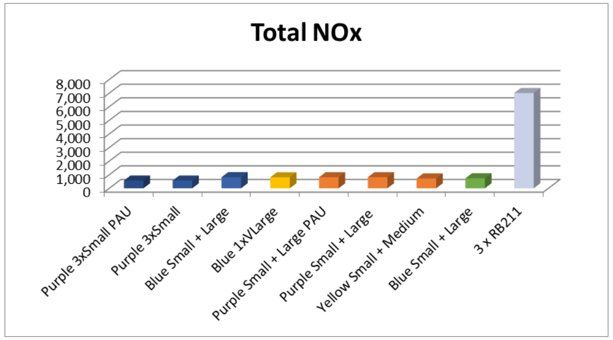
For the calculated criteria E6 to E8, the T/SP/ENV/21 BAT model derives estimated environmental performance for the candidate options, based on OEM tender return information. In respect of the criteria ‘E9. Environmental Hazard’, and ‘E10. Noise (betterment and evidence to support)’ which were evaluated rather than calculated, the same approach was adopted as described in respect of the technical criteria (see section 6.3). The scores are presented graphically below, alongside key scoring themes. Lot 2A results are coloured blue, Lot 2B yellow, Lot 2C orange and Lot 2D green.

Environmental scoring results (All lots)

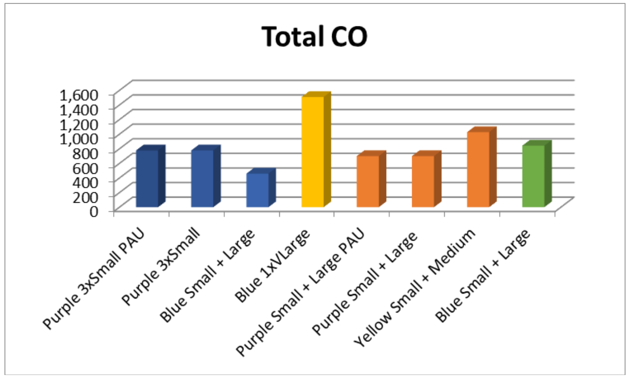
- Inherent efficiency of single unit running can be seen in the tCO_2e graph (Blue 1 x Very Large).
- NOx performance is comparable amongst all options, with Purple offering some advantage, but overall the emissions levels are low.
- Weaker CO performance of Blue 1 x Very Large is consequence of fitting a large unit to a wide envelope.
- The lower graphs show the degree of improvement that could be realised; this was determined by assessing how existing RB211 units may operate against the Lot 2C PDS duty (noting the RB211 would not be 'available' in reality).
- Significant benefit could be realised for any improvement case, especially for NOx and CO, however this does not negate National Grid's obligation to pick BAT from within the pool of candidate options.
- The tCO_2e benefit is less marked; there has been less of a paradigm shift in efficiency performance (due in part to the way DLE systems operate); the existing units already have lower emission dry gas seals, thus reductions in methane emissions from new plant in this area would be limited too.

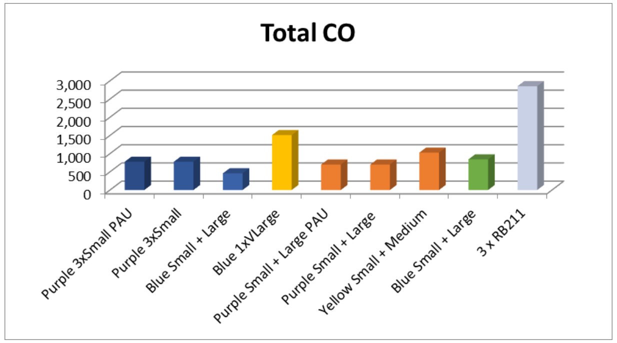
tNOx



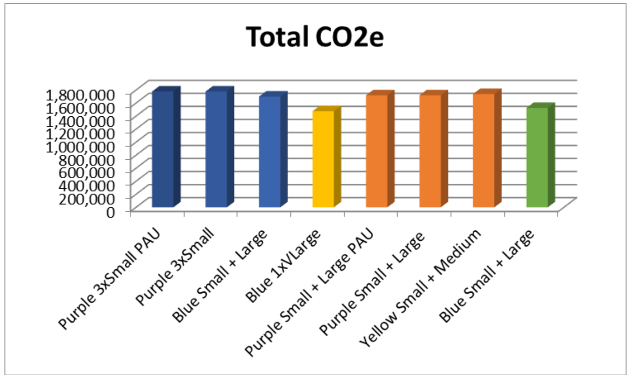


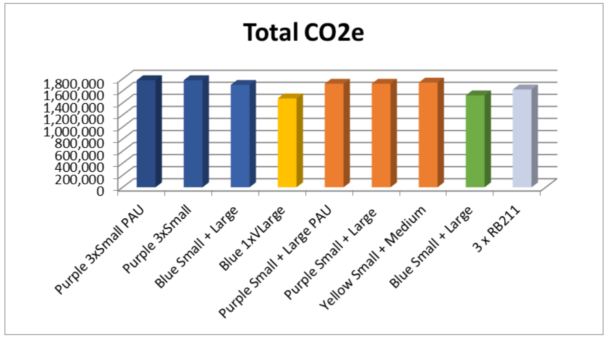
tCO

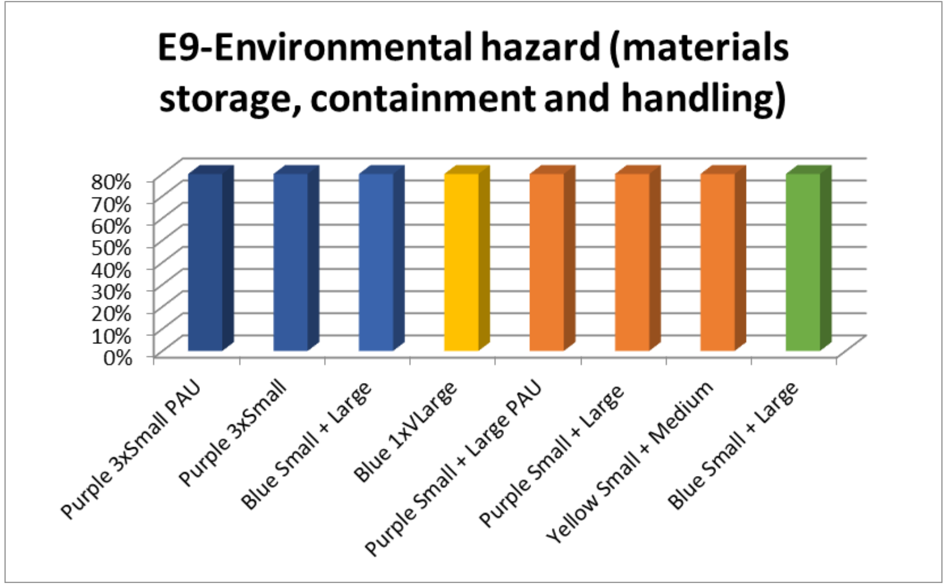
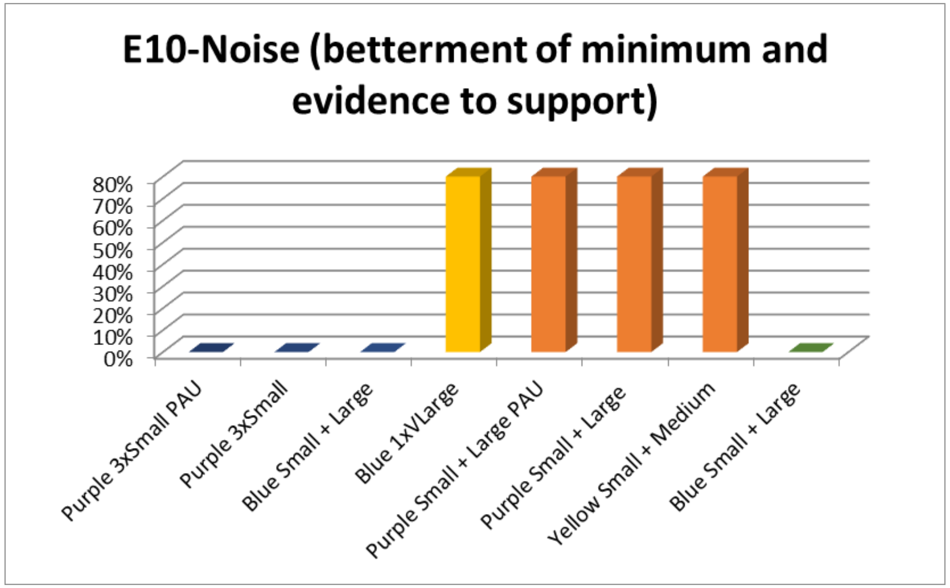




tCO_2e





E9. Environmental Hazard	E10. Noise (betterment / evidence to support)
• All units score equally for E9. • There were no SCR bids, all remaining units applied industry standard good practice in terms of containment and management of oils and fluids.	• All bidders provided a good degree of evidence to support their noise performance; the assessment of this criteria focused on detailed studies conducted on Lot 2B and Lot 2C options.
	

7.3 Review of BAT model outputs

This section presents selected BAT results, showing the combined environmental-technical scores against the calculated whole life costs; graphical cost benefit charts are used with key themes highlighted in the accompanying commentary.

Figure 24 Lot 2A, 2B, 2C and 2D overall illustration

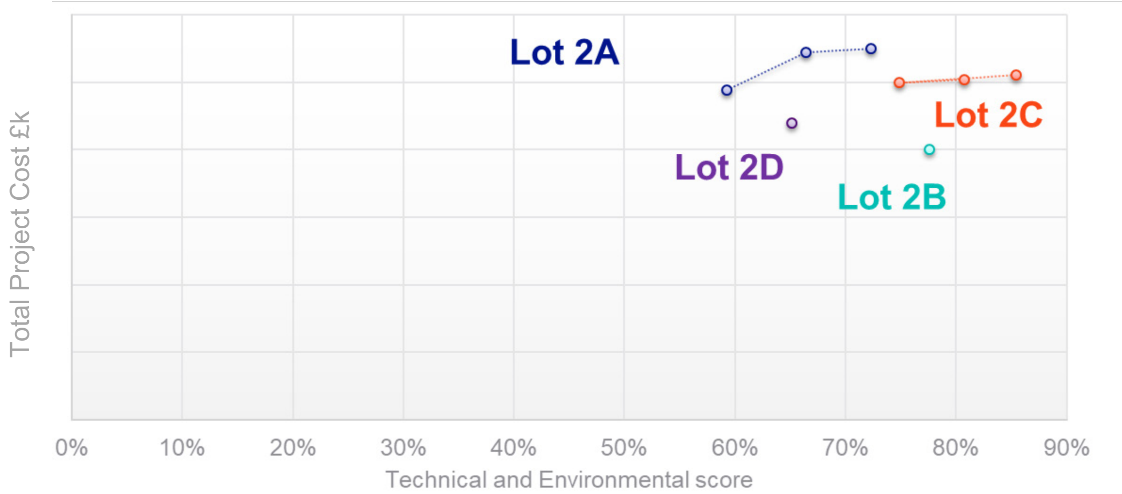
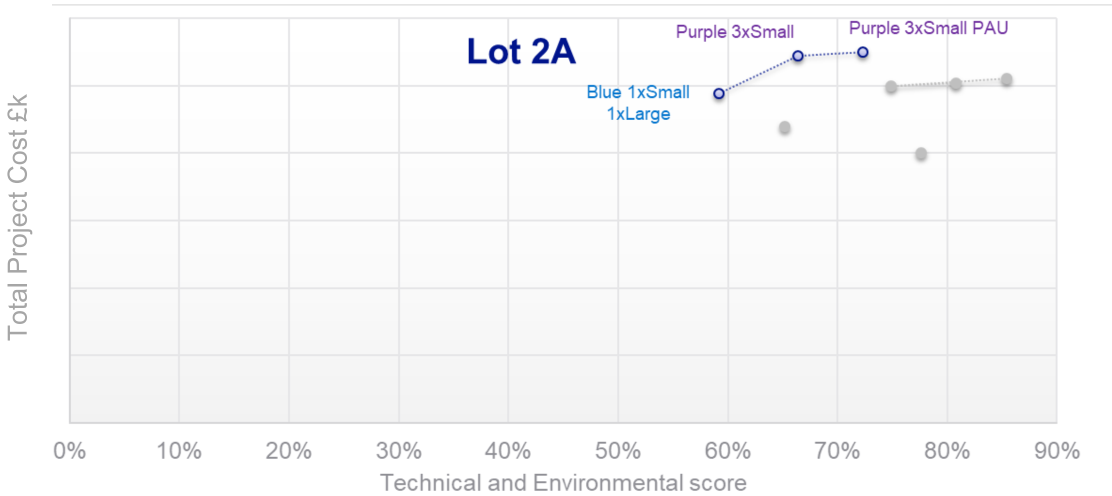


Figure 25 Lot 2A BAT model outputs

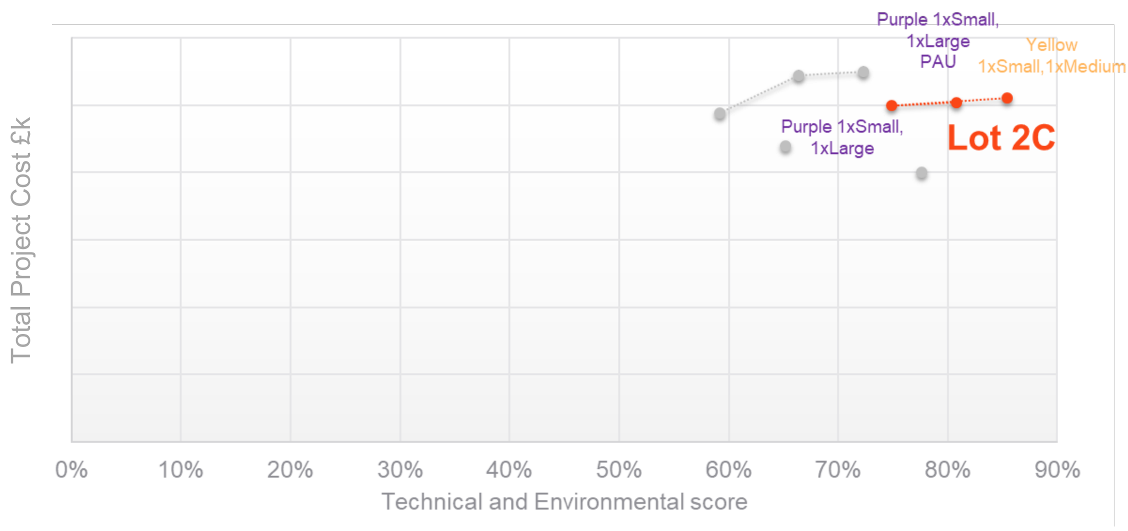


The following observations are noted:

- Operating cost, in particular fuel, is the primary component of whole life cost for a high hours duty site over a 20 year modelled period.
- For Lot 2A the three unit options (Purple 3xSmall units, PAU and traditional build) offer some environmental-technical benefit over the Blue two unit option, albeit at significantly higher whole life costs. A large number of machines would tend to maximise flexibility by allowing usage to be optimised to the required duty, however, they have the highest whole life cost options of any of the lots.

- Regarding the two Purple options, there remains uncertainty as to how much real-world separation (cost and performance) there would be between the PAU and traditional on-site build options so these can effectively be considered as a single option. PAU is a new concept explored for the first time in this call off to potentially drive savings through the delivery programme.

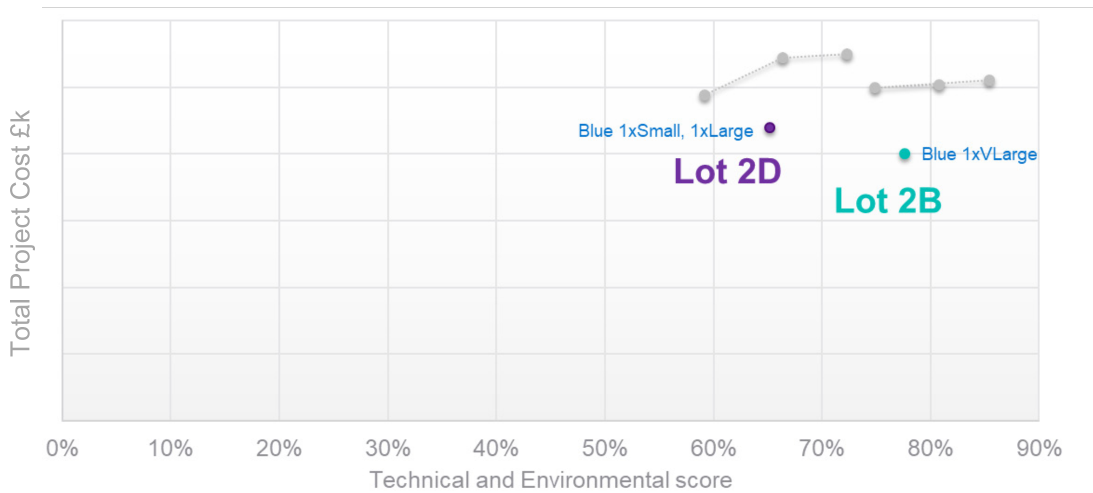
Figure 26 Lot 2C BAT model outputs



The following observations are noted:

- The Lot 2C options offer a high degree of environmental-technical performance (although the lots cannot be directly compared in this respect, and are plotted together for simplicity).
- The whole life cost of these options is lower than the Lot 2A scenario (costs are comparable on these charts), indicating that, when combined with the effective performance, they could be candidate BAT options.
- Although the Yellow option offers some performance gain (albeit at a small increase in whole life cost) the three options comprising this Lot are difficult to meaningfully separate on BAT grounds.

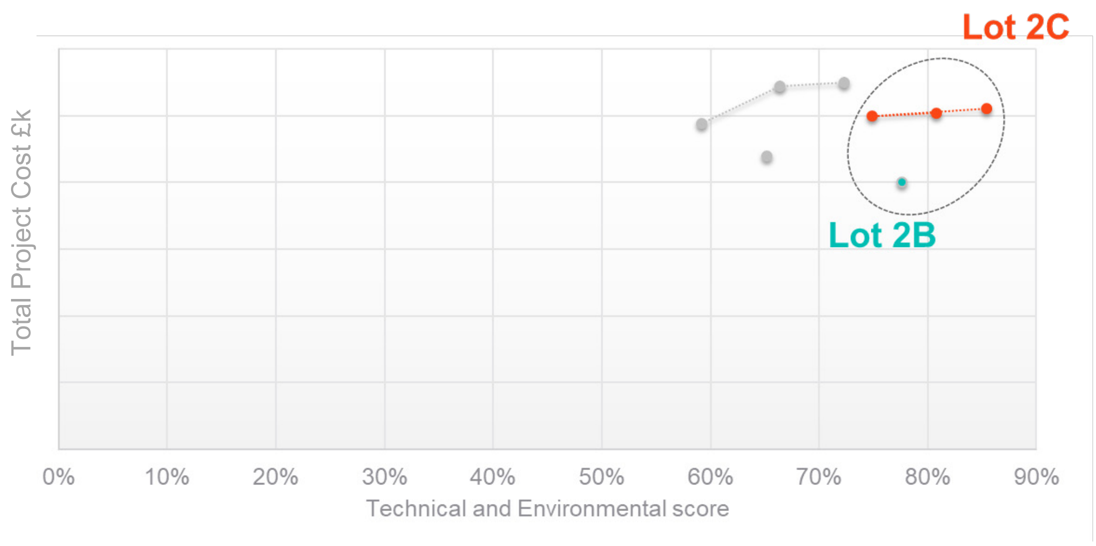
Figure 27 Lot 2B and 2D BAT model outputs



The following observations are noted:

- Lot 2D is the same technical solution as offered by Blue in response to Lot 2A, warranting no further discussion.
- Lot 2B option from Blue (a single very large unit) appears to offer a favourable cost benefit balance, but further comparison was required against other Lot solutions. This is discussed subsequently.

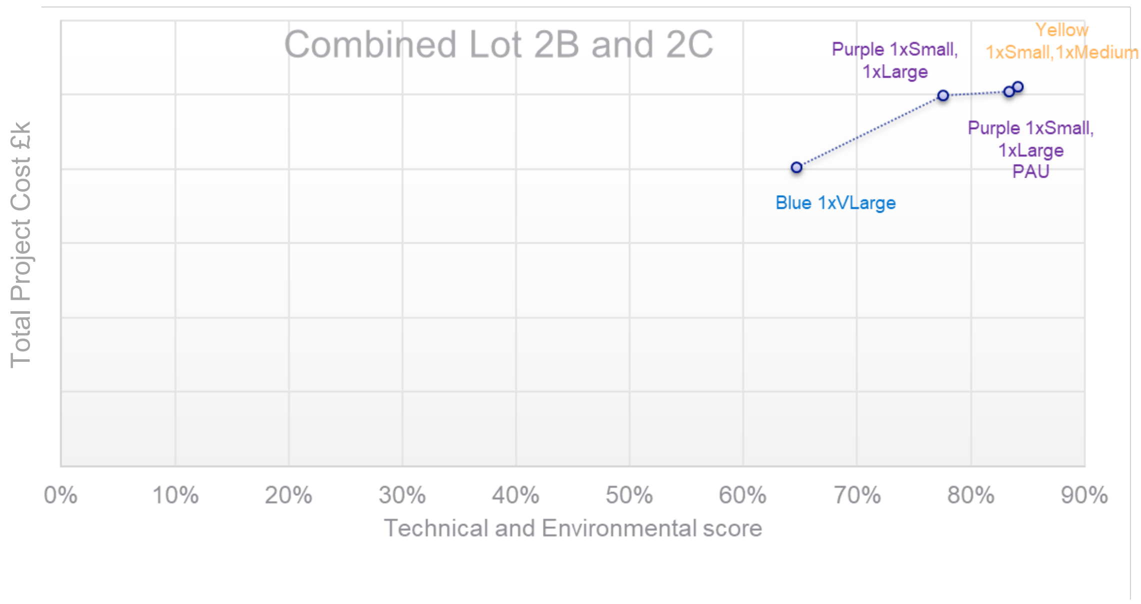
Figure 28 Candidate BAT zone



The following observations are noted:

- The above presentation highlights the previous discussion points, specifically that options from Lots 2B and 2C would appear to form a 'zone' of candidate BAT solutions.
- Due to the BAT tool methodology, these would need to be combined into a single composite Lot to enable direct side by side comparison.

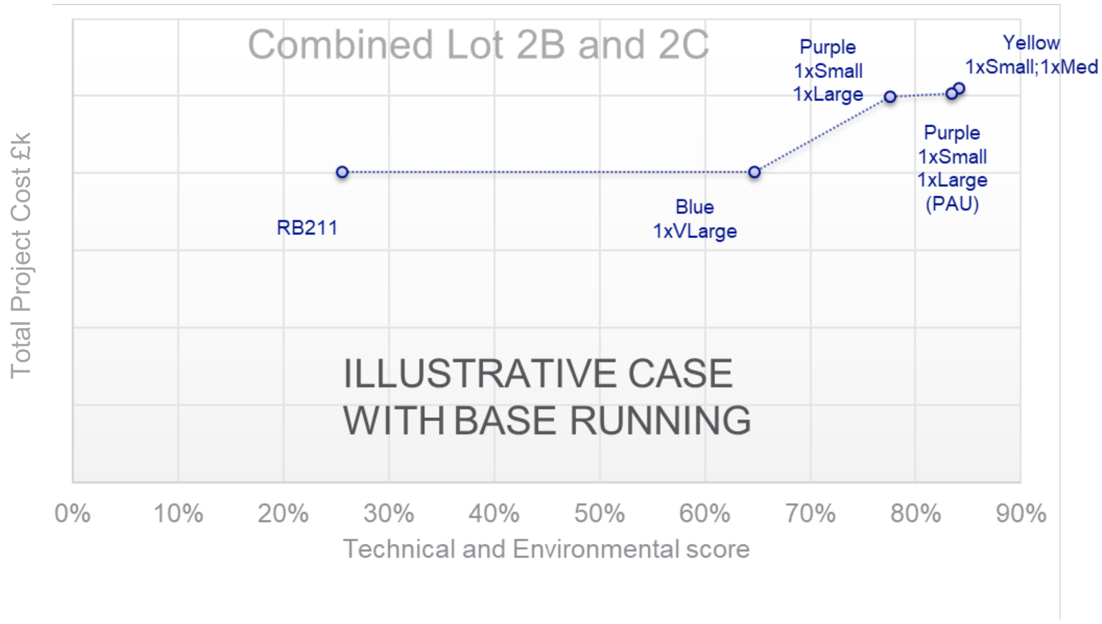
Figure 29 Combined Lot 2B and Lot 2C BAT model outputs



The following observations are noted:

- Yellow and Purple options offer a material increase in technical / environmental score compared to the Blue option, albeit at a higher whole life cost.
- The BAT tool does not include other costs factors which could be material to the decision, specifically constraints costs that may arise from reliance on a single new unit, compared to the higher resilience multiple unit options.
- All three options have the potential to be candidate BAT options, however sound engineering judgement, greater versatility (flexibility) and the higher overall environmental technical score would favour the Yellow or Purple options as the preferred BAT solution. The results are considered too close to offer any material separation of these cases within the limitations of the BAT tool.

Figure 30 Comparative illustration to base case

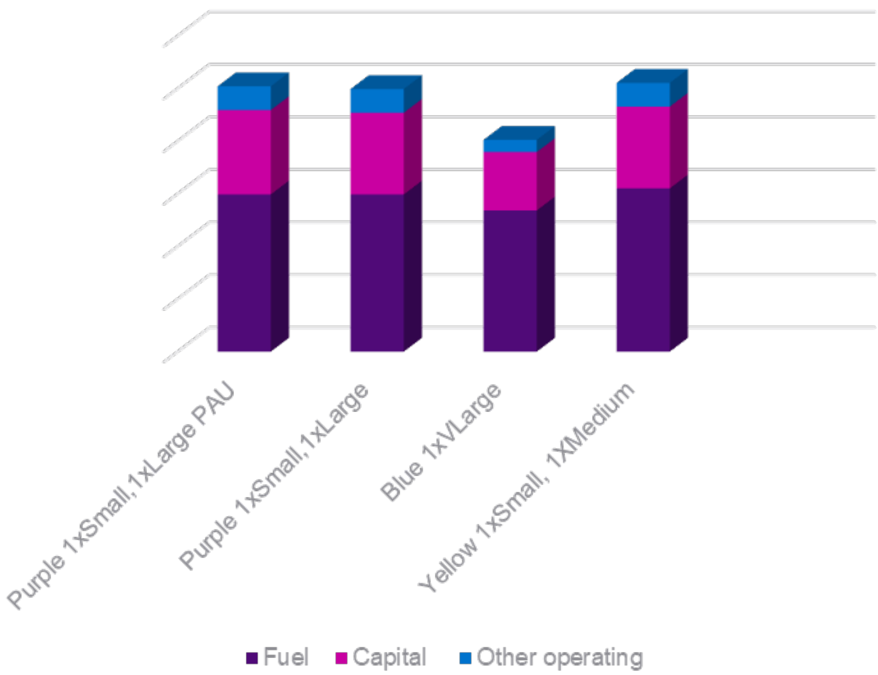


The following observations are noted:

- The preferred BAT options offer a material gain in performance over base case, albeit at an increase in whole life cost. Even though there are fuel efficiency gains associated with new plant options, over the modelled 20-year design life, this does not negate the capital expenditure required.
- This case is purely illustrative, the existing units can't be considered as 'available' and would fail the majority of pass/fail contract award criteria (part of the tender evaluation but outside of the BAT assessment process).

Further information is provided in respect of the whole life cost breakdown for Lot 2B/2C, in support of the selection rationale. This shows the contribution of fuel, capital and other operating costs (e.g. maintenance).

Figure 31 Cost breakdown Lot 2B/2C



The following observations are noted:

- The Blue option offers the potential for lower whole life fuel costs, but as noted previously constraint risks will need to be considered subsequently through application of National Grid's CBA Tool.
- Energy savings will continue to accrue for the whole life of the plant (at least 40 years, compared to the modelled 20 years in the BAT study) so new unit efficiency over legacy gas turbines will be realised.
- Whilst National Grid would not realise energy benefits outside of their current price control period (due to re-baselining of operating cost), the societal (consumer) benefits should not be ignored.
- There is very little separate in running or capital cost between the Purple and Yellow solutions.

7.4 Review with the environmental regulator

At this point in the project, the results of the call off BAT assessment were reviewed with the Hatton site's environmental regulator the EA on 9 May 2019 in order to share key findings and seek support in respect of the indicated BAT assessment conclusions.

8 Conclusions

8.1 Introduction

This chapter presents conclusions in summary form in respect of the principal study elements discussed previously. Limitations inherent in a study such as this are then discussed, followed by future activities.

8.2 Summary conclusions

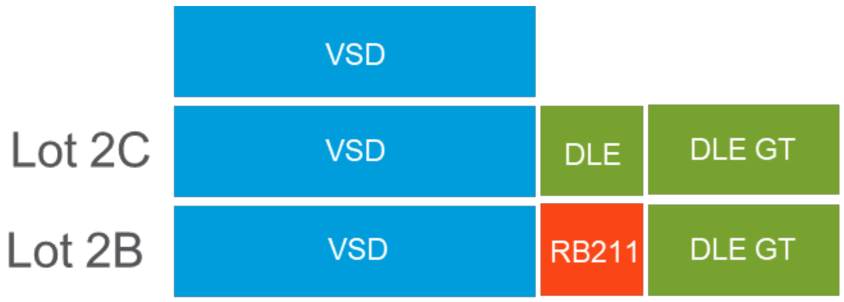
The following summary conclusions can be noted:

- The pre-call off indicative BAT assessment provided an effective test bed environment to rehearse the main decision steps for the actual call off event, including PDS points.
- The indicative options derived at the pre-call of stage were consistent with the subsequent market derived solutions, except in respect of SCR cases. The indicative pre-call off BAT assessment concluded that SCR was unlikely to represent BAT for Hatton; this was borne out via the market call off as no OEM suppliers offered SCR solutions, even after National Grid sought clarification as to whether catalytic solutions would be viable.
- There was close agreement in terms of the likely BAT options between the indicative pre-call off and call off BAT assessments.
- These findings enhance confidence in the two-stage pre-call off process for future compressor machinery call off events.
- In respect of the call off BAT assessment, the solutions offered in Lot 2B and 2C were considered to represent the candidate BAT options. Whilst any of these could be considered candidate BAT, the technical environmental score and professional engineering judgement would tend to favour the Yellow (1 x Small plus 1 x Medium) or Purple (1 x Small plus 1 x Medium) over the Blue solution (1 x Very Large).
- Whilst the Blue Lot 2B solution appears to offer a lower whole life cost (albeit with an attendant reduction in score) this does not include potential constraint costs associated with reliance on a single machine; these will need to be quantified and considered during the subsequent application of the National Grid CBA Tool.
- The environmental regulator also commented that a single unit solution would be likely to increase reliance on legacy gas turbine units, which was contrary to the underlying principles of BAT.

The concluding position can be illustrated in respect of likely reliance on legacy plant during normal operations (VSD availability) and abnormal operating conditions (reduced VSD availability).

Figure 32 shows that all normal running scenarios should be capable of being delivered using BAT plant via Lot 2C (i.e. VSD units or new low emission gas turbines). For Lot 2B, under certain high process duty demand scenarios, the legacy 500 hours RB211 would still need to be called upon to provide compression.

Figure 32 Illustration of BAT for normal running (Lot 2B and Lot 2C)



The degree of resilience differs between Lots in the event of reduced VSD availability. This is illustrated in the following figure if the VSD were unavailable. Legacy running (compliant under 500 hours rules) would be required for at least some duty points for all backup scenarios (Figure 33).

Figure 33 Resilience to VSD unavailability (Lot 2B and 2C)

8.3 Limitations

- An inherent limitation in the T/SP/ENV/21 BAT model is that it does not holistically consider 'ephemeral' conditions (each run of the model only allows you to lock in running conditions for the full 20 years). These have to be addressed via sensitivities cases; these were extensively explored at the pre-call off BAT assessment stage.
- Simple cost-benefit modelling will not capture the complexity of National Grid's regulated business funding and requirements of operating under a price control regime (i.e. operating costs benefits arising from investment cannot be accrued beyond the current defined price control period, simple models such as this do not consider revenues from increased regulated asset value (RAV) associated with investment). Some of these matters are addressed within the National Grid CBA Tool.
- The BAT model is only one methodology to consider in the decision process; it is a decision support process not a decision-making process.
- Models such as this require assumptions which are always open to challenge (weightings, scores, derived costs). As far as possible, peer review by National Grid stakeholders and with environmental regulators was adopted.
- Input data is derived from varying sources or estimates, each has its own level of accuracy, such that modelled findings should be viewed as relative and indicative.
- Modelling future energy costs can only ever be an estimate based on reasonably foreseeable supply, demand and market conditions; the T/SP/ENV/21 operating cost model is based on this premise. However, it is at least applied consistently to all cases.

8.4 Future activities

The following future activities are in progress / required:

- Application of the National Grid CBA Tool to the selected call off candidate BAT options to allow full consideration of wider network operating factors, including constraint costs. This will support the determination of the final preferred option.
- Conclusion of the formal market call off event.
- Further discussion with Ofgem.
- National Grid internal financial sanction.
- BAT assessment reporting to support future applications for permit variations to the environmental regulator.

Appendices

Appendix 1 CBA model and ENV/21 comparison

Theme	CBA Model		T/SP/ENV/21	
Capital Cost	✓	eHub, all components	✓	eHub, all components
Maintenance	✓	Included in site opex line in model	✓	MAINT/6 interventions and manufacturers recommendations (risked)
Asset Health	✓	Estimates based on intervention assumed on five yearly basis	✓	Network engineering cost book weighted probability of failure
Energy Cost	✓	FES (flow assumptions and annual profiles)	✓	FES Wholesale / commercial based on derived PDS and run hours estimates
Operability / Technical	×	Not included unless demonstrable financial constraints can arise	✓	Operability, versatility, envelope, constructability
Constraints	✓	Failure of supply & associated risk cost (contracts)	×	Not included at this stage
Sensitivities	✓	Composite year data made up of typical operating conditions	✓	Based on series of static conditions
Emissions CO_2	✓	Monetised based on FES carbon prices; sensitivities considered.	✓	Derived from fuel usage / type. Scored
Emissions NOx	✓	Monetised based on cost/tonne	✓	Derived from actual engine performance at different engine loads. Scored
Emissions CO	×	Not included, due to lack of monetised data on CO impact costs	✓	Derived from actual engine performance at different engine loads. Scored
Modelled period	✓	25 years, although revenue cost recovered from consumer up to year 45	✓	20 years
Discounted cash flow	✓	3.5% for years 0-30, 3% for years 30-45	×	Functionality in but not used yet
Complex cost model	✓	4.04% weighted average cost of capital, 4 or 5 year investment spend profile	×	Simplified, investment in year zero, cost of capital not included

About the study authors

Project Environmental Solutions Ltd. (PESL) was founded in 2014 and brings together a small team of consultants with extensive experience in providing niche specialist technical services to National Grid through numerous projects within GT, ET, Capital Delivery and the former Gas Distribution business. We have worked extensively on gas transmission compressor replacement projects, undertaking cost-benefit Best Available Techniques (BAT) assessments for existing, new and retrofit schemes. Our team were key project team members for the development of the Compressor Machinery Train and Compressor Balance of Plant BAT assessment tools, which are now widely used to support asset selection decisions.

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Project Environmental Solutions

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Hatton Compressor Upgrade:
Revised Lot 2B call off BAT assessment

National Grid Gas plc

December 2020

FINAL – PUBLIC REGISTER REVISION

Project Environmental Solutions
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Quality control sheet

Project details

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Date	17 December 2020

Client details

Client contact	Phebion Mudoti
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Document details

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Contents

1 Introduction

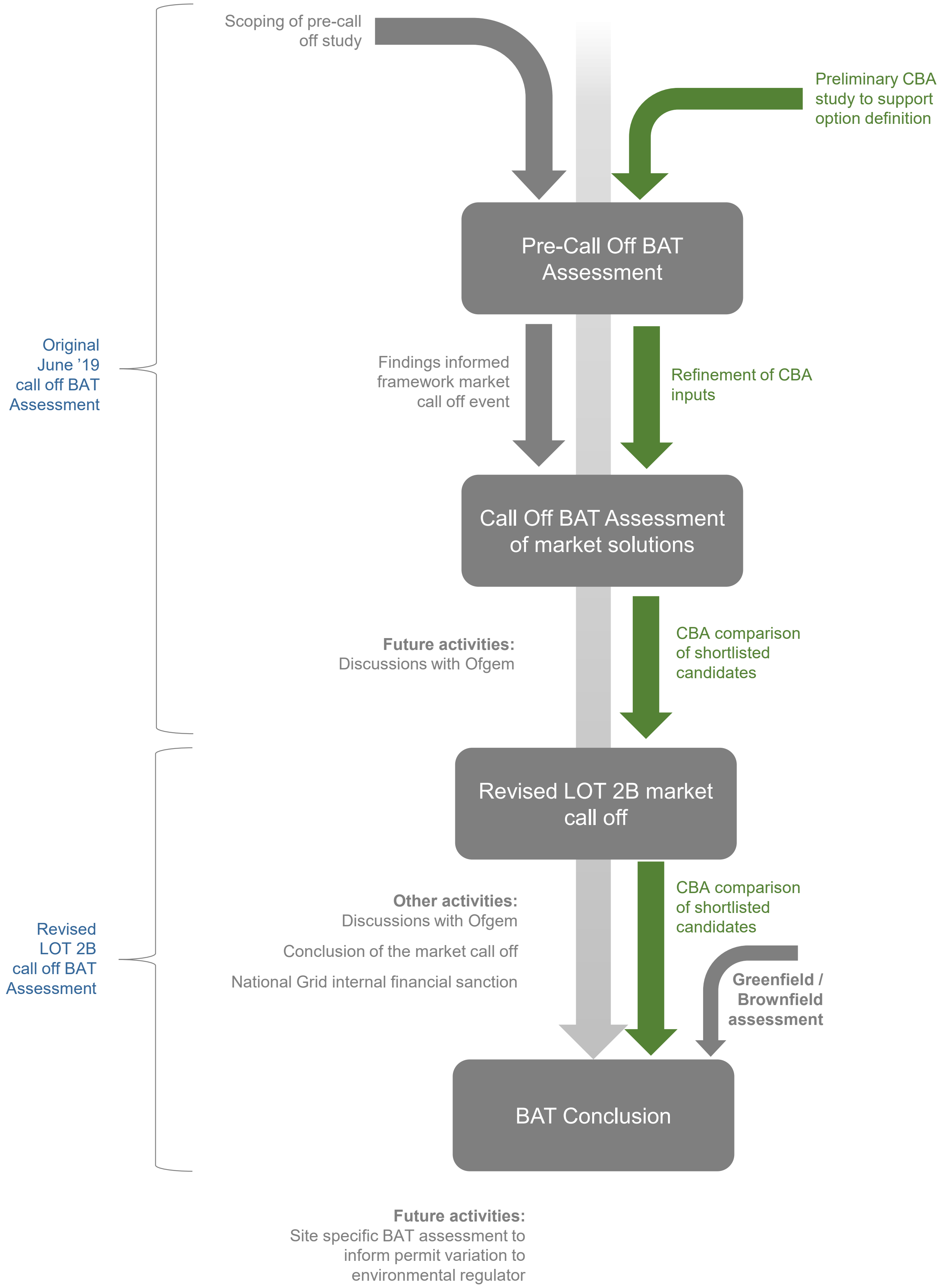
National Grid Gas plc (National Grid) commissioned Project Environmental Solutions Ltd (PESL) to support the Best Available Technique (BAT) assessment conducted to determine the most appropriate compressor machinery train upgrade options for the Hatton Gas Compressor Station (hereafter Hatton), to meet the requirements of the Environment Agency (EA) in respect of the site's Environmental Permit and Ofgem[1], in respect of National Grid's gas transporter licence obligations.

1.1 Study approach and reporting

This report describes the revised Lot 2B updated call off BAT assessment carried out in respect of the proposed Hatton gas compressor upgrade project. The original assessment[2] was carried out in two stages; a 'pre-call off Preliminary BAT assessment' to provide indicative results and test key assessment assumptions, followed by a 'call off BAT assessment' undertaken on market derived candidate solutions offered by participants on National Grid's Gas Pipeline Compressor Machinery Train Package Framework (hereafter 'the Framework'). The market call off identified solutions considered to represent candidate BAT options as Lots 2B and 2C (single unit and two unit solutions, respectively). Following submission of the original Hatton BAT assessment report in June 2019, and subsequent review and discussions with Ofgem during 2020, their position was that Lot 2B (a single unit solution to meet medium power process duty) was the only solution to be taken forward. This report therefore summarises the methodology, reporting and conclusions of National Grid's revised call off BAT assessment, to include solely Lot 2B. The outputs of this work were presented to National Grid in May 2020 for approval. As with the original call off BAT assessment this revised assessment has also been carried out in parallel with an internal assessment using National Grid's Cost Benefit Analysis (CBA) Tool.

[1] Ofgem - The Office of Gas and Electricity Markets, the government regulator for gas and electricity markets in Great Britain.
[2] 'HAT Best Available Technique (BAT)_vFINAL.pdf'

Figure 1 Original and revised Lot 2B BAT assessment study and report overview



1.2 Report structure

The remainder of this report sets out:

- To recap the project drivers and site overview in Chapter 2.
- An overview of the BAT process in Chapter 3.
- The revised Lot 2B call off BAT assessment methodology and findings, discussed in Chapters 4 and 5, respectively.
- Key conclusions, together with study limitations and future activities, discussed in Chapter 6.

Information Boxes

At key points in the document information boxes are provided which present additional information for the benefit of the reader. These boxes are designed to reflect the different levels of familiarity amongst the audience of the topics in question; the remaining report text outside of these boxes is designed to provide key elements of the study and its findings for the reader familiar with the principal issues that are being addressed.

2 Project drivers and site overview

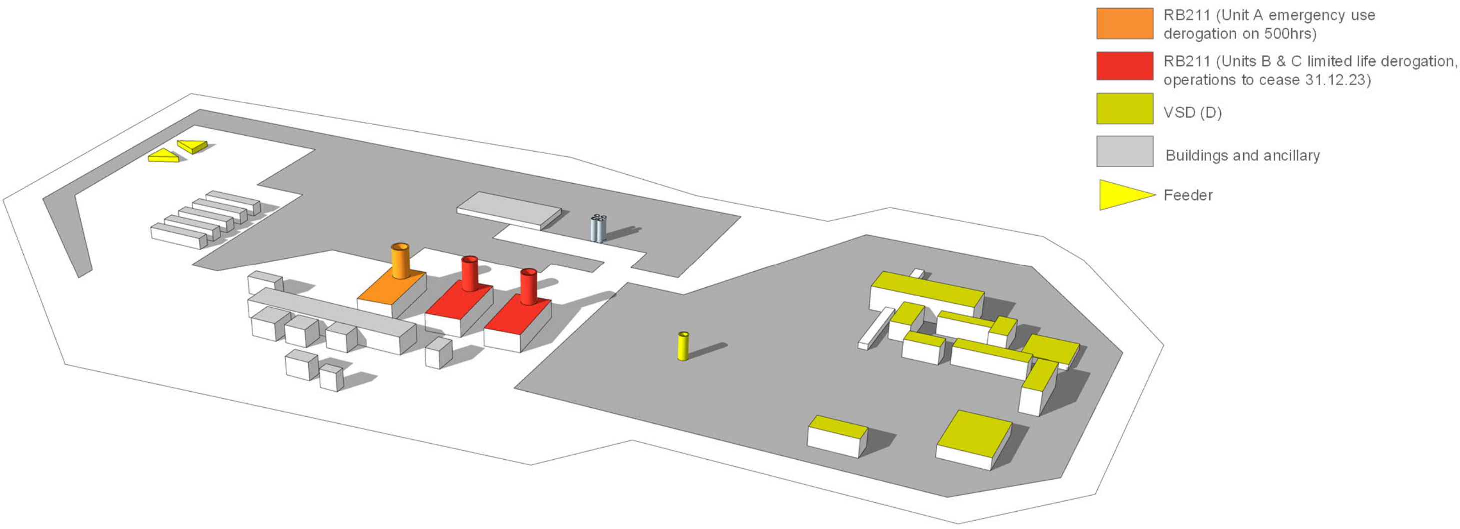
This chapter recaps the contextual overview of National Grid's Hatton site and explains the key drivers behind the proposed compressor upgrade project.

2.1 Hatton site overview

National Grid's Hatton site is a key compressor installation that has historically seen high levels of duty; its purpose is to compress gas, increasing flows and pressures in the network for onward transmission to the wider network and ultimately customers. Existing equipment comprises three legacy gas turbine driven compressors (Units A, B and C) installed in the 1980s, and a single modern electric Variable Speed Drive (VSD) compressor (Unit D) installed in the mid-2000s. The site's Environmental Permit dictates that the BAT VSD unit is used, when operationally available, in preference to the legacy gas turbine driven compressors.

Key plant is illustrated on the site schematic below, the table underneath shows the modular way in which existing units can be combined to accommodate the full range of site power requirements (as megawatts (MW)).

Figure 2 Hatton schematic (pre-2023 operation)



1:	RB211 (22 MW)		RB211 (22 MW)	VSD unavailable
2:	RB211	VSD (35 MW)	RB211	VSD available

2.2 Project background

Gas turbine back-up to the electric VSD must be maintained into the future to provide security of supply, the site already relies substantially on third party energy supplies in using the VSD for bulk compression. As such, no further investment in electric drives is considered appropriate at the site; instead compression upgrades must utilise low emission gas turbine driven units.

There are three primary drivers for the proposed gas turbine compressor upgrade project:

- **Tightening environmental regulatory requirements associated with legacy gas turbines.** The existing Large Combustion Plant[3] (LCP) at the site comprising three Rolls-Royce RB211-24C gas turbine driven compressor sets (hereafter RB211s) are not capable of meeting existing plant emissions limits as set out in the Industrial Emissions Directive[4] (IED). As such, National Grid elected to place Unit A onto the 500 hours 'emergency use' derogation, this being the maximum hours the unit can run per year for the remainder of its operational life. Units B and C were placed under Limited Life Derogation (LLD) whereby they must be retired on the sooner of 17,500 run hours from derogation or 31.12.2023. Associated Emissions Levels (AELs) contained in the Large Combustion Plant BAT Reference (BREF) documents[5] also drive future compliance standards for the site, as may emission limit values set out in the Medium Combustion Plant[6] (MCP) Directive (depending on the size of any new combustion plant installed).
- **Mass emissions reduction.** National Grid is required to regularly review network wide environmental emissions performance with the Environment Agency (EA), Scottish Environment Protection Agency (SEPA) and Natural Resources Wales (NRW); this is called the Network Review, annual updates of which are set by a condition in all the sites' permits. This process, carried out in discussion with the environmental regulators, involves the review of options to make material improvements to site mass emissions of NOx (as well as improvements in CO emission concentrations). The improvements focus on those sites with higher running hours and older gas turbine compressor machinery; although Hatton was subject to an earlier phase of the Emissions Reduction Programme (ERP), when the VSD was installed, the remaining usage of the RB211 units makes the site a Network Review priority despite lead duty being preferentially met by the BAT compliant electric VSD compressor.
- **Asset Health.** There are a number of asset health issues associated with the compressor machinery at Hatton due to age and high utilisation.

[3] Plant with an individual thermal input in excess of 50MW
[4] Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control)
[5] Best Available Techniques (BAT) Reference Document for the Large Combustion Plants Industrial Emissions Directive 2010/75/EU (Integrated Pollution Prevention and Control) JOINT RESEARCH CENTRE. European IPPC Bureau. (December 2017) and Commission Implementing Decision (EU) 2017/1442 of 31 July 2017 establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for large combustion plants (August 2017).
[6] Directive (EU) 2015/2193 of the European Parliament and of the Council of 25 November 2015 on the limitation of emissions of certain pollutants into the air from medium combustion plants

3 BAT process overview

This chapter provides an overview of the principles of BAT and its application by National Grid to compressor machinery train selection. These principles are common to the original pre-call off and market led call off BAT assessments, and the revised Lot 2B call off BAT assessment (for which this report details), with only detailed aspects of the methodology varying with the stage of work.

3.1 Defining BAT

The principle of BAT underpins the IED regime; it can be defined as follows:

- **Best** means the most effective techniques for achieving a high general level of protection for the environment as a whole.
- **Available** means techniques developed on a scale which allows implementation in the relevant industrial sector under economically and technically viable conditions, taking into consideration the cost and advantages, whether or not the techniques are used or produced in the United Kingdom as long as they are reasonably accessible to the operator.
- **Techniques** includes both technology and the way the installation is designed, built, maintained, operated and decommissioned.

This definition can be distilled to its key expectation, namely that of a cost benefit analysis:

> *"The selection of techniques and practices to protect the environment should achieve an appropriate balance between benefits to the environment as a whole and the costs incurred by the operator"*

Inherent in this process is the requirement to consider whole life cost, together with drivers towards sustainability, low emissions, high efficiency and flexible technology; these demands are consistent with the objectives of RIIO[7] and will drive customer benefit.

3.2 The National Grid approach to the assessment of BAT

National Grid is legally bound under the IED to comply[8] with the requirements of BAT in respect of its compressor installations operating gas turbine driven compressor plant. Beyond this, National Grid made a policy decision in 2013 that BAT would be the primary selection mechanism for all new and substantially modified compressor machinery trains. This approach is consistent with National Grid's corporate objective to demonstrate Whole Life Value for its internal and external stakeholders. Other key requirements e.g. health and safety and system integration are addressed via compliance with National Grid's engineering standards.

A BAT assessment methodology has been developed by National Grid in discussion with the EA[9] and SEPA, based on an approach defined by the UK environmental regulators (See Information Box 1).

By following the principles of the regulators' approach, the National Grid method takes full account of the required considerations under sites' environmental permits, but in addition also seeks to:

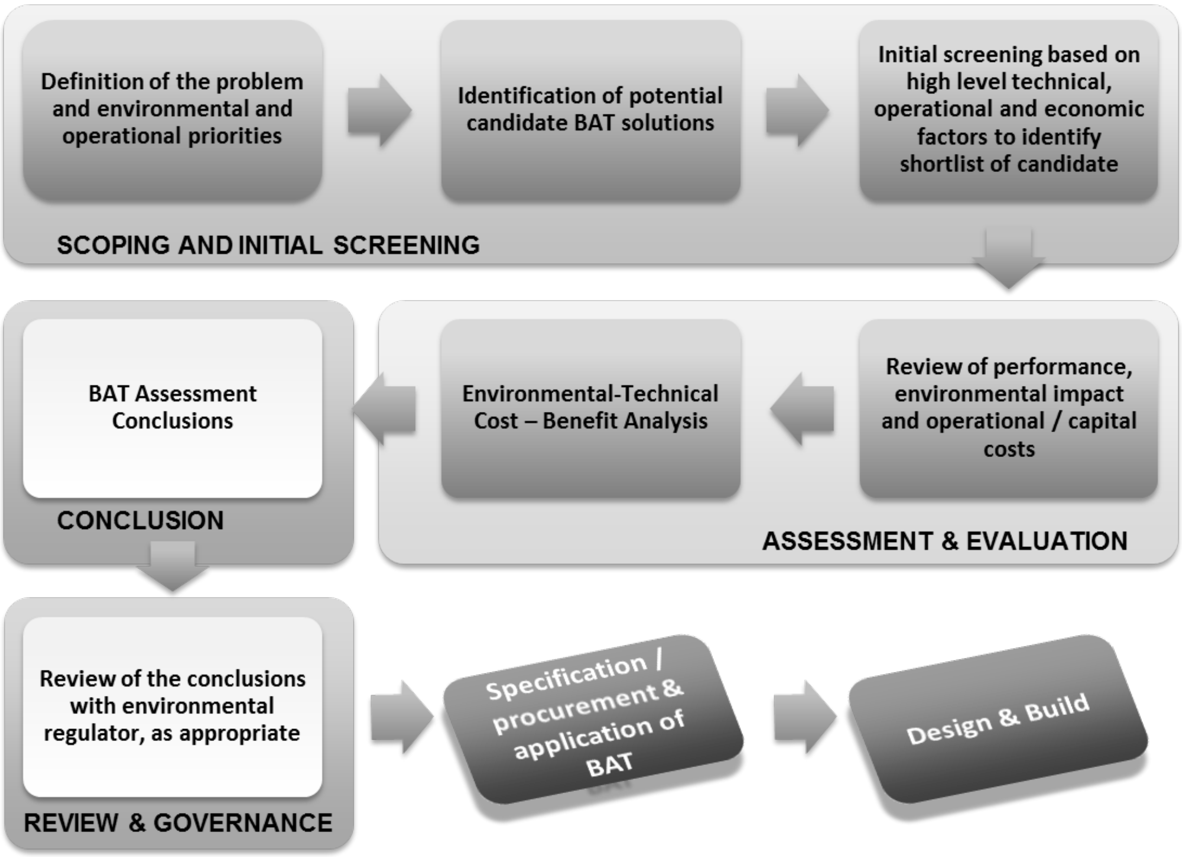
7 RIIO. Revenue=Incentives+Innovation+Outputs, Ofgem's performance-based framework to set network price controls
8 Legally binding implementation is through site Environmental Permits in England and Wales and Pollution Prevention and Control (PPC) permits in Scotland
9 Consultation on the BAT methodology commenced prior to the separation of the EA and NRW

- Ensure that the Company's legal obligations with regard to procurement legislation and rules can be met, as the method is designed to be used as part of a live procurement event.
- Take account of primary operational criteria essential to the management of a critical national infrastructure asset, where its operator is subject to stringent legal gas supply obligations.
- Support the achievement of the Company's wider sustainability obligations, in particular carbon dioxide reduction targets under its 'Our climate commitment' initiative[10].
- Align with Ofgem's expectations under the RIIO-T1 price control review[11].

The National Grid BAT assessment approach is a stepwise process (Figure 3), underpinned by a novel environmental-technical cost benefit analysis methodology which draws together the environmental and operational priorities that inform a particular decision relating to compressor machinery selection or modification. It is a decision support tool not a decision-making tool, professional environmental assessment and engineering judgement remains a key part of the process.

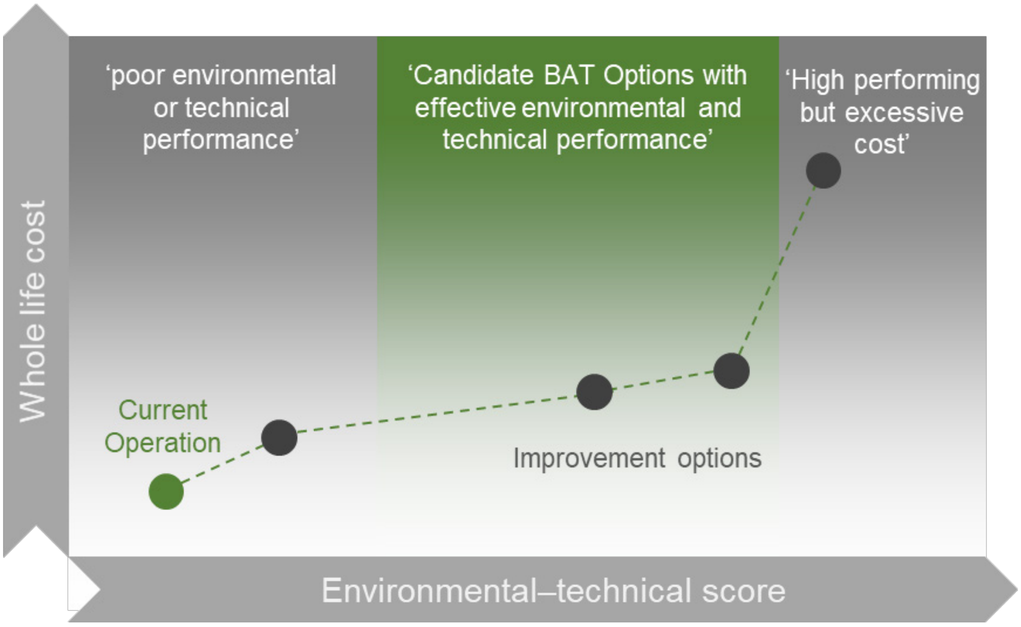
Due to the multiple drivers (comprising regulatory and commercial factors), the process brings technical / commercial / environmental evaluation criteria into a common assessment, rather than separate evaluations, and uses whole life cost rather than capital cost, reflecting that operating cost (fuel) is the greater proportion over a 20-40 years design life for compressor machinery.   The approach uses spreadsheet models and delivers graphical outputs (Figure 4) and is formalised in National Grid Specification Procedure T/SP/ENV/21.

Figure 3   Principles of the National Grid BAT assessment process



10 https://www.nationalgrid.com/group/responsibility-and-sustainability/environmental-sustainability/our-climate-commitment
11 RIIO-T1, price control period 2013 – 2021.

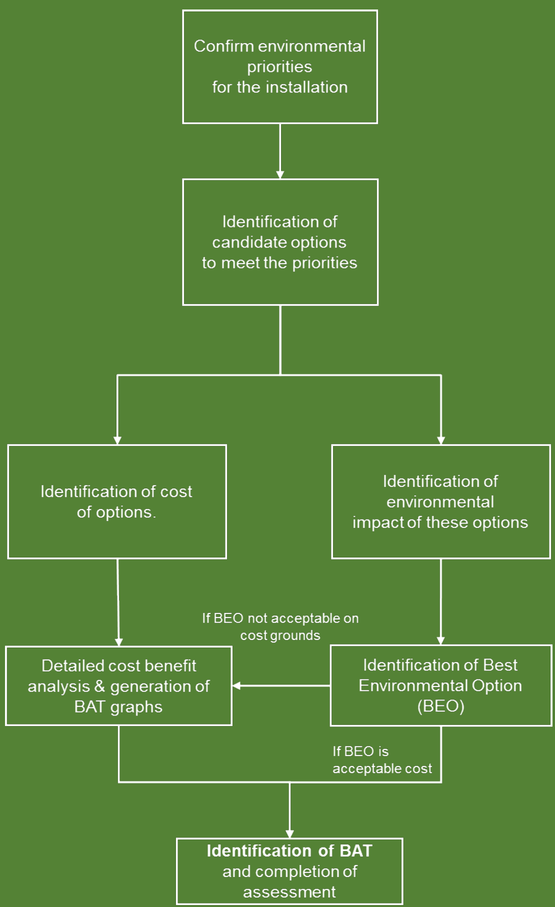
Figure 4 Conceptual illustration of graphical outputs from BAT model



Information Box 1: Principles of approach to BAT defined by UK environmental regulators

The assessment of BAT is a stepwise process following an established approach set out by the UK environmental regulators: the EA, SEPA and NRW. This method forms the basis for the National Grid BAT assessment approach.

Stepwise Regulator’s BAT Model



- Given the adoption of BAT assessment as the primary selection method for new and substantially modified gas compressor machinery train, National Grid has defined additional operating criteria to be considered in the BAT assessment.

  These additional parameters, such as reliability, versatility, ownership, and constructability are all consistent with the principles of BAT and relate to the way the installation is “designed, built, maintained, operated and decommissioned.”

3.3 BAT assessment and the CBA tool

In parallel to the BAT assessment process, National Grid has developed another Cost Benefit Analysis model (referred to as ‘the CBA Tool’). This is used to support need case approval for investment funding both internally within National Grid and externally with Ofgem.

There is much in common between the BAT assessment and CBA process, and the two tools share many common inputs. The principal differences relate to:

- Monetising of externalities in CBA tool (such as emission of NOx), which are addressed as scores in the BAT tool.
- Qualitative scoring of operational factors in the BAT tool (such as emissions limits compliance); such factors are only included within the CBA tool if they bring a monetised constraint cost risk.
- The CBA tool considers wider network interactions, such as the availability of other network stations, whereas the BAT tool is site specific.

A tabular presentation of the inputs and key assessment principles associated with the BAT model and CBA tool are presented in Appendix 1 to provide further guidance to the reader.

4 Revised Lot 2B off BAT assessment (methodology)

This chapter provides an overview of the revised Lot 2B methodology, setting out in a stepwise manner the development of the BAT assessment tender evaluation model.

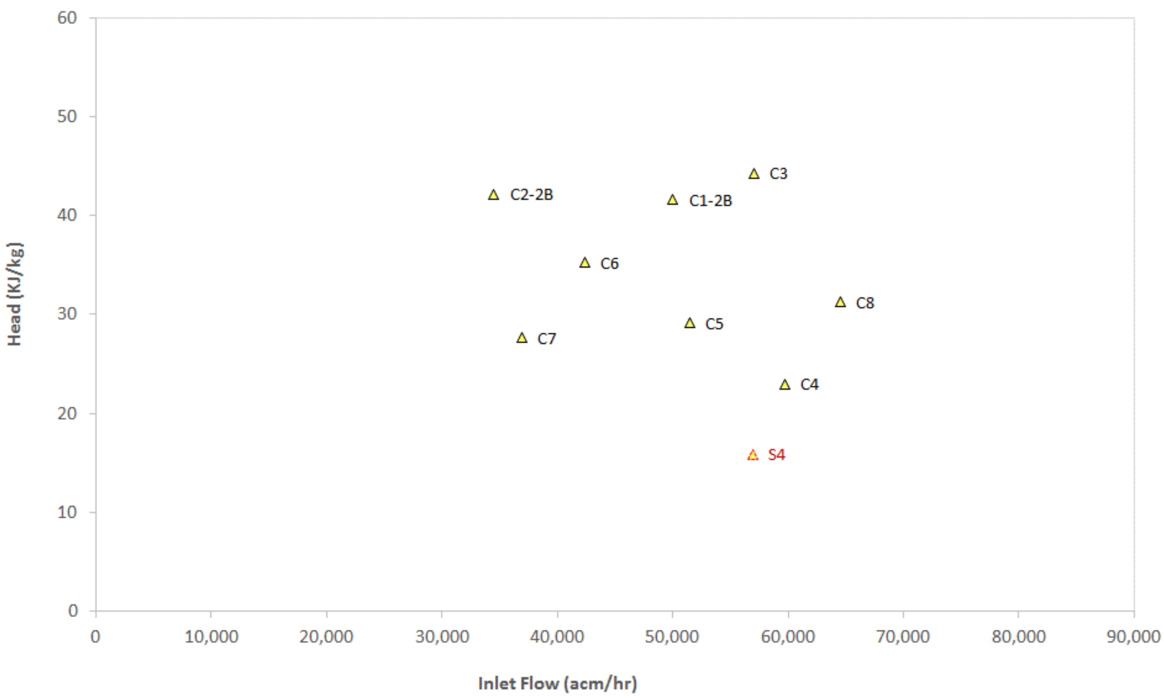
4.1 Process Duty Specifications (PDS) and sensitivity cases

The PDS defines a series of likely operating points for the station, each reflecting a snapshot of a given gas flow and pressure lift that would be expected of the station to meet its operating requirements. Whilst the exact combination of process flow and lift conditions experienced by the station are almost without limit, operations tend to cluster around areas of the site operating 'envelope' (see Information Box 2).

For the original pre-call off and 2019 call off BAT assessment, representative points were selected by National Grid network analysts and rotating machinery engineers to represent typical and boundary PDS points; respectively these explore where the bulk of the site duty is seen and where extremes of duty (such as peak winter demand) can reasonably be predicted. Each PDS point was attributed with a 'frequency' value which can be translated into the number of hours that running at that point is likely to be required in any given year.

PDS points were reviewed and updated as part of the revised Lot 2B call off BAT assessment, based on the original call off PDS points. Two revised core process duty points (C1-2B and C2-2B) sought to better define the process duty the new single unit must meet whist operating in parallel with either the existing electric VSD or 500 hour "Emergency Use" RB211 Unit A compressor at Hatton. Overall Lot 2B was designed to test realistic boundary points for expected duty and bulk points in the middle of the envelope, as well as boundary points to test more extreme circumstances. A minor sensitivity case was assessed in addition to the Basis of Design case; this was called 'Sensitivity 1' (S1) and included an additional allocation of 660 running hours against point S4 (shown in Figure 5 in red) to test the ability to operate in this beneficial, but non-core process map area,

Figure 5 Hatton PDS points for call off (single unit process duty map, revised Lot 2B)



Information Box 2: Envelopes and compressor matching

The envelope is the area of available operations constrained by the physical characteristics of the installed compressors, either operating individually or in parallel with other units on site.

Any compressor machinery package of broadly the right size will be suited to a specific site's duty points to a greater or lesser extent; manufacturers will look to match standard drivers and pipeline compressors / compressor impellers to those site duty points. A well matched compressor will be able to deliver the required flow or lift conditions, in efficient areas of the compressor map, avoiding poor flow (surge) or excess speed (choke) conditions.

The situation is further complicated as the driver (gas turbine) must be well matched to the compressor, as if the engine load falls outside of the predetermined Dry Low Emission (DLE) power range, emissions can rapidly increase.

4.2 Updated market call off to determine available options and package costs

National Grid launched a revised Lot 2B call off in January 2020, via tender bulletin, for a low emission gas turbine driven compressor. Responses were received from two global compressor suppliers; each offering a single option, comprising one compressor machinery train. Anonymity of bidders is preserved throughout this report using colours to represent each OEM. The terminology used i.e. 'large' and 'very large' units equates to LCP sized plant (>70MW and >100MW thermal input, respectively). These also align conceptually to the range of current machinery at site (refer also to Chapter 2).

Lot 2B (2020) – Single unit solution to meet medium power process duty (+ existing RB211 500 hours unit) outside existing boundary. Bids from:
Blue: 1 x Very Large Purple: 1 x Large

4.3 Technical and environmental criteria and weightings

The T/SP/ENV/21 BAT model requires that the technical and environmental criteria relevant to the decision are defined and weighted in accordance with their relative importance in any given decision, taking account of site, unit and project specific issues. The call off technical and environmental criteria, and their associated weightings, were determined in a fully documented process supervised by National Grid Global Procurement[12] and subject to formal governance.

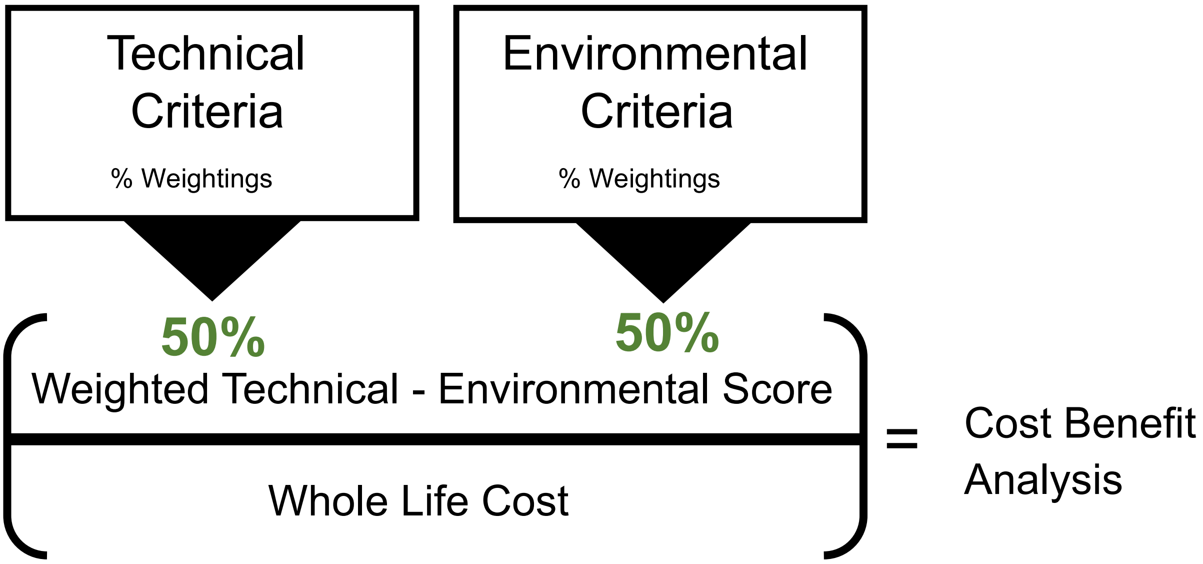
This chapter presents the chosen criteria and weightings used in the assessment. The individual scored outcomes and combined BAT assessment results are presented later in the report in Chapter 5.

4.3.1 Model structure and overall technical and environmental weighting

The overall model structure and weightings defined reflected that this assessment was driven by environmental *and* technical (operational) requirements. The model requires a weighting to be set between technical and environmental criteria; in line with the 2019 pre-call off and call off BAT assessments a relative weighting of 50% technical to 50% environmental was selected. Environmental improvements are an important part of any investment, especially for high running hours sites such as Hatton, therefore it should be noted that certain elements of the technical criteria, discussed in the following sub-section, include key environmental considerations e.g. emissions compliant envelope versatility and future proofing (emissions headroom) and are thus considered as part of the technical criteria in the BAT model.

[12] National Grid document: PAC3275-06-99-00-6011-NGG-0071-rev03.docx

Figure 6 Hatton BAT model structure and high-level weightings



4.3.2 Technical criteria and weightings

Specific 'technical' evaluation criteria (operational and deliverability considerations) were developed for the original 2019 call off to meet the objectives of delivering an effective call off event to identify BAT from market available solutions; these were transferred unchanged into the revised 2020 call off.

The follow key considerations were reflected in deriving the technical criteria and associated weightings for the 2019 / 2020 call off events:

- Emissions compliant versatility and future proofing (emissions limits) were the primary technical criteria, with similar weightings.
- Constructability focused on modular (pre-assembled unit (PAU)) approaches to construction, as this offered potential project deliverability and cost benefits for National Grid.
- Ownership / maintenance complexity focused on potential areas of added value associated with the ownership proposition.
- Technical criteria T1 through to T7 again represented other technical evaluation criteria addressed outside of the BAT evaluation process[13].

Criteria	Target achievement for candidate option (maximum score)	Weighing
T8. Versatility (emissions compliant envelope)	Broad unconstrained flexibility to operate at full range of expected process conditions offering a full turn down range from min-gov. Very well matched to duty profile.	20%
T9. Future proofing (emission limits)	Good emissions performance headroom compared to MCP / LCP ELV and BREF AELs for NOx / CO across required turndown range. Good potential to remain compliant if current ELVs are reduced.	15%
T10. Operability / Maintenance Complexity	Excellent serviceability, market leading standards of ownership proposition, delivering added value.	5%
T11. Modular Build Approach	Solution capable of factory assembly with minimum site-based work to integrate component section during install.	10%
		=50%

[13] National Grid document: PAC3275-06-99-00-6011-NGG-0071-rev03.docx

4.3.3 Environmental criteria and weighting

Specific ‘environmental’ evaluation criteria (emissions and environmental performance considerations) were developed for the original 2019 call off to meet the objectives of delivering an effective call off event to identify BAT from market available solutions; these were transferred unchanged into the revised 2020 call off.

The follow key considerations were reflected in deriving the technical criteria and associated weightings for the 2019 / 2020 call off events:

- The key emissions criteria (tNOx, tCO_2e and tCO) were the primary environmental criteria, with similar weightings.
- The overall environmental weighting was 50%; however, environmental aspects associated with emissions levels, compliance and efficiency are also embedded in certain of the technical criteria, in particular T8 and T9 further increasing the importance placed on these key decision factors.
- Environmental hazard was retained; it was originally included given the potential for the market to offer SCR based solutions. By the time the revised Lot 2B was launched, it was apparent that no SCR solutions would be offered. However, in retaining this criterion, it a) allowed evaluation of package hazardous liquid management (e.g. lube oils) and, b) ensured that the criteria remained the same as the 2019 call off, to allow comparability between events.
- Noise (betterment over minimum / evidence to support) reflected the importance of noise in the final site upgrade and to accommodate the fact that site and design specific information would be obtained during the updated call off event.
- Environmental criteria E1 through to E5 represented other environmental evaluation criteria addressed outside of the BAT evaluation process[14].

Criteria	Target achievement for candidate option (maximum score)	Weighing
E6. Mass Emissions tNOx	Lowest mass emission of oxides of nitrogen (NOx) over 20-year period (arising from direct combustion of natural gas). Remains the environmental regulators’ priority for control.	20%
E7. Mass Emissions tCO_2e	Lowest mass emission of carbon dioxide equivalent (CO_2e) over 20-year period (arising from direct combustion of natural gas and seal gas losses). Can be considered analogous for high machinery train efficiency and low resource (fossil fuel consumption).	10%
E8. Mass Emissions tCO	Lowest mass emission of carbon monoxide (CO) over 20-year period (arising from direct combustion of natural gas). Included within the site environmental permits, but historical assessments confirm that no significant ‘real world’ environmental impacts arise from NTS CO emissions.	5%
E9. Environmental Hazard	Low risk to the water environment, (most sites connected to local surface water via drainage systems and can be unmanned for extended periods of time). Included primarily in case of SCR offers. Qualitatively scored criteria.	5%
E10. Noise, betterment / evidence to support	Betterment of minimum acceptable target noise level to provide headroom and de-risk, evidence-based submission addressing known issues (e.g. tonality).	10%
		=50%

[14] National Grid document: PAC3275-06-99-00-6011-NGG-0071-rev03.docx

4.4 Cost information

The T/SP/ENV/21 BAT model combines operating costs with capital costs to calculate an indicative whole life cost over a 20-year design life; this can be calculated as a Net Present Value (NPV) if required.

4.4.1 Model structure

The whole life cost calculation is derived from a series of sub-components and calculations; the resulting sum is plotted against the weighted technical-environmental score described previously. Each of the cost components is presented in more detail over the following paragraphs; detailed cost data has not been provided in this report as it includes commercially sensitive information. This information is available on request from the National Grid Project Sponsor[15], as appropriate.

4.4.2 Maintenance data analysis

Scheduled maintenance interventions data (including major overhauls) were provided by the OEMs specific to their offered machinery packages and the duty hours, and conditions defined by PDS points. This was reviewed and risked by engineering specialists in National Grid. The scope was standardised between both bidders to allow an effective comparison.

Further, inspection only maintenance interventions data provided by National Grid Engineering and Asset Management (EAM) was analysed for selected units in the existing gas turbine fleet to provide an estimate of internal, National Grid, maintenance cost for the new machinery. As both candidate options were comparable the same internal maintenance costs were applied to both; this was not therefore a differentiator in the BAT assessment.

4.4.3 Total target cost data

The National Grid Capital Delivery eHub cost estimation team provided updated target cost models for compressor upgrades (including estimates for Front End Engineering Design (FEED), Detailed Design, Build and Commission (DDBC), project services, and National Grid internal costs). eHub costs were based on the ‘greenfield’ build location option (between the current compressor and AGI boundary fences).

4.4.4 Whole life operating cost

The T/SP/ENV/21 BAT model includes a built-in estimator for operating cost, which uses National Grid Future Energy Scenario (FES) data for future gas and electricity prices. Operating costs combine estimated energy costs (based on unit gas and electrical power demand and FES cost data) with user input data on maintenance, consumables, etc. No weightings are applied in the cost calculations.

The T/SP/ENV/21 model derives the cost of an hour of operation based on engine MW input, then factors this up by the running hours over 20 years (for the base case and sensitivity running hours). It is important to note that no 20-year energy cost projection will be accurate. However, the FES data is published and is recognised within the National Grid business and more widely; it was therefore applied consistently to all the options under consideration. The model can also calculate present value of future expenditure, no NPV calculation sensitivity was undertaken at the pre-call off BAT assessment stage.

4.4.5 Normalising of scope and risk costs and options

Due to differences in supply capability between OEMs, the scope of equipment supply was normalised to ensure like for like comparison (e.g. if a particular equipment sub-component could not be supplied by the OEM, estimated costs for sourcing said item at the DDBC stage were added). Similarly, a range of technical and commercial project risks were monetised by engineering and procurement specialists in National Grid.

[15] Phebion Mudoti, Senior Engineer - System Development, Gas Transmission.

4.4.6 Asset health / failure data

Recognising that even newly installed equipment would age over the 20-year design life, an estimate was included for future asset health / failure costs. This was included on a per machinery train basis, not differentiating between OEM suppliers. Information derived from National Grid data[16] was interrogated to define a list of relevant interventions and an associated expenditure estimate (considering only those explicitly related to the compressor machinery train or enclosure related balance of plant, such as unit fire and gas systems).

The data was then categorised into ‘asset health’, ‘failure’ or ‘maintenance’ and an estimated ‘events in 20 years’ frequency value was assigned. The collated data and event frequency had previously been subjected to peer review in EAM.

Failure cost data was calculated on the basis of a ‘weighted percentage probability of exposure’, e.g. a 1% failure probability of a £100k asset in any given year exposes the business to a weighted probability of a £1k cost in a year or a £20k cost over a 20 year period.

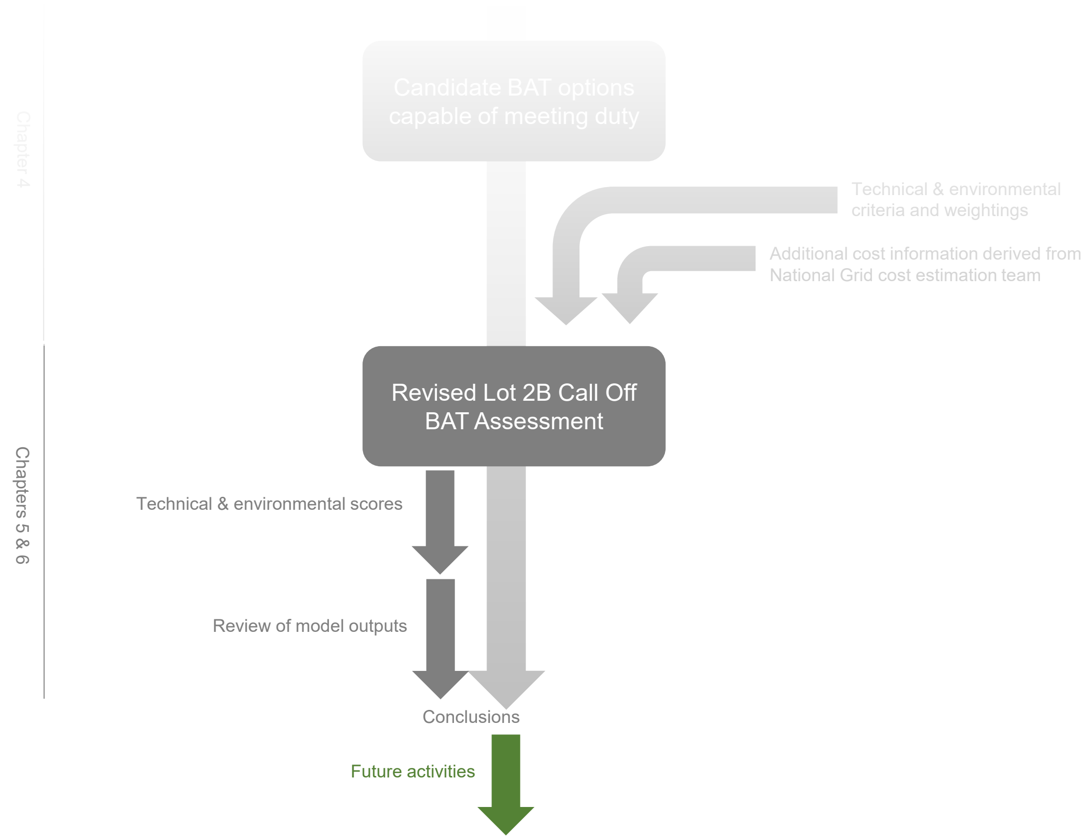
As both candidate options were comparable the same asset health / failure data costs were applied to both; this was not therefore a differentiator in the BAT assessment.

[16] 2017 Engineering and Asset Management Databook of asset health replacement and failure costs. The Databook provided a range of different degrees of complexity associated with failure interventions and also information on related failures that can extend beyond a single component to a wider assembly. As such, ‘medium’ complexity ratings were adopted and where single or multiple related systems interventions are identified, the worst case was selected.

5 Revised Lot 2B call off BAT assessment (findings)

The findings of the revised Lot 2B call off BAT assessment are presented in this chapter. The technical and environmental scores are summarised, after which key outcomes of the cost-benefit BAT assessment are presented. Overall conclusions are presented in Chapter 6.

Figure 7 Overview of revised Lot 2B call off BAT assessment process



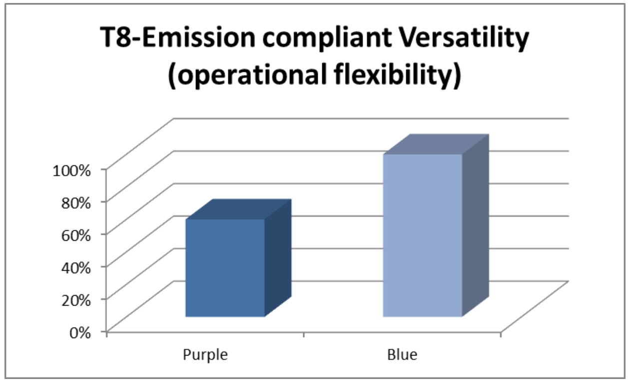
5.1 Technical scoring results

The candidate options for the revised Lot 2B call off BAT assessment were scored against the technical evaluation criteria, in line with National Grid's approved evaluation methodology[17]. The scores are presented graphically below, alongside key scoring themes.

[17] National Grid document: PAC3275-06-99-00-6011-NGG-0071-rev03.docx

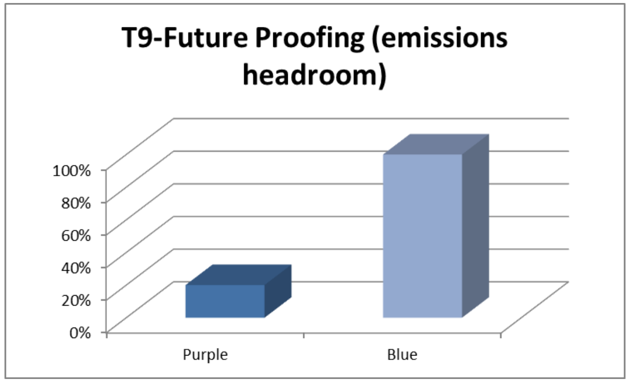
T8. Emission compliant versatility

- Blue offers greatest emission compliant versatility.
- Purple benefitted from a late uplift from 40% to 60% score for this criteria, but this carries residual risk due to uncertainty over accuracy of the OEM submission.



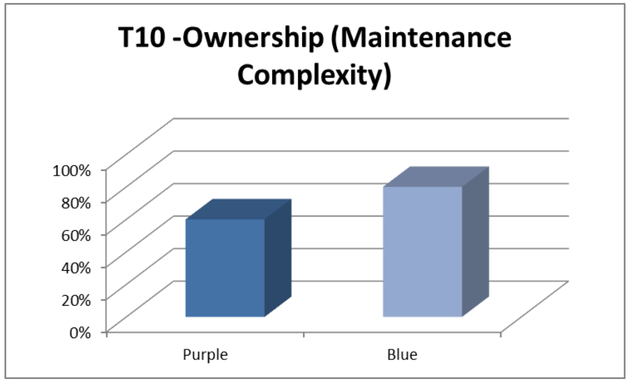
T9. Future proofing (emission limits)

- One of most significant differentiators; Purple does not fully comply with BREF conclusions on CO and provides no headroom against LCP annual average NOx.
- Blue performance offers headroom against all key variables.



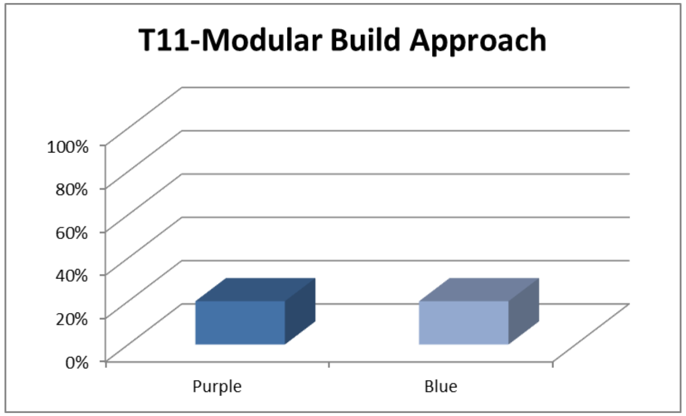
T10. Ownership (maintenance complexity)

- After much negotiation Blue considered to offer better ownership proposition than Purple.
- The business would be an ‘early adopter’ if Purple were selected ~ this inevitably carries ownership uncertainty / risk.



T11. Modular Build Approach

- Non-differentiating criteria.
- Neither package offers any real concession to original modular build objective.



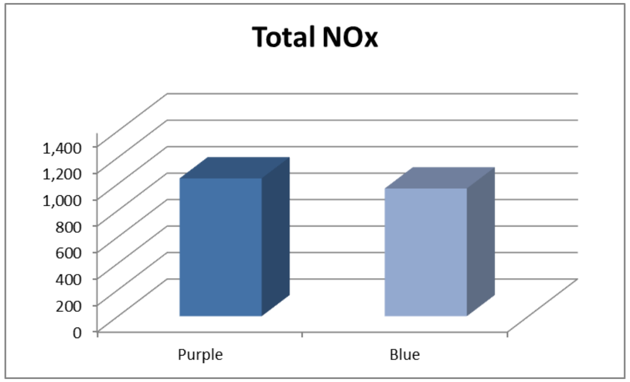
5.2 Environmental scoring results

For the calculated criteria E6 to E8, the T/SP/ENV/21 BAT model derives estimated environmental performance for the candidate options, based on OEM tender return information. In respect of the criteria ‘E9. Environmental Hazard’, and ‘E10. Noise (betterment and evidence to support)’ which were evaluated rather than calculated, the same approach was adopted as described in respect of the technical. The scores are presented graphically below, alongside key scoring themes.

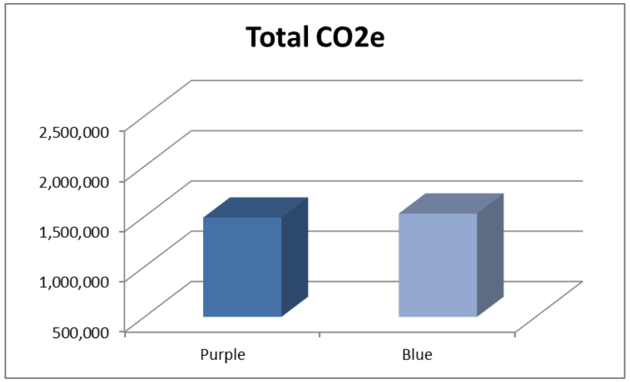
Environmental scoring results

- Slightly lower mass emissions NOx and CO performance for Blue.
- tCO2e is comparable.
- Overall emissions performance can be considered to be broadly comparable.

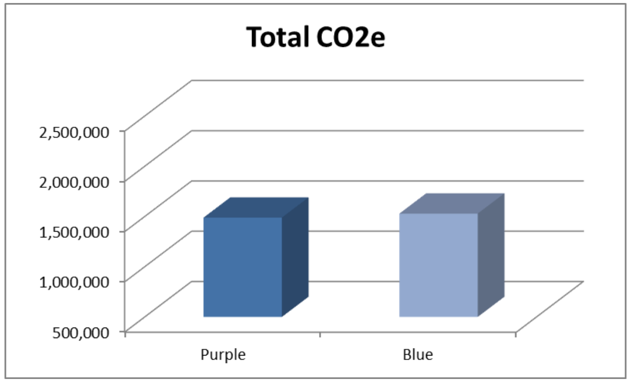
tNOx



tCO

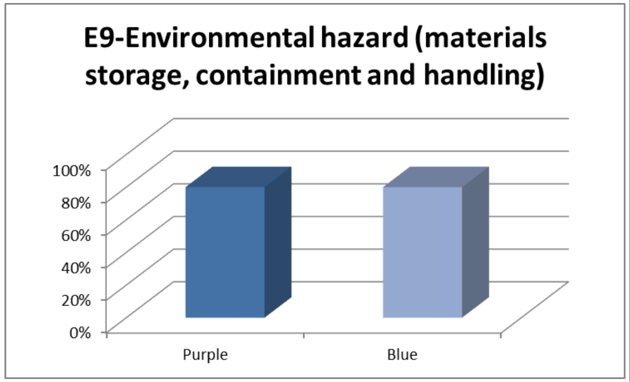


tCO_2e



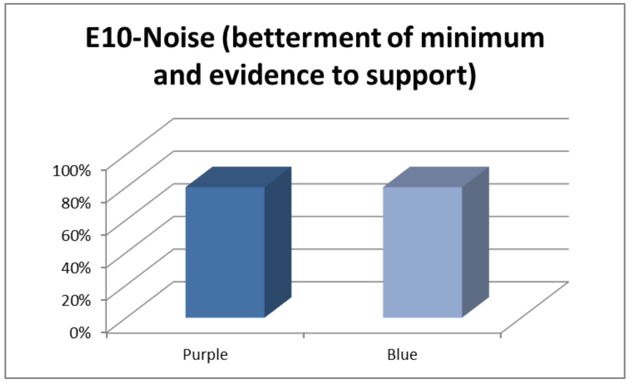
E9. Environmental Hazard

- Environmental risk (liquid containment) likely to meet good industry practice in both applications.



E10. Noise (betterment / evidence to support)

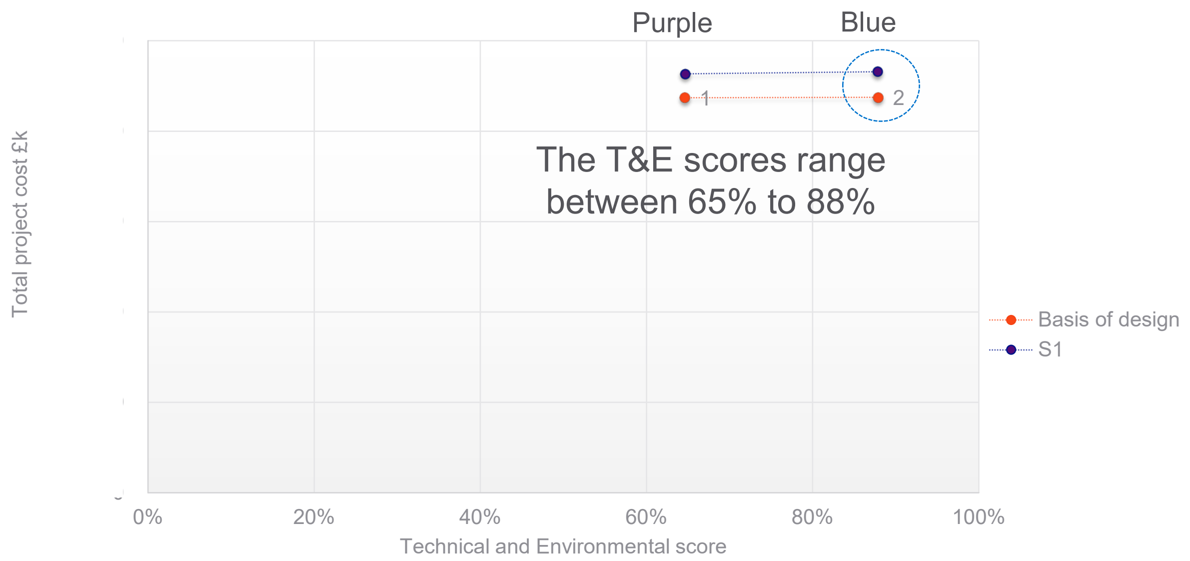
- Noise performance is on paper slightly better for Purple but lack of evidence to indicate real world betterment sufficient to warrant different score.



5.3 Review of BAT model outputs

This section presents the BAT results, showing the combined environmental-technical scores against the calculated whole life costs; graphical cost benefit charts are used with key themes highlighted in the accompanying commentary.

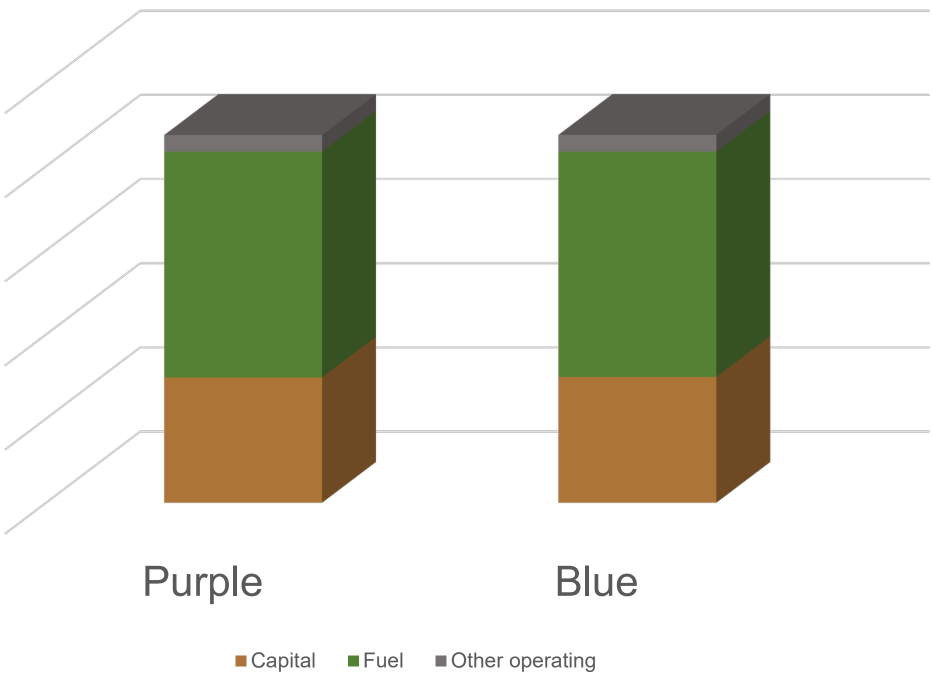
Figure 8 Final BAT results



The following observations are noted:

- The Blue option offers a significant betterment over the Purple option in respect of technical and environmental score.
- Total project cost is not a differentiator between the options.
- The sensitivity case S1 assessment outcome is consistent with the Basis of Design outcome, total project costs being slightly higher for both options (driven by fuel usage, associated with the additional 660 run hours per annum).

Figure 9 Cost breakdown



The following observations are noted:

- Overall cost variances are within uncertainty bands associated with the data gathering and modelling methodology.
- Package cost difference between the options was negligible.

5.4 Residual risks

Some, potentially material, residual risks were observed during the BAT / tender evaluation process. These are summarised below:

- The Purple solution included a package element considered to be of an older generation than other package elements, with certain potential operating implications.
- A key package element in the Purple solution was not proven in use, and National Grid would be considered an early adopter.

6 Conclusions

6.1 Introduction

This chapter presents conclusions in summary form in respect of the principal study elements discussed previously. Limitations inherent in a study such as this are then discussed, followed by future activities.

6.2 Summary conclusions

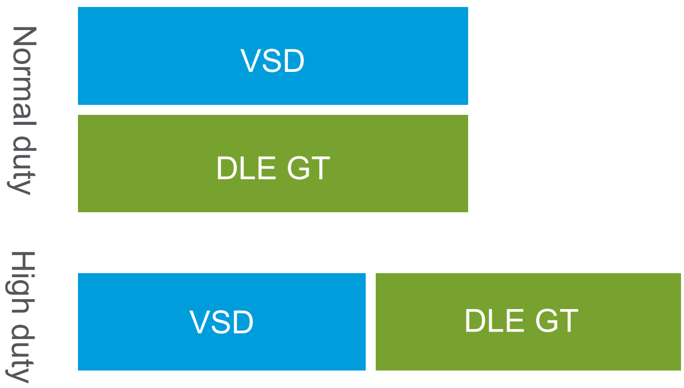
The following summary conclusions can be noted:

- The solutions offered in the revised 2020 Lot 2B performed similarly on environmental criteria, such that there was no clear 'best environmental option'.
- The Blue solution performed better in the technical criteria, resulting in an overall significant betterment in the environmental / technical score.
- Neither total project cost nor package costs were a material differentiator between options.
- Overall Blue was therefore considered to represent the candidate BAT option.

The concluding position can be illustrated in respect of likely reliance on legacy plant during normal operations (VSD availability) and abnormal operating conditions (reduced VSD availability).

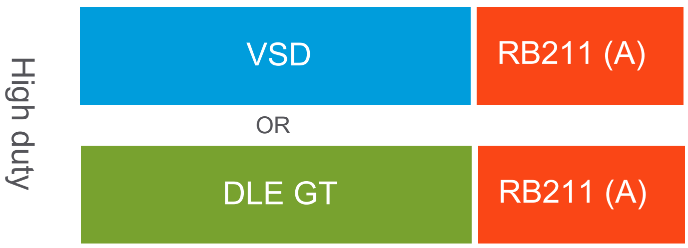
Figure 10 shows that normal running scenarios should be capable of being delivered using BAT plant via Lot 2B (i.e., VSD unit or new low emission gas turbine, or a combination of the two).

Figure 10 Illustration of BAT for normal vs high running scenarios



Under certain high process duty demand scenarios, the legacy 500 hours RB211 would still need to be called upon to provide compression in the event that one of the BAT machines were unavailable, see Figure 11 below.

Figure 11 Resilience to VSD / DLE GT unavailability



6.3 Limitations

- An inherent limitation in the T/SP/ENV/21 BAT model is that it does not holistically consider ‘ephemeral’ conditions (each run of the model only allows you to lock in running conditions for the full 20 years). These have to be addressed via sensitivities cases; these were extensively explored at the original pre-call off BAT assessment stage.
- Simple cost-benefit modelling will not capture the complexity of National Grid’s regulated business funding and requirements of operating under a price control regime (i.e. operating costs benefits arising from investment cannot be accrued beyond the current defined price control period, simple models such as this do not consider revenues from increased Regulated Asset Value (RAV) associated with investment). Some of these matters are addressed within the National Grid CBA Tool.
- The BAT model is only one methodology to consider in the decision process; it is a decision support process not a decision-making process.
- Models such as this require assumptions which are always open to challenge (weightings, scores, derived costs). As far as possible, peer review by National Grid stakeholders and with environmental regulators was adopted.
- Input data is derived from varying sources or estimates, each has its own level of accuracy, such that modelled findings should be viewed as relative and indicative.
- Modelling future energy costs can only ever be an estimate based on reasonably foreseeable supply, demand and market conditions; the T/SP/ENV/21 operating cost model is based on this premise. However, it is at least applied consistently to all cases.

6.4 Other activities

The following other activities took place following the immediate conclusion of the revised Lot 2B BAT assessment:

- Conclusion of the market call off, including agreement of emissions and performance guarantees.
- Conclusion of discussions with Ofgem in respect of the proposed compressor machinery upgrade at Hatton, resulting in preliminary approval of a single unit solution.
- Internal review and sanction of the findings within National Grid.
- Completion of a Front-End Engineering Design (FEED) feasibility study to look at greenfield and brownfield options.

6.5 Future activities

The following future activities are required:

- Additional, site specific BAT assessment and reporting to support an application for an Environmental Permit variation to the Environment Agency. This will centre in the same machinery train conclusions as presented in this report, but cover additional balance of plant aspects and local environmental considerations.

Appendices

Appendix 1 CBA model and ENV/21 comparison

Theme	CBA Model		T/SP/ENV/21	
Capital Cost	✓	eHub, all components	✓	eHub, all components
Maintenance	✓	Included in site opex line in model	✓	MAINT/6 interventions and manufacturers recommendations (risked)
Asset Health	✓	Estimates based on intervention assumed on five yearly basis	✓	Network engineering cost book weighted probability of failure
Energy Cost	✓	FES (flow assumptions and annual profiles)	✓	FES Wholesale / commercial based on derived PDS and run hours estimates
Operability / Technical	×	Not included unless demonstrable financial constraints can arise	✓	Operability, versatility, envelope, constructability
Constraints	✓	Failure of supply & associated risk cost (contracts)	×	Not included at this stage
Sensitivities	✓	Composite year data made up of typical operating conditions	✓	Based on series of static conditions
Emissions CO_2	✓	Monetised based on FES carbon prices; sensitivities considered.	✓	Derived from fuel usage / type. Scored
Emissions NOx	✓	Monetised based on cost/tonne	✓	Derived from actual engine performance at different engine loads. Scored
Emissions CO	×	Not included, due to lack of monetised data on CO impact costs	✓	Derived from actual engine performance at different engine loads. Scored
Modelled period	✓	25 years, although revenue cost recovered from consumer up to year 45	✓	20 years
Discounted cash flow	✓	3.5% for years 0-30, 3% for years 30-45	×	Functionality in but not used yet
Complex cost model	✓	4.04% weighted average cost of capital, 4 or 5 year investment spend profile	×	Simplified, investment in year zero, cost of capital not included

About the study authors

Project Environmental Solutions Ltd. (PESL) was founded in 2014 and brings together a small team of consultants with extensive experience in providing niche specialist technical services to National Grid through numerous projects within GT, ET, Capital Delivery and the former Gas Distribution business. We have worked extensively on gas transmission compressor replacement projects, undertaking cost-benefit Best Available Techniques (BAT) assessments for existing, new and retrofit schemes. Our team were key project team members for the development of the Compressor Machinery Train and Compressor Balance of Plant BAT assessment tools, which are now widely used to support asset selection decisions.

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Appendix 7: Balance of plant BAT studies

NATIONAL GRID

Hatton Compressor Station – IED (LCP) Phase 2 Compressor Project

Balance of Plant BAT Studies

Document No Rev 1: 415013-00025-EN-REP-00002
26 August 2022

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PROJECT 415013-00025 - Hatton Compressor Station – IED (LCP) Phase 2 Compressor Project - Balance of Plant BAT Studies

Rev	Description	Originator	Reviewer	Worley Approver	Revision Date	Customer Approver	Approval Date
Rev A	Issued for Disciple Check	A. Stephen	E Creaney		26 Feb 2021		
Rev 0	Issued for Use	M. Bosa	E. Creaney	M. Bosa	16 Mar 2021		
Rev 1	Re-issued for Use	Alexander Stephen A. Stephen	Jessica Badenhorst J. Badenhorst	Alexander Stephen A. Stephen	26 Aug 2022		

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List of figures

Acronyms

Acronym	Term
ANG	Absorbed Natural Gas
BAT	Best Available Techniques
BoP	Balance of Plant
BS	British Standard
CEMS	Continuous Emissions Monitoring System
CO	Carbon Monoxide
dB(A)	A-weighted decibel
EHS	Environmental, Health, and Safety
FEA	Formal Environmental Assessment
FEED	Front End Engineering Design
GHG	Greenhouse Gas
IED	Industrial Emissions Directive
IPPC	Integrated Pollution Prevention and Control
LCP	Large Combustion Plant
LER	Local Equipment room
MSCMD	Million Standard Cubic Metres
NOx	Oxides of Nitrogen
Project	Hatton IED (LCP) Phase 2 Compressor Project
Site	Hatton Compressor Station
VSD	Variable Speed Drive

1. Introduction

1.1 Project Background

National Grid's UK compressor sites are affected by the requirements of the Integrated Pollution Prevention and Control (IPPC) and Large Combustion Plant (LCP) elements of the Industrial Emissions Directive (IED). The regulations require National Grid to comply with limits on the gaseous emissions of oxides of nitrogen (NOx) and carbon monoxide (CO) to manage local air quality around all its gas driven compressor sites.

To meet the requirements of the LCP elements of the IED, Gas Turbine driven Compressors B & C at Hatton Compressor Station (Site) will be retired by December 2023 as they will not meet the NOx and CO emission limits. National Grid intend to replace these units with a single larger unit that is compliant with the IED emissions limits. This is the Hatton Compressor Station – IED (LCP) Phase 2 Compressor Project (Project)

The current compressor infrastructure comprises three identical gas turbine driven compressors (units A, B & C) and an electric driven Variable Speed Drive (VSD) compressor (Unit D) configured to run as a single unit, or as any two units in parallel. The station maximum flow set point is 128 Million Standard Cubic Metres (MSCMD).

Hatton is pivotal in the transmission of high east flows to the wider network, main relevant entry points are Teesside, Easington and Theddlethorpe. As well as supporting large directly connected loads and storage sites in the immediate vicinity, Hatton also facilitates North to South flows and is therefore critical to exit loads across the south of the country and international exports.

For further information on the project scope, please refer to the Project Execution Plan [1] and the Process Basis of Design [2].

1.2 Purpose of this Document

This document is intended to provide a record of the Best Available Techniques (BAT) design decisions taken at FEED and Detailed Design. Where there may have been a query over the latest BAT for a certain element, Worley has investigated and either confirmed or updated the design accordingly.

2. Existing BAT Studies

National Grid has developed a standard specific to BAT:

- T/SP/ENV/22 Specification for Best Available Techniques (BAT) Assessment for Compressor Balance of Plant, National Grid (2017).

National Grid has developed a series of BAT studies relevant to the compressor, pipework and associated Balance of Plant (BoP):

Table 2-1: BAT Studies and Supporting Documentation

Document Title	Originator	Year
Options for removing gas from compressor casing and pipework	National Grid	2014
7050-0180-075-03-1001-001 – Venting BAT Supporting Note	Costain	2016
Standby Power Generation	National Grid	2014
Micro-renewable (for power) technologies	National Grid	2014
7050-0180-075-03-1002-001 – Standby Power Generation BAT supporting Note	Costain	2015
Valve Actuation	National Grid	2014
7050-0180-075-03-1100-001 - Valve Actuator BAT Summary Report	Costain	2015
Actuator BAT Assessment	Mott Macdonald	2016
PREM250-REP-0000-0002 Valve Actuators	Premtech	2017
Non-operational buildings - heating, cooling and ventilation	National Grid	2014
Switch rooms, MCC, UPS and battery rooms - heating, cooling and ventilation	National Grid	2014
7050-0180-075-03-1103-001 - Operational and Non-Operational Building BAT Supporting Note	Costain	2015
Compressed Air BAT	National Grid	2014
7050-0180-075-03-1104-001 Compressed Air BAT Supporting Note	Costain	2015
Lighting	National Grid	2014
7050-0180-075-03-1105-001- Lighting BAT Supporting Note	Costain	2015
Surface Water Drainage and Firewater	National Grid	2014
Foul Drainage	National Grid	2014
NGGT0112 - Collated noise BAT case studies	Project Environmental Solutions	2019

3. Depressurisation to Atmosphere

3.1 Reasons for Depressurisation

Depressurisation represents the intentional release of natural gas for the following reasons:

- Emergency shut-down – fast release for safety or equipment integrity (e.g. a compressor station, an individual compressor, or a length of pipe)
- Maintenance – for routine maintenance or modification. May be possible to release slowly.
- Operational – release from compressor while in stand-by, to avoid running ancillary equipment (e.g. ventilation fans).

In addition, unintentional release is likely and may result as follows:

- Fugitive releases – leaking valves, seals, pumps, connections etc.

3.2 BAT Options

There are commercial and environmental impacts associated with depressurisation as the release of gas represents the loss of a valuable commodity and methane emission has the potential to contribute to global warming.

Potential technology options for depressurisation and safe disposal of natural gas are as follows:

- Venting unburnt gas to atmosphere – proven technology and is the current method of depressurisation for existing compressors on site. This offers fast release in an emergency, is relatively quiet, no flame, low cost. However, inventory would be lost and this method would release the greatest volume / potency of GHGs and a new vent stack would be visible off site.
- Recompression back to a live section. Avoids loss of inventory and GHGs. However, it is not fast enough for emergency release. If used for recovering gas from compressors, a recompression unit and additional pipework would be required adding cost and complexity to the design.
- Absorbed Natural Gas (ANG) Storage and Recovery – The stored gas could be used on site or recompressed. However, the efficiency of the system is known to degrade over time and also cause changes to the composition of the discharged gas.
- Flaring vented gas. Due to the visual impact and noise issue of an open flare, only an enclosed ground flare is considered as an option. This would provide fast relief and lower GHGs than venting. However, it is higher cost, emits noise and would be a source of visual disturbance off site.
- Retain Gas within Compressor – specialised seals would help to reduce lost inventory. However, it does not account for gas outside of the compressor or emergency release.

3.3 Decision

For emergency release, only venting or flaring offer the speed of depressurisation required to maintain an acceptable level of safety. Due to the nearby sensitive receptors to the site, venting is considered to be the preferred method of emergency release. It should be noted that National Grid is reviewing options for depressurisation through the CH4RGE gas recovery project.

Recompression was considered for non-emergency releases, however, the added cost of an additional small compressor and complexity of tying into a live part of the system was not considered practical in the design. ANG was not considered to be a practical for non-emergency release due to performance degradation and effect on gas quality.

Therefore, the recommended method for depressurisation on the Site is to vent unburnt hydrocarbons to atmosphere. To reduce the inventory lost, the pipe length should be minimised by installing a new vent stack close to the new compressor. Additionally, to further reduce inventory, compressor isolation valves are to be placed as close to the entry and exit points of the compressor enclosure as possible.

4. Standby Power

4.1 Reasons for Back-up Power

Back-up power is an operational and safety critical issue. If the site were to lose power entirely, there are certain processes that would not be able to continue, and the site would shut-down. Therefore, back-up generators are required to start as soon as possible and supply back up power until such time as the mains supply is restored.

4.2 BAT Options

An existing BAT study identified several possible options for back-up power. Whilst no major technology additions are known to the authors at this time, the option of a gas reciprocating engine was revisited to update to current market offerings. The findings from previous studies, benchmarking and re-evaluation are summarised below.

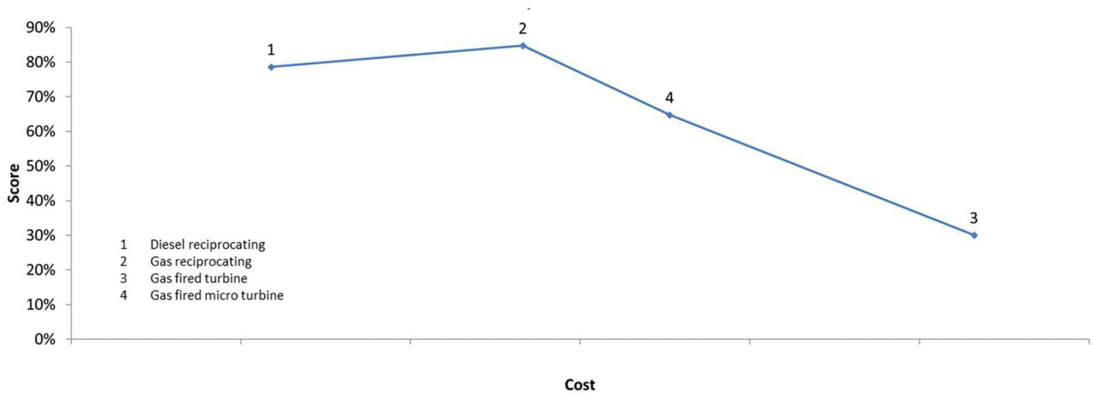
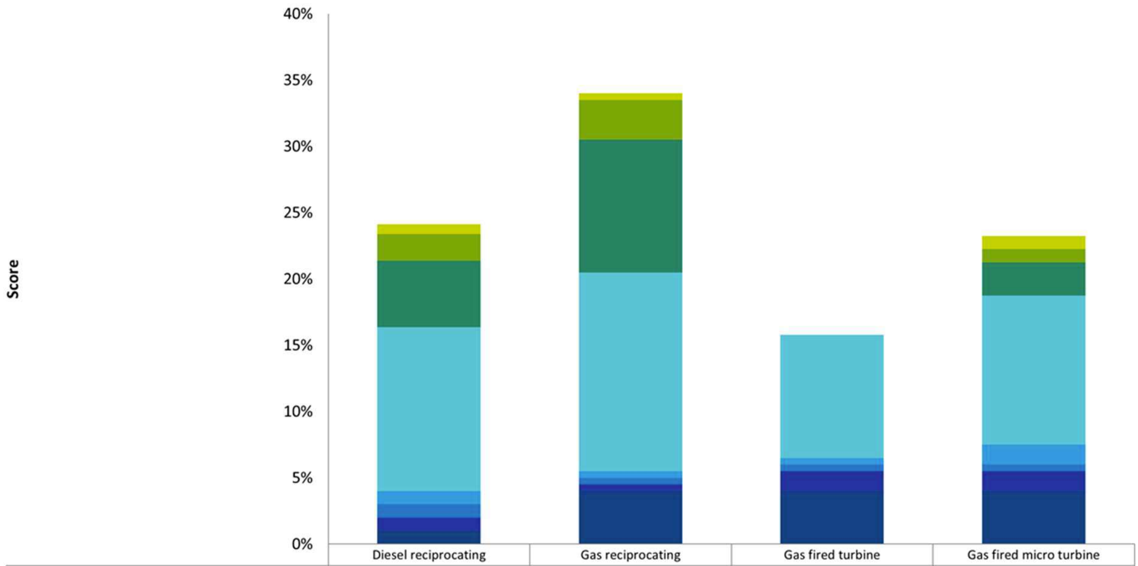


Figure 4-1: Estimated Cost of Standby Power Options

From Figure 4-1, the diesel reciprocating option is expected to be the lowest cost solution. Although the OPEX of gas fuel is lower than diesel, the CAPEX is significantly lower for a diesel reciprocating generator versus a gas reciprocating generator (four times lower based on vendor information).



	Diesel reciprocating	Gas reciprocating	Gas fired turbine	Gas fired micro turbine
Fugitive: to Land/Water	0%	0%	0%	0%
Liquid waste: waste quantity	0%	0%	0%	0%
Solid waste: waste hazard	1%	1%	0%	1%
Raw materials: material quantity	2%	3%	0%	1%
Noise: Qualitative	5%	10%	0%	3%
Global Warming potential: Total on and off site CO2e	12%	15%	9%	11%
Air emissions: CO: Qualitative	1%	1%	1%	2%
Air emissions: SOX: Qualitative	1%	1%	1%	1%
Air emissions: NOX direct: Qualitative	1%	1%	2%	2%
Air emissions: Fine Particulate: Qualitative	1%	4%	4%	4%

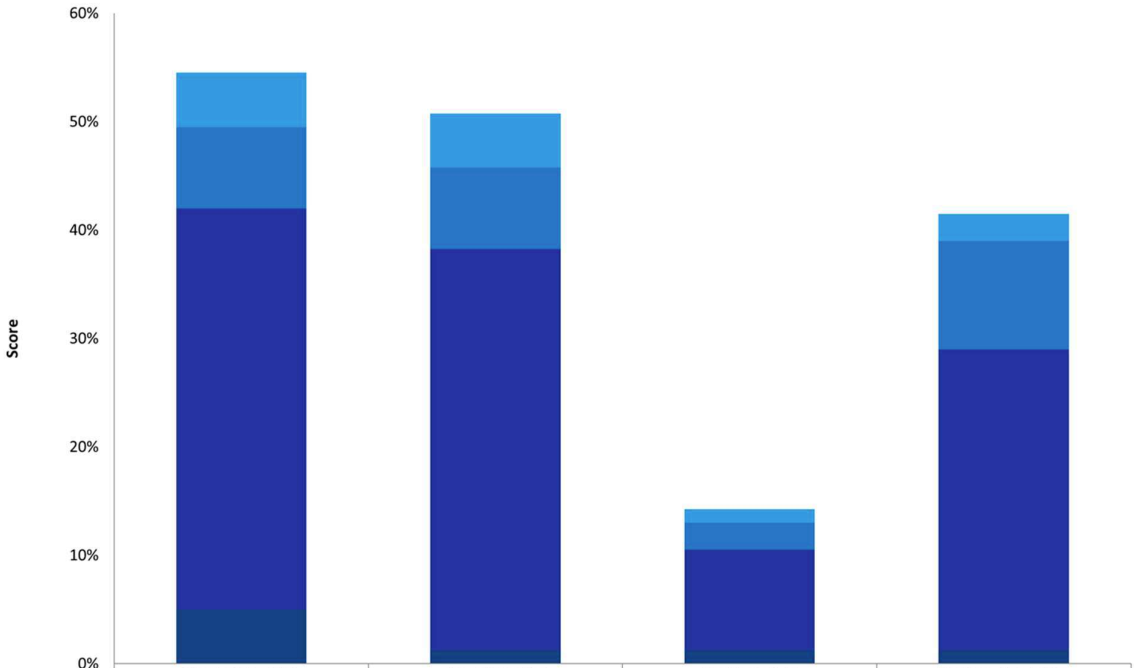
Figure 4-2: Estimated Environmental Scoring of Standby Power Options

From Figure 4-2, the Gas reciprocating option scores the highest for environmental criteria. This is due mainly to its low CO_{2e} waste gases from combustion as well as low particulate emissions and noise.

However, whilst it is likely that future emissions regulations are only going to become more stringent, all options including the diesel reciprocating engine are compliant with current legislation and regulatory limits for the intended purpose.

It is worth noting that noise from diesel reciprocating and micro gas turbine options can be mitigated to acceptable levels using enclosures and standard measures.

The gas reciprocating option may need a noise enclosure itself to achieve stringent noise limits at the nearest receptor (37dB(A) approximately 200 m from source).



	Diesel reciprocating	Gas reciprocating	Gas fired turbine	Gas fired micro turbine
Constructability	5%	5%	1%	3%
Maintainability	8%	8%	3%	10%
Reliability	37%	37%	9%	28%
Versatility	5%	1%	1%	1%

Figure 4-3: Estimated Technical Scoring of Standby Power Options

From Figure 4-3, the diesel reciprocating options scores most highly due to its versatility and availability in the event of a site wide shut-down and depressurisation. Any gas option capable of this same level of versatility would require a tie in offsite and/or significant additional gas fuel storage onsite.

4.3 Summary Findings

- Diesel reciprocating engine – proven technology, low CAPEX. However, relatively high emissions, spill potential, space for fuel storage, OPEX for fuel purchase, and load bank required adding cost.
- Gas reciprocating engine – proven technology, gas is readily available on site for low OPEX, and local atmospheric emissions from gas generation are less significant than diesel. However, CAPEX is high, load bank requirement further increases cost, and issues of where to tie in for gas fuel remain in the event of Site shut-down and depressurisation.
- Gas turbine – proven technology, gas is readily available on site. However, low efficiency for power generation alone, not suitable for the power rating of the Site, long start up time, and issues of where to tie in.
- Gas micro turbine – proven technology, gas is readily available on site. However, efficiency is relatively low, the micro turbine is relatively expensive and issues of where to tie in.
- Fuel cell – relatively expensive technology and not widely available commercially for the intended purpose.
- Solar PV + batteries – whilst solar panels could have been placed on the roof of the outer acoustic enclosure it would require additional structural support. Battery storage is not sufficient at this stage to provide full back up power requirements (energy density, area required and cost).

4.4 Decision

The decision has been made to proceed with diesel reciprocating generators as the back-up power supply for the project.

Although gas reciprocating engines are a proven technology and the option for a gas a reciprocating engine is BAT in many respects, as backup power supply, the higher CAPEX and lower availability (compared to diesel alternatives) mean that they are seldomly adopted. Indeed, benchmarking against other recent oil and gas projects reveals that diesel power generation is the preferred method of back-up power for reasons of availability, reliability, maintainability and CAPEX.

It was for these reasons diesel generators was selected for the backup power generation solution.

5. Valve Actuation

5.1 Purpose of Valve Actuation

Valve actuators are required for isolation, control and emergency shutdown. Two use cases are generally considered, Emergency Shut Down (ESD) actuators and non-ESD actuators. Whilst cost and environmental performance are important considerations, speed and reliability are overriding factors, especially in the case of ESD.

5.2 BAT Options

- Direct Gas (with Spring Return) – environmental disadvantages of this design include the release of gas during operation, likely fugitive emission leaks and noise. The technology is proven and is readily available. Suitable for ESD and non-ESD. It may be possible to include Emissions Control Actuator Technology (ECAT) to capture escaping gas, however this would add significant cost and complexity to the design.
- Gas-over-Oil (Double Acting) – environmental disadvantages of this design include the release of gas during operation, possible fugitive emission leaks and noise. The technology is proven and is readily available. Suitable for ESD and non-ESD. It may be possible to include Emissions Control Actuator Technology (ECAT) to capture escaping gas, however this would add significant cost and complexity to the design.
- Pneumatic – direct release of GHG is avoided, the technology is proven and available. However, ancillary equipment is required (air compressor / increased air compressor capacity) with associated cost, emissions (noise) and waste (oil, filters). Suitable for ESD and non-ESD.
- Direct Electric Motor – this offers low noise operation, no direct loss of inventory and relatively low CAPEX and OPEX. Suitable for non-ESD only due to low speed of actuation.
- Electro-hydraulic (Scotch Yoke) – this offers good speed of operation for ESD, no direct loss of inventory, low noise operation and relatively low CAPEX and OPEX. A small volume of hydraulic oil is contained in each valve (app. one litre per valve). Suitable for ESD and non-ESD.
- Electro-hydraulic (Vane) – this offers good speed of operation. However, the technology is relatively expensive and not readily available from all vendors.
- Manually operated – good environmental performance, reliability, CAPEX and OPEX. However, only local control is possible and closing speed is slow. Therefore, not suitable for ESD or non-ESD where central control may be required.

5.3 Decision

Direct electric motors are selected for non-ESD valve actuation due to environmental performance, cost and operability from a central control room. For ESD, electro-hydraulic (scotch yoke) is selected for speed of operation, environmental performance, cost and central control. Hydraulic oil shall be specified as low toxicity and biodegradable.

Design will incorporate three (3) fully actuated ESD primary isolation valves on the suction, discharge and recycle lines.

For secondary isolation, three manual actuation valves (namely XV-2501, XV-2504 and XV-2506) will be installed adjacent to the primary isolation valves.

The decision has been made to proceed with manually operated valves over electrical actuation for secondary isolation based on the following:

- The secondary isolation valves are infrequently operated and normally remain in the open position.
- The manual valves present significant CAPEX cost savings (circa £42.6k).
- Use of manual valves simplify the design as they do not require installation of associated electrical and control items, thereby providing additional cost savings.
- This removes the need for ongoing maintenance of the electrical actuators, providing reduction in future OPEX costs.
- There will be 3 fully actuated ESD primary isolation valves installed on the suction, discharge and recycle lines.

6. Operational Buildings

6.1 Purpose of Operational Buildings

Operational buildings provide protection and conditions conducive to safe and continued operation of the equipment and processes contained within them. To maintain optimal internal conditions there are a number of possible heating, cooling and ventilation technologies available.

6.2 BAT Options

Heating requirement can be met through use of:

- Gas fired boiler – this may offer the cheapest heating solution. However, gas is not odorised on site, which presents a safety constraint. There is also an added space constraint with this option if it were viable.
- Electric Heating – this would provide good heat output at a low CAPEX. However, other options provide cooling as well and OPEX is high compared to some options.
- Air conditioning unit – this would provide good space saving as a HVAC cassette condensing unit would be mounted externally. The unit would be able to cool as well as heat. Overall cost may be the lowest when considering dual function. Potential environmental impact of F-gas to be carefully managed by licensed contractors.
- Air source heat pump – this offers good efficiency and dual heating / cooling. However, additional space is required for the unit and associated pipework, and the CAPEX is high compared to traditional HVAC cassette unit.
- Ground source heat pump – greater energy density over air source heat pumps. However, there is a risk of disturbing buried site infrastructure and installation cost is generally high compared to other options.

Cooling requirement can be met through use of:

- Air source heat pumps – see above
- Ground source heat pumps – see above
- Air conditioning unit – see above

Ventilation requirement can be met through use of:

- Natural ventilation – this is the cheapest, simplest and most efficient option for ventilation. It is generally adequate, however, there may be a need for increased ventilation in the case of large battery rooms to vent gasses.
- Forced ventilation (supply / extraction fan) – this is electrically powered, has a higher CAPEX and OPEX than natural ventilation. However, it offers an increased rate of ventilation that may not be possible through natural ventilation alone.

6.3 Decision

The Worley specified Local Equipment Room (LER), comprising electrical and instrumentation switches and battery room, will utilise an electrically powered HVAC cassette for heating and cooling.

Ventilation will be natural air flow.

7. Compressed Air

7.1 Reasons for Compressed Air

Compressed air will be used for seal system separation gas, compressor cleaning and various control valves and actuators [22]. It should be noted that use of compressed air is an energy intensive process and has therefore been limited as much as possible in the design.

7.2 BAT Options

- Variable speed oiled – the main advantage of a variable speed compressor is that a single unit can provide a range of outputs. However, variable speed units are not as efficient as fixed speed compressors at a single output rate. Oiled units require maintenance that results in some oil and filter wastes and there is a spill risk of the oil, estimated at 10 L.
- Variable speed oil-free – environmental spill risk of oil is eliminated, and maintenance wastes and costs are reduced. However, oil-free compressors are significantly more expensive than oiled compressors and noisier in operation.
- Fixed speed – fixed speed compressors are the most efficient at a given maximum output. However, a range of outputs would generally be required in operation i.e. the output is not constant it is variable. The unit would need to be sized for the maximum output and would therefore loose efficiency at lower loads.

7.3 Decision

Due to the limited and variable use case for compressed air, a single variable speed unit will be adequate to provide maximum, minimum and average flow rates.

Benchmarking against recent oil & gas projects indicates that oiled compressors are significantly less expensive than oil-free units.

The unit will be oiled to lower CAPEX and to keep noise to a minimum. Low noise operation is specified to achieve less than 80 dB at 1m from source. Oil is specified as low toxicity and biodegradable where possible. A drainage risk assessment has been completed accounting for potential oil spills from the air compressor [23].

8. Lighting

8.1 Purpose of Lighting

The main uses of lighting are for safe operation and security. Careful consideration must also be given to unintended nuisance that may be caused by excessive lighting to local residents and wildlife. Energy usage and efficient design is also a consideration. LED lighting is highly efficient, particularly when compared to older technologies and has become the standard lighting technology for reasons of energy efficiency, CAPEX and OPEX with exceptional longevity. A lighting study and drawings have been completed for FEED [24][25] & [26].

8.2 BAT Options

Various use cases and corresponding LED lighting options exist within the design:

- External Security Lighting – lights need to be bright and cover a large area without being obscured. LED flood lighting mounted on hinged poles is the best available option for this. Hinged poles allow for installation and maintenance at ground level.
- External Road Lighting – lights need to be bright and targeted to the road surface. LED flood lighting mounted on hinged poles is the best available option for this.
- External Area Lighting - lights need to be bright and cover a large area without being obscured. LED flood lighting mounted on hinged poles is the best available option for this.
- Internal LER Cab Lighting – lights need to cover the internal space, which will have relatively low elevation, and be accessible for maintenance. LED tube lighting provides excellent internal coverage at low elevation and is easily accessible for maintenance.
- Internal Acoustic Cab Lighting – a range of lighting scenarios exist within the acoustic cab. Some areas are open with high elevation, while other spaces are more enclosed around stairs and equipment. LED flood lights mounted to walls would be used in open areas, tube lights will be used in enclosed areas with low elevation.

8.3 Decision

Lighting will be by LED in all instances as this provides the best energy efficiency, CAPEX, OPEX and longevity of any lighting technology known to the engineering team. LED lighting is readily available from vendors and in the full range of required lighting configurations. External lighting will be provided by LED flood lighting, internal cab LER lighting will be LED tube lighting and internal acoustic cab lighting will be a combination of LED flood lighting and LED tube lighting.

9. Drainage

9.1 Purpose of Drainage

Good drainage design is essential to prevent flooding onsite and offsite and to protect the environment from potential spills. The new compressor design includes covered areas such as roofs, roads and hardstanding and new sources of potential spills such as lube oil, diesel fuel and hydraulic fluid.

9.2 BAT Options

A drainage zoning and risk assessment has been completed [23]. A summary of the findings, mitigations and controls are provided in Table 9-1.

Table 9-1: Summary of Drainage Mitigation and Control

Source (spills & runoff)	Toxicity	Mitigation and Control	Residual Risk	Notes
Lube oil cooler	Oil - Hazardous Toxic to humans, wildlife and ecosystems	▪ Bunded with connection to below ground oil containment chamber (sized to 110% volume of total oil inventory of compressor i.e., 12,500 litres). ▪ Roads routed to restrict vehicular access to area ▪ Penstock valves, normally closed ▪ Regularly emptied ▪ Oil interception located upstream of attenuation ▪ Visual detection of leaks ▪ Spill kits ▪ Low toxicity and low persistence oil where possible	Low risk	Bunded area is impermeable and would contain the full volume of oil. Any possible escape of oil from bunded area would be a significantly reduced volume that could be contained before reaching highly sensitive receptors (controlled waters). Bunds are fitted with Aquasentry Bund Water Control Units (de-watering system) to automatically control levels of rain water within bunds.
Turbine & compressor	Oil - Hazardous Toxic to humans, wildlife and ecosystems	▪ Bunded with connection to below ground oil containment chamber ▪ Hard standing concrete floor ▪ Spill kits ▪ Enclosed, no rainwater ▪ No direct link to drainage system ▪ Low toxicity and low persistence oil where possible	Very low risk	Bund system to compressor cab to include a sealed junction between external cladding and flow slab and channel drains across door thresholds. Compressor cab to have a small upstand to inner face of the channel drain to contain wash water and prevent it from entering oil containment Bunds are fitted with Aquasentry Bund Water Control Units (de-watering system) to automatically control levels of rain water within bunds.
Oiled air compressor	Oil - Hazardous Toxic to humans, wildlife and ecosystems	▪ Hardstanding concrete floor ▪ Spill kits ▪ Enclosed, no rainwater ▪ No direct link to drainage system ▪ Low toxicity and low persistence oil where possible	Very low risk	

Source (spills & runoff)	Toxicity	Mitigation and Control	Residual Risk	Notes
Generator (oil & coolant)	Oil - Hazardous Toxic to humans, wildlife and ecosystems Glycol - Hazardous	▪ Hardstanding concrete floor ▪ Spill kits ▪ Enclosed, no rainwater ▪ No direct link to drainage system ▪ Low toxicity and low persistence oil / coolant where possible	Low risk	
Diesel fuel for generator	Diesel - Hazardous Flammable Toxic to humans, wildlife and ecosystems	▪ Bunded to 110% volume minimum with an allowance for rain water / some firewater ▪ Roads routed to restrict vehicular access to area ▪ Penstock valves, normally closed ▪ Regularly emptied ▪ Oil interceptor ▪ Visual detection of leak ▪ Spill kits	Low risk	Bunded area is impermeable and would contain the full volume of diesel. Any possible escape of diesel from bunded area would be a significantly reduced volume that could be contained before reaching highly sensitive receptors (controlled waters) Bunds are fitted with Aquasentry Bund Water Control Units (de-watering system) to automatically control levels of rain water within bunds.
Diesel loading area	Diesel - Hazardous Flammable Toxic to humans, wildlife and ecosystems	▪ Gullied area of hardstanding ▪ Shut off valves for area ▪ Approved licensed contractors ▪ Site procedures - banks man etc. ▪ Visual detection ▪ Spill kits	Low risk	Diesel loading area drained to a valved gully, connected to the potentially comminated drainage system. Valve is normally open and closed during operations. Any remaining leak or spill potential would be contained in the area of hardstanding. Machinery, pumps etc would be switched off and a licensed contractor would remove any hazardous waste.

Source (spills & runoff)	Toxicity	Mitigation and Control	Residual Risk	Notes
Car park and layby (oil, fuel & coolant)	Oil, fuel, glycol - Hazardous Flammable (if high conc.) Toxic to humans, wildlife and ecosystems	▪ Gullied connection ▪ Hardstanding ▪ Interceptor ▪ Visual inspection ▪ Spill kits	Very low risk	
Firewater run off	Dispersants & fire-retardant - Hazardous	▪ Bunded areas around high-risk items (Zone 1) to include an allowance for firewater ▪ Connection to site drainage to be isolated where possible in event of a fire ▪ Interceptor will collect oil that is washed into the drainage system	Very low risk	it is unlikely that the full volume of any inventory would escape due to controls in place. Any reduced inventory caught up in firewater would be captured in the drainage system or in the worst case captured in surrounding gravelled areas and land Bunds are fitted with Aquasentry Bund Water Control Units (de-watering system) to automatically control levels of rain water within bunds.
Oil separator	Other than water, may include: Oil / dilute fuel / glycol - Hazardous Toxic to humans, wildlife and ecosystems	▪ Below ground, plastic, HDPE ▪ Upstream shut off valve ▪ Sized for the area and volume of potential spills / surface water runoff ▪ Inspected regularly with collection of waste oil by licensed contractor	Very low risk	

Source (spills & runoff)	Toxicity	Mitigation and Control	Residual Risk	Notes
Roads	Other than water, may include: Oil / dilute fuel / glycol - Hazardous Toxic to humans, wildlife and ecosystems	Soakaways stone filled French drain. A significant volume will be attenuated in the soakaways allowing for biological treatment of contaminants over time. Any excess goes to attenuation tank/swale to slow down storm water and reduce possible downstream flooding	Very low risk	
Roof run off	Rain water - Non-hazardous	Roof run off will be directed via a perforated pipe system to road soakaway system to attenuation tank/swale. The attenuation tank/ swale will slow down storm water and reduce possible downstream flooding	Very low risk	
Hardstanding run off (non-haz)	Rain water - Non-hazardous	Soakaways stone filled French drain. A significant volume will be attenuated in the soakaways. Any excess goes to attenuation tank/swale	Very low risk	
Transformer	Oil - Hazardous Toxic to humans, wildlife and ecosystems	▪ Bunded to 110% volume minimum with an allowance for rainwater / some firewater ▪ Roads routed to restrict vehicular access to area ▪ Penstock valves, normally closed ▪ Regularly emptied ▪ Oil interceptor ▪ Visual detection of leak ▪ Spill kits ▪ Low toxicity and low persistence oil where possible	Low risk	Bunded area is impermeable and would contain the full volume of oil. Any possible escape of oil from bunded area would be a significantly reduced volume that could be contained before reaching highly sensitive receptors (controlled waters)

Source (spills & runoff)	Toxicity	Mitigation and Control	Residual Risk	Notes
Hydraulic valves	Oil - Hazardous Toxic to humans, wildlife and ecosystems	▪ Visual detection of leak ▪ Spill kits ▪ Low toxicity and low persistence oil where possible	Very low risk	
CEMS condensate	Weakly acidic water	▪ Lagged pipe to prevent freezing ▪ Drain to curbed area ▪ Weakly acidic water neutralised before reaching controlled waters ▪ No potential ice formation on hardstanding, reducing slip/trip potential	Very low risk	

9.3 Decision

Various mitigation and control measures have been developed at concept phase to prevent increased run-off or environmental contamination. The drainage design incorporates the principles and techniques of Sustainable Drainage Systems (SuDS) wherever practical.

10. Noise

10.1 Purpose of Noise Mitigation

The Site operates under an existing planning and permitting regime, which includes a very low noise requirement at the boundary of nearby residential receptors. The noise limit is effectively 37 dB(A) at the boundary of Strawberry Bungalow approximately 200 m to the west.

Several processes have the potential to generate noise above the limit, namely compressor and generator operation, depressurisation venting, ancillary machinery operation such as the air compressor and flow and resonant noise from pipework. A separate report detailing concept phase noise mitigation techniques in the design has been developed [27].

10.2 BAT Options

A summary of the information contained in the Operational Noise & Vibration Control Measures Report is provided below.

- Compressor and gas turbine – these will be housed in primary enclosures designed to attenuate noise during operation. However, this will only be effective for a proportion of the noise and elevated levels will remain outside of the primary enclosures. Therefore, a secondary larger enclosure has been specified to attenuate noise to acceptable levels. The enclosure's performance has been designed to achieve noise limits for the site during operation
- Pipework:
  - Buried Pipework – new pipework has been designed to be buried as much as possible. This will attenuate noise and vibration from gas flowing through pipework to a large extent.
  - Low Radius Angles – bends have been made as shallow as possible to reduce flow noise through pipework. Lower angle radiuses and sweeping curves should result in lower flow noise and 90^{o} bends have been avoided where practical. This will be particularly important on riser sections and any pipework above ground.
  - Acoustic Lagging of Above Ground Pipework - above ground sections of pipework will be lagged with high performance noise deadening elastomeric foam. Acoustic lagging has been fitted to other above ground pipework on the Site and has been successful in reducing noise to acceptable levels during operation. Elastomeric foam with a vinyl cover offers a good balance between cost and acoustic performance [21].
- Vent & Silencer - planned venting activities during commissioning and start-up will be subject to noise limits. An inline silencer has been included in the design. This will reduce the pressure in an expansion chamber and therefore noise from high pressure gas flow. Further noise reductions will be achieved by absorptive core elements which will reduce vibration and noise transmission. Additionally, an in-line silencer is an optimal design as it works with the gas flow and does not introduce further restrictions which may represent additional noise and vibration sources.

10.3 Decision

Noise is a special concern for the project and careful selection of techniques have been included to reduce noise to levels that are as low as practical. Noise mitigation techniques are in line with best practice guidance including BS 5228-1 Code of practice for noise and vibration control on construction and open sites [28].

11. Piling

11.1 Purpose of Piling

Following geotechnical investigation of ground conditions and analysis of loads, piling is required to support the foundations for the compressor, turbine and exhaust stack.

11.2 Options

Possible options included:

- Concrete piles – industry standard low cost approach. Some waste will be produced as piles are cut to length once installed. Potential for high noise levels during percussive installation. It may be possible to press piles in if noise is a special concern.
- Helical piles – used in situations where noise and vibration are a particular concern e.g. urban environments close to sensitive human receptors and structures. Increased cost compared to concrete piles. Reduced waste as piles can be made to length and installed to ground level or below.
- Increased concrete foundation depth – this could negate the need for piles if the concrete foundation is made thick enough to provide the required stability. However, there would be a significantly increased amount of concrete required as well as increased spoil waste from excavations. Cost would also be increased relative to concrete piles.

11.3 Decision

Concrete piles have been selected. This is driven by cost, material requirements and ease of installation. Vibration will not be an issue to no sensitive structures in close proximity.

Noise from percussive piling is a concern for local residents, however, the residents are over 300 m distance and piling activity will be confined to daytime hours for a maximum of 2 weeks.

Local residents will be consulted by project representatives prior to piling.

12. Electrical Transformer

12.1 Need for Electrical Transformer

An electrical transformer is a design critical component, required to step down voltage from 11 kv transmission levels to 415 v three phase suitable for industrial use i.e. compressor operation. This process creates heat, a key aspect of an electrical transformer is its ability to cool itself to prevent overheating, poor performance and fire. Mineral oil is traditionally used as the medium for absorbing and dissipating heat. Recent designs have included resin as the cooling medium.

12.2 Options

Possible options included:

- Oil filled transformer - this is the traditional format for a transformer and is relatively low cost. The oil does not need to be replaced as it would do in an engine or turbine for example. However, the oil does present a low potential spill risk, which can be mitigated with protective curbing and appropriate routing of vehicles to avoid collision.
- Resin filled transformer – this would reduce the potential for spills. However, the cost is high compared to a traditional oil filled transformer.

12.3 Decision

An oil filled transformer was determined to be the best option after consultation with vendors and review of the costs. Any low potential spill risk from the oil can be adequately mitigated by providing curbed protection and careful routing of vehicles.

13. References

[1] Worley, Hatton Compressor Station – IED (LCP) Phase 2 Compression Project Execution Plan Feasibility & FEED Phases, 415013-00011-PM-PLN-0001

[2] Worley, Hatton Compressor Station – IED (LCP) Phase 2 Compression Project, Process Basis of Design, 415013-00011-PR-BOD-0001

[3] National Grid 2014 Options for removing gas from compressor casing and pipework

[4] Costain 2016 Venting BAT Supporting Note 7050-0180-075-03-1001-001

[5] 2014 Standby Power Generation National Grid

[6] National Grid 2014 Micro-renewable (for power) technologies

[7] Costain 2015 Standby Power Generation BAT Supporting Note 7050-0180-075-03-1002-001

[8] National Grid 2014 Valve Actuation

[9] Costain 2015 Valve Actuator BAT Summary Report 7050-0180-075-03-1100-001

[10] Mott Macdonald 2016 Actuator BAT Assessment

[11] Premtech 2017 PREM250-REP-0000-0002 Valve Actuators

[12] National Grid 2014 Non-operational buildings - heating, cooling and ventilation

[13] National Grid 2014 Switchrooms, MCC, UPS and battery rooms - heating, cooling and ventilation

[14] Costain 20157 Operational and Non-Operational Building BAT Supporting Note 050-0180-075-03-1103-001

[15] National Grid 2014 Compressed air BAT

[16] Costain 2015 7050-0180-075-03-1104-001 Compressed Air BAT Supporting Note

[17] National Grid 2014 Lighting

[18] Costain 2015 Lighting BAT Supporting Note 7050-0180-075-03-1105-001

[19] National Grid 2014 -Surface Water Drainage and Firewater

[20] National Grid 2014 - Foul Drainage

[21] Project Environmental Solutions 2019 Collated noise BAT case studies NGGT0112

[22] Worley, 2021. Utility Summary, Hatton Compressor Station - IED (LCP) Phase 2 Compressor Project, 415013-00011-PR-LST-0008

[23] Worley, 2021. Conceptual Environmental and Sustainability Management Controls, Hatton Compressor Station - IED (LCP) Phase 2 Compressor Project, 415013-00011-EN-REF-0001

[24] Worley, 2021. Lighting Calculation–Hatton Gas Compressor Unit-E, Hatton Compressor Station - IED (LCP) Phase 2 Compressor Project, 415013-00011-EL-CAL-0003

[25] Worley, 2021. Hatton Compressor Station Lighting Layout Overall Unit-E, Hatton Compressor Station - IED (LCP) Phase 2 Compressor Project, 415013-00011-EL-DLS-0001

[26] Worley, 2021. Hatton Compressor Station Lighting Layout Acoustic Cab Area, Hatton Compressor Station - IED (LCP) Phase 2 Compressor Project, 415013-00011-EL-DLS-0002

[27] Worley, 2021. Operational Noise & Vibration Control Measures - FEED Study, Hatton Compressor Station - IED (LCP) Phase 2 Compressor Project, 415013-00011-EN-STD-0002

[28] BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites Part 1: Noise & Part 2: Vibration

Appendix 8: BAT conclusions summary

BAT requirement	Relevant sections for reference / notes on applicability
BAT 1. In order to improve the overall environmental performance, BAT is to implement and adhere to an environmental management system (EMS) that incorporates all of the following features: 1. Commitment of the management, including senior management; 2. Definition, by the management, of an environmental policy that includes the continuous improvement of the environmental performance of the installation; 3. Planning and establishing the necessary procedures, objectives and targets, in conjunction with financial planning and investment; 4. Implementation of procedures paying particular attention to: (a) structure and responsibility, (b) recruitment, training, awareness and competence, (c) communication, (d) employee involvement, (e) documentation, (f) effective process control, (g) maintenance programmes, (h) emergency preparedness and response, (i) safeguarding compliance with environmental legislation; 5. Checking performance and taking corrective action, paying particular attention to: (a) monitoring and measurement (see also the JRC Reference Report on Monitoring of emissions to air and water from IED installations – ROM), (b) corrective and preventive action, (c) maintenance of records, (d) independent (where practicable) internal or external auditing in order to determine whether or not the EMS conforms to planned arrangements and has been properly implemented and maintained; 6. Review, by senior management, of the EMS and its continuing suitability, adequacy and effectiveness; 7. Following the development of cleaner technologies;	**BAT in place.** For items 1 – 7 and 9 refer to Section III: Supporting Information, Form C2, Question 3d Management systems.

BAT requirement	Relevant sections for reference / notes on applicability
8. Consideration for the environmental impacts from the eventual decommissioning of the plant at the stage of designing a new plant, and throughout its operating life including: (a) avoiding underground structures (b) incorporating features that facilitate dismantling (c) choosing surface finishes that are easily decontaminated (d) using an equipment configuration that minimises trapped chemicals and facilitates drainage or cleaning (e) designing flexible, self-contained equipment that enables phased closure (f) using biodegradable and recyclable materials where possible;	For item 8, BAT has been considered throughout the design process, including consideration for eventual decommissioning; modular systems have been selected, that are largely above ground. Certain plant items, such as high-pressure gas pipelines, need to be underground for reasons of safety, noise and vibration mitigation.
9. Application of sectoral benchmarking on a regular basis;	For item 9, National Gas Transmission is an active participant in sector bodies such as Marcogaz
10. Quality assurance/quality control programmes to ensure that the characteristics of all fuels are fully determined and controlled (see BAT 9);	For item 10 refer to information provided in response to BAT 9.
11. a management plan in order to reduce emissions to air and/or to water during other than normal operating conditions, including start-up and shutdown periods (see BAT 10 and BAT 11)	For item 11 refer to information provided in response to BAT 10 and 11.
12. a waste management plan to ensure that waste is avoided, prepared for reuse, recycled or otherwise recovered, including the use of techniques given in BAT 16;	For item 12 see Section III: Supporting Information, Form C3, Question 6e Describe how you avoid producing waste in line with Council Directive 2008/98/EC on waste.
13. a systematic method to identify and deal with potential uncontrolled and/or unplanned emissions to the environment, in particular: (a) emissions to soil and groundwater from the handling and storage of fuels, additives, by-products and wastes (b) emissions associated with self-heating and/or self-ignition of fuel in the storage and handling activities;	For item 13 see Section III: Form C2, Q6-5 Accident Management Plan.
14. a dust management plan to prevent or, where that is not practicable, to reduce diffuse emissions from loading, unloading, storage and/or handling of fuels, residues and additives;	Item 14 is not applicable as no dusty materials are used or stored on site.

<table>
<tr><th>BAT requirement</th><th>Relevant sections for reference / notes on applicability</th></tr>
<tr><td>15. a noise management plan where a noise nuisance at sensitive receptors is expected or sustained, including:
a) a protocol for conducting noise monitoring at the plant boundary
(b) a noise reduction programme
(c) a protocol for response to noise incidents containing appropriate actions and timelines
(d) a review of historic noise incidents, corrective actions and dissemination of noise incident knowledge to the affected parties;</td><td>For item 15 refer to Appendix 4 Noise Management Plan.</td></tr>
<tr><td>16. for the combustion, gasification or co-incineration of malodourous substances, an odour management plan, including:
(a) a protocol for conducting odour monitoring
(b) where necessary, an odour elimination programme to identify and eliminate or reduce the odour emissions
(c) a protocol to record odour incidents and the appropriate actions and timelines
(d) a review of historic odour incidents, corrective actions and the dissemination of odour incident knowledge to the affected parties.</td><td>Item 16 is not applicable as no odour materials are used or stored on site. Gas in the NTS is unodorised.</td></tr>
<tr><td>BAT 2. BAT is to determine the net electrical efficiency and/or the net total fuel utilisation and/or the net mechanical energy efficiency of the gasification, IGCC and/or combustion units by carrying out a performance test at full load, according to EN standards, after the commissioning of the unit and after each modification that could significantly affect the net electrical efficiency and/or the net total fuel utilisation and/or the net mechanical energy efficiency of the unit. If EN standards are not available, BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality.</td><td>BAT in place.
Full commissioning tests will be carried out over the entire power range to ISO standards, including compliance tests against energy performance guarantees. This includes FAT (factory acceptance tests) and SAT (site acceptance tests). The full operating envelope is mapped, for confirmation and setting of compressor surge and choke lines.</td></tr>
<tr><td>BAT 3. BAT is to monitor key process parameters relevant for emissions to air and water including those given below.
<table><tr><th>Stream</th><th>Parameter(s)</th><th>Monitoring</th></tr><tr><td rowspan="3">Flue-gas</td><td>Flow</td><td>Periodic or continuous determination</td></tr><tr><td>Oxygen content, temperature, and pressure</td><td rowspan="2">Periodic or continuous measurement</td></tr><tr><td>Water vapour content (1)</td></tr></table></td><td>BAT in place.
Refer to Section III: Supporting Information, Form C3, Question 4a Describe the measures you use for monitoring emissions. Both CEMS and periodic monitoring includes the key process parameters indicated here.</td></tr>
</table>

<table>
<tr><th>BAT requirement</th><th>Relevant sections for reference / notes on applicability</th></tr>
<tr><td>
BAT 4. BAT is to monitor emissions to air with at least the frequency given below and in accordance with EN standards. If EN standards are not available, BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality.
<table>
<tr><th>Substance/Parameter</th><th>Fuel/Process/Type of combustion plant</th><th>Combustion plant total rated thermal input</th><th>Standard(s) (1)</th><th>Minimum monitoring frequency (2)</th><th>Monitoring associated with</th></tr>
<tr><td>NO_X</td><td>— Coal and/or lignite including waste co-incineration
— Solid biomass and/or peat including waste co-incineration
— HFO- and/or gas-oil-fired boilers and engines
— Gas-oil-fired gas turbines
— Natural-gas-fired boilers, engines, and turbines
— Iron and steel process gases
— Process fuels from the chemical industry
— IGCC plants</td><td>All sizes</td><td>Generic EN standards</td><td>Continuous (3) (5)</td><td>BAT 20
BAT 24
BAT 28
BAT 32
BAT 37
BAT 41
BAT 42
BAT 43
BAT 47
BAT 48
BAT 56
BAT 64
BAT 65
BAT 73</td></tr>
<tr><td>CO</td><td>— Coal and/or lignite including waste co-incineration
— Solid biomass and/or peat including waste co-incineration
— HFO- and/or gas-oil-fired boilers and engines
— Gas-oil-fired gas turbines
— Natural-gas-fired boilers, engines, and turbines
— Iron and steel process gases
— Process fuels from the chemical industry
— IGCC plants</td><td>All sizes</td><td>Generic EN standards</td><td>Continuous (3) (5)</td><td>BAT 20
BAT 24
BAT 28
BAT 33
BAT 38
BAT 44
BAT 49
BAT 56
BAT 64
BAT 65
BAT 73</td></tr>
</table>
</td><td>
BAT in place.
Refer to Section III: Supporting Information, Form C3, Question 4a Describe the measures you use for monitoring emissions.
</td></tr>
<tr><td>BAT 5. BAT is to monitor emissions to water from flue-gas treatment with at least the frequency given below and in accordance with EN standards. If EN standards are not available, BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality.</td><td>Not applicable – no flue gas treatment.</td></tr>
</table>

BAT requirement	Relevant sections for reference / notes on applicability
BAT 6. In order to improve the general environmental performance of combustion plants and to reduce emissions to air of CO and unburnt substances, BAT is to ensure optimised combustion and to use an appropriate combination of the techniques given below: (a) Fuel blending and mixing (b) Maintenance of the combustion system (c) Advanced control system (d) Good design of the combustion equipment (e) Fuel choice	**BAT in place.** Refer to Section II: Proposed Changes which provides a summary of the fuel blending and mixing, maintenance regimes, advanced control systems, equipment design and fuel choice.
BAT 7. In order to reduce emissions of ammonia to air from the use of selective catalytic reduction (SCR) and/or selective non-catalytic reduction (SNCR) for the abatement of NOX emissions, BAT is to optimise the design and/or operation of SCR and/or SNCR (e.g. optimised reagent to NOX ratio, homogeneous reagent distribution and optimum size of the reagent drops).	Not applicable – no SCR or SNCR – DLE used instead for NOx control.
BAT 8. In order to prevent or reduce emissions to air during normal operating conditions, BAT is to ensure, by appropriate design, operation and maintenance, that the emission abatement systems are used at optimal capacity and availability.	**BAT in place.** Refer to Section II: Proposed changes which provides a summary of the equipment design, operation and maintenance regimes.
BAT 9. In order to improve the general environmental performance of combustion and/or gasification plants and to reduce emissions to air, BAT is to include the following elements in the quality assurance/quality control programmes for all the fuels used, as part of the environmental management system (see BAT 1): (i) Initial full characterisation of the fuel used including at least the parameters listed below and in accordance with EN standards. ISO, national or other international standards may be used provided they ensure the provision of data of an equivalent scientific quality; 17.8.2017 EN Official Journal of the European Union L 212/19 (ii) Regular testing of the fuel quality to check that it is consistent with the initial characterisation and according to the plant design specifications. The frequency of testing and the parameters chosen from the table below are based on the variability of the fuel and an assessment of the relevance of pollutant releases (e.g. concentration in fuel, flue-gas treatment employed); (iii) Subsequent adjustment of the plant settings as and when needed and practicable (e.g. integration of the fuel characterisation and control in the advanced control system (see description in Section 8.1)).	**BAT in place.** Plant is mains natural gas fired which meets all applicable quality requirements and standards. No further testing or characterisation is necessary.

BAT requirement	Relevant sections for reference / notes on applicability
BAT 10. In order to reduce emissions to air and/or to water during other than normal operating conditions (OTNOC), BAT is to set up and implement a management plan as part of the environmental management system (see BAT 1), commensurate with the relevance of potential pollutant releases, that includes the following elements: — appropriate design of the systems considered relevant in causing OTNOC that may have an impact on emissions to air, water and/or soil (e.g. low-load design concepts for reducing the minimum start-up and shutdown loads for stable generation in gas turbines), — set-up and implementation of a specific preventive maintenance plan for these relevant systems, — review and recording of emissions caused by OTNOC and associated circumstances and implementation of corrective actions if necessary, — periodic assessment of the overall emissions during OTNOC (e.g. frequency of events, duration, emissions quantification/estimation) and implementation of corrective actions if necessary.	**BAT in place.** Gas compressor operations are designed to accommodate a wide range of operating conditions, such that OTNOC are not considered to be a material concern. The station, including the new compressor has been designed to provide a wider operating envelope from low flow / lift conditions to very high flow / lift conditions, this being necessary to meet a wide range of external gas supply and demand conditions up to an including ‘peak day 13 demand’ in a one-in-twenty winter. With this variable operation in mind, the SGT-750 emissions control system has guaranteed performance to 30% MCR, this being effectively the minimum governed speed of the compressor (i.e. the point at which meaningful compression work is done). As the gas turbine operation is governed by the compressor operation, the extremes of the compressor envelope are fully governed by the control logic, with minimum and maximum speeds set, and also choke and surge control lines. The control system alters the performance of the engine to keep operations in this zone to reduce process upset risks such as vibration. Refer also to Section II: Proposed Changes for process description and Section III: Form C2, Q6-5 Accident Management Plan, which includes a summary of measures taken to reduce risks during abnormal operations. CEMS and PEMS systems are used to monitor emissions. Data is analysed and managed in accordance with documented procedures including taking corrective actions where necessary.
BAT 11. BAT is to appropriately monitor emissions to air and/or to water during OTNOC.	**BAT in place.** CEMS provides continuous monitoring of emissions to air, including during OTNOC.

BAT requirement	Relevant sections for reference / notes on applicability
BAT 12. In order to increase the energy efficiency of combustion, gasification and/or IGCC units operated ≥ 1 500 h/yr, BAT is to use an appropriate combination of the techniques given below. (a) Combustion optimisation (b) Optimisation of the working medium conditions (c) Optimisation of the steam cycle (d) Minimisation of energy consumption (e) Pre heating of combustion air (f) Fuel preheating (g) Advanced control system (h) Feed-water preheating using recovered heat (i) Heat recovery by cogeneration (j) CHP readiness (k) Flue-gas condenser (l) Heat accumulation (m) Wet stack (n) Cooling tower discharge (o) Fuel pre-drying (p) Minimisation of heat losses (q) Advanced materials (r) Steam turbine upgrades (s) Supercritical and ultra-supercritical steam conditions	**BAT in place.** Refer to Section II: Proposed Changes and Section III: Supporting Information, Form C3, Question 6a for description of equipment design and operation to maximise energy efficiency. Application of the specific listed techniques are as follows (where applicable): a) computer controlled DLE combustion system. b) selection of compressor drivers to best deliver the optimised compression requirements, minimising the use of inefficient gas recycle operations d) lube oil heat recovery is used to preheat fuel gas, to reduce energy consumption e) Not applicable, DLE control system operating philosophy is to reduce flame temperature g) advanced computer controlled combustion and unit control system in place i) heat recovery used for fuel gas preheating only. CHP / cogeneration not viable for NTS open cycle compressors for technical and legal reasons. 1)Irregular operating mode of NTS compressors prevents long term third party heat supply opportunities from being realised. 2)Gas transporter licence conditions restrict the export of electricity. j) CHP / cogeneration not viable for NTS open cycle compressors for technical and legal reasons. Refer also to Part III Supporting Information. C3: Q 12. o) Fuel gas undergoes conditioning to remove liquids (including moisture and heavy hydrocarbons) prior to combustion to improve efficiency and reduce the risk of engine damage. q) highly specialised alloys are utilised within the SGT-750 engine to optimise efficiency and reliability. Items c, f, h, j, k, l, m, n, p, r, s are not applicable due to the technology in use on site.

BAT requirement	Relevant sections for reference / notes on applicability
BAT 13. In order to reduce water usage and the volume of contaminated waste water discharged, BAT is to use one or both of the techniques given below. (a) Water recycling (b) Dry bottom ash handling	**Not applicable** For item 'a' there are no suitable re-use opportunities for water (e.g. surface water runoff) on site; engine washing requires potable water. Item b not applicable.
BAT 14. In order to prevent the contamination of uncontaminated waste water and to reduce emissions to water, BAT is to segregate waste water streams and to treat them separately, depending on the pollutant content.	**BAT in place.** Refer to Section II: Proposed Changes and Section III: Supporting Information, Form C3, Question 2 Emissions to Water for description of waste water streams. Engine washwater is collected and disposed of separately. Uncontaminated surface water runoff is discharged to watercourse.
BAT 15. In order to reduce emissions to water from flue-gas treatment, BAT is to use an appropriate combination of the techniques given below, and to use secondary techniques as close as possible to the source in order to avoid dilution.	Not applicable – no flue gas treatment.
BAT 16. In order to reduce the quantity of waste sent for disposal from the combustion and/or gasification process and abatement techniques, BAT is to organise operations so as to maximise, in order of priority and taking into account life-cycle thinking: (a) waste prevention, e.g. maximise the proportion of residues which arise as by-products; (b) waste preparation for reuse, e.g. according to the specific requested quality criteria; (c) waste recycling; (d) other waste recovery (e.g. energy recovery), by implementing an appropriate combination of techniques.	**BAT in place.** There are no significant changes predicted to solid waste generation from the installation as a result of the proposed changes. There are some additional liquid waste arising, although these are similar in nature to existing waste streams. Refer to Section III: Supporting Information, Form C3, Question 6e.
BAT 17. In order to reduce noise emissions, BAT is to use one or a combination of the techniques given below: (a) Operational measures (b) Low-noise equipment (c) Noise attenuation (d) Noise-control equipment (e) Appropriate location of equipment and buildings	**BAT in place.** Refer to Section 7.2 of Appendix 3 Noise Management Plan for detailed assessment against BAT 17 requirements.
BAT 18 – 39	Not applicable – activities not carried out on site.

BAT requirement	Relevant sections for reference / notes on applicability
BAT 40. In order to increase the energy efficiency of natural gas combustion, BAT is to use an appropriate combination of the techniques given in BAT 12 and below. (a) Combined cycle	**BAT in place.** Refer to BAT 12 above. Proposed technology is open cycle gas turbine, CCGT operation is not viable for NTS open cycle mechanical drive compressors for technical and legal reasons.
BAT 41	Not applicable – no boilers on site.
BAT 42. In order to prevent or reduce NOX emissions to air from the combustion of natural gas in gas turbines, BAT is to use one or a combination of the techniques given below. (a) Advanced control systems (b) Water / steam addition (c) Dry low-NOx burners (DLN) (d) Low load design concept (e) low-NOx burners (LNB) (f) SCR	**BAT in place.** Refer to Section II: Proposed Changes for process description. Advanced control system and DLN (otherwise known as DLE) technology is in use, the latter being the OEMs chosen method for NOx control (water / steam injection only being used for liquid fuel applications). The DLE systems has advanced low load capabilities operating to guaranteed performance levels down to 30% MCR. The DLE systems is capable of very high NOX abatement efficiency, negating the need for complex end-of-pipe solutions such as SCR.
BAT 43	Not applicable, applies to engines only.
BAT 44. In order to prevent or reduce CO emissions to air from the combustion of natural gas, BAT is to ensure optimised combustion and/or to use oxidation catalysts.	**BAT in place.** Optimised combustion is used, the DLE system operates to guaranteed CO performance levels down to 30% MCR – refer to Section II: Proposed Changes
BAT 45	Not applicable, applies to engines only.

Appendix 9: Environmental Management System certification

national gas transmission

ISO 14001

Certificate of Registration

ERM Certification and Verification Services

Exchequer Court
33 St. Mary Axe
London EC3A 8AA
Tel: +44 (0)20 3206 5281
Fax: +44 (0)20 3206 5442
post@ermcvs.com

This is to certify that

National Gas Transmission

ERMCVS

at

National Grid House
Warwick Technology Park, Gallows Hill
Warwick
CV34 6DA
United Kingdom

has been registered to ISO 14001:2015 for

Certificate Number: 618
Initial Issue Date (prev. CB): 20 July 2018
Initial ERM CVS Issue: 31 March 2021
Revision Date: 7 March 2023
Expiry Date: 11 January 2026
Version #: 3

UKAS MANAGEMENT SYSTEMS

National Gas Transmission including reasonable areas of influence from activities in design, development, construction, maintenance, operation and decommissioning of gas infrastructure and associated land and property.

Signed on behalf of ERM CVS by:

Ron Crooks

Ron Crooks
Partner, Head of Certification

Appendix 10: Risk assessment methodology

Risk Matrix and Terminology Used for Risk Assessments

		Consequence			
		Severe	**Medium**	**Mild**	**Minor/Negligible**
Probability (Likelihood)	**High Likelihood**	Very high risk	High risk	Moderate risk	Moderate/Low risk
	Likely	High risk	Moderate risk	Moderate/Low risk	Low risk
	Low Likelihood	Moderate risk	Moderate/Low risk	Low risk	Negligible risk
	Highly Unlikely	Moderate/Low risk	Low risk	Negligible risk	Negligible risk

Under such a classification system the following categorisation of risk has been developed and the terminology adopted as follows:

Term	**Description**
Very high risk	Severe harm to a receptor may already be occurring OR a high likelihood that severe harm will arise to a receptor, unless immediate remedial action works / mitigation measures are undertaken.
High risk	Harm is likely to arise to a receptor, and is likely to be severe, unless appropriate remedial actions / mitigation measures are undertaken. Remedial works may be required in the short term, but likely to be required over the long term.
Moderate risk	Possible that harm could arise to a receptor but low likelihood that such harm would be severe. Harm is likely to be medium. Some remedial works may be required in the long term.
Moderate / low risk	Possible that harm could arise to a receptor, but where a combination of likelihood and consequence results in a risk that is above low, but is not of sufficient concern to be classified as medium. It can be driven by cases where there is an acute risk which carries a severe consequence, but where the exposure is unlikely.
Low risk	Possible that harm could arise to a receptor. Such harm would at worse normally be mild.
Negligible risk	Low likelihood that harm could arise to a receptor. Such harm unlikely to be any worse than mild.

Classification of Consequences

Classification	Definition
Severe	• Acute risks to human health • Short-term risk of pollution of sensitive water resource (e.g. major spillage into controlled waters) • Impact on controlled waters e.g. large scale pollution or very high levels of contamination • Catastrophic damage to buildings or property (e.g. explosion causing building collapse) • Ecological system effects – irreversible adverse changes to a protected location. Immediate risks
Medium	• Chronic risks to human health • Pollution of sensitive water resources (e.g. leaching of contaminants into controlled waters) • Ecological system effects – substantial adverse changes to a protected location • Significant damage to buildings, structures and services (e.g. damage rendering a building unsafe to occupy, such as foundation damage)
Mild	• Non-permanent health effects to human health • Pollution of non-sensitive water resources (e.g. pollution of non-classified groundwater) • Damage to buildings, structures and services (e.g. damage rendering a building unsafe to occupy, such as foundation damage) • Substantial damage to non-sensitive environments (unprotected ecosystems e.g. crops)
Minor/Negligible	• Non-permanent health effects to human health (easily prevented by appropriate use of PPE) • Minor pollution to non-sensitive water resources • Minor damage to non-sensitive environments (unprotected ecosystems e.g. crops) • Easily repairable effects of damage to buildings, structures, services or the environment (e.g. discoloration of concrete, loss of plants in a landscaping scene)

Classification	Definition
High Likelihood	An event is very likely to occur in the short term, and is almost inevitable over the long term OR there is evidence at the receptor of harm or pollution
Likely	It is probable that an event will occur. It is not inevitable, but possible in the short term and likely over the long term
Low Likelihood	Circumstances are possible under which an event could occur. It is by no means certain that even over a longer period such an event would take place, and less likely in the short term
Highly Unlikely	Probability is so low that it is close to zero; It is improbable that an event would occur even in the very long term