Air Quality Impact Assessment to Support a Bespoke Installation Permit Application: Pattemore's Dairy, Mosterton Road, Misterton, Crewkerne, Somerset, TA18 8NT

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Contents

LIST OF TABLES

LIST OF FIGURES

Abbreviations

AAD	Ambient Air Quality Directive (2008/50/EC)
AEL	Associated Emissions Level
AD	Anaerobic Digestion/ Digester
AOD	Above Ordnance Datum
APIS	Air Pollution Information System
AQMA	Air Quality Management Area
AQIA	Air Quality Impact Assessment
AQS	Air Quality Standards
AQSR	Air Quality Standards Regulations 2010
BAT	Best Available Techniques
CH_4	Methane
CIP	Clean in Place
Defra	Department for the Environment, Food and Rural Affairs
DERC	Dorset Environmental Records Centre
EA	Environment Agency
EAL	Environmental Assessment Level
EC	European Commission
ELV	Emission Limit Value
EPR	Environmental Permitting Regulations
EPUK	Environmental Protection UK
ETL	Earthcare Technical Ltd
EU	European Union
GFS	Global Forecast System
IAQM	Institute of Air Quality Management
IED	Industrial Emissions Directive
kWe	Kilowatts electrical output
kWthi	Kilowatts thermal input
kWtho	Kilowatts thermal output
LAQM	Local Air Quality Management
LWS	Local wildlife site
MCPD	Medium Combustion Plant Directive
n/a	Not applicable
NGR	National Grid Reference
O_2	Oxygen
PC	Process Contribution
PEC	Predicted environmental concentration
PVRV	Pressure and vacuum relief valve
SERC	Somerset Environmental Records Centre
SNCI	Site of Nature Conservation Interest
SSDC	South Somerset District Council

SC	Somerset Council
SO_2	Sulphur dioxide
SAC	Special Area of Conservation
SG	Specified generators
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
TG	Technical Guidance

1 Introduction

1.1 Background

Earthcare Technical Ltd (ETL) has been commissioned to undertake an Air Quality Impact Assessment (AQIA) on behalf of Pattemore's Transport (Crewkerne) Limited in support of an application for a bespoke installation permit (Permit ref: EPR/NP3127SX) at Pattemore's Dairy site, Mosterton Road, Misterton, Crewkerne, Somerset, TA18 8NT ('the Site') operated by Pattemore's Transport (Crewkerne) Limited (Pattemore's), herein termed 'the Operator'.

Pattermore's currently hold the following permits associated with on-site activities:

- Permit EPR/NP3124SP for Medium Combustion Plant (MCP) under a SR2018 No 7 Standard Rules for new, low risk, stationary MCP between 1 to less than 20MWthi (in operation on or after 20/12/2018) for one new boiler on site.
- U6 Exemption (WEX378383) using sludge to re-seed a wastewater treatment plant.
- Permit SW/EPR/ZB3799NK Discharge to surface water (Site Grid Reference ST4597807133).

The SR2018 No 7 Standard Rules for new, low risk, stationary MCP between 1 to less than 20MWthi (in operation on or after 20/12/2018) currently held (Ref EPR/NP3124SP) is for Boiler 2. The permit application seeks to consolidate the permit for Boiler 2 into the proposed Installation Permit. The existing MCP permit will be surrendered once the Installation Permit has been issued.

As summarised in Table 1and shown on Figure 2, Emissions point and permit boundary plan, the consolidated installation permit will include combustion plant emissions to air from 3 No. fixed boilers (emission points A1, A2 and A3) and 1. No mobile (standby) boiler on site (emission point A4), all of which are used to produce steam for onsite processes. An emergency standby diesel generator is also available for on-site use.

Table 1 Combustion plant

Emission point - description	Size (MWthi)	Approx. Date of Commissioning	Grid reference (X, Y)	Fuel
A1 - Boiler 1	3.34	Jun-01	346015, 107164	Kerosene
A2 - Boiler 2	3.33	Oct-22	346002, 107175	Kerosene
A3 - Boiler 3	0.72	Sep-95	345939, 107181	Kerosene
A4 - Standby Boiler 4 *	3.27	Nov-02	346001, 107189	Kerosene
A5 - Standby generator	1.21	2004	346019, 107173	Diesel
Notes: * Boiler 4 is a mobile standby boiler. The grid reference denotes the boiler's location for most of the time, including during the service/ maintenance of Boiler 1 and Boiler 2.				

The European Union (EU) MCP Directive (MCPD) controls apply to all in-scope MCP with a rated thermal input of each unit between 1MWthi and 50MWthi regardless of the type of fuel used. Gas oil-fired boilers, Boiler 1, Boiler 2 and Boiler 4, have a rated thermal input in the 1MWthi – 5MWthi range and are in scope as they are *'combustion units, such as an engine, boiler or turbine'* and do not fall under any of the exclusions in the guidance.

Boiler 1 and Boiler 4 were commissioned prior to 2018 and will be required to meet the MCPD Emission Limit Values (ELVs) for existing plant by 1 January 2030.

Boiler 2, commissioned in 2022, will continue to be required to meet the MCPD ELVs for new plant.

Gas oil-fired Boiler 3 is rated <1MWthi and is not an MCP. Its operation is however a Directly Associated Activity – combustion to another Chapter II activity. Monitored emissions data from Boiler 3 have been used in the AQIA, that will also inform site-specific Best Available Techniques (BAT).

The emergency standby diesel generator (1.2MWthi) is used in abnormal operating circumstances; for the sole purpose of providing power at the site during an onsite emergency i.e. when mains power is unavailable and/or during testing for 30 minutes every month. It is therefore used/ tested for less than 50 hours per year (typically for 6 hours per year) and is therefore not subject to MCPD or Specified Generator (SG) controls and as such is not included within the assessment.

An H1 risk assessment using the Environment Agency's (EA's) H1 tool,[1] which is a conservative tool, is used to screen out the pollutants from the proposed emission sources that do not require further assessment. The completed H1 tool and a report have been submitted to the EA.[2] The assessment concluded that the following pollutants and environmental assessment levels (EALs) or air quality standards (AQS) require detailed assessment, and they are considered in this report:

- Sulphur Dioxide (SO_2) (15-min mean)
- Sulphur Dioxide (24-hour mean)
- Nitrogen Dioxide (NO_2) (annual and 1-hour mean)
- Nitrogen Dioxide (ecological – annual mean and daily mean)

The pollutants to be considered include oxides of nitrogen (NOx) and nitrogen dioxide (NO_2) and sulphur dioxide (SO_2). All sources on the Site which emit these pollutants under normal operation have been considered as part of this assessment.

[1] Atmospheric Dispersion Modelling Liaison Committee (ADMLC) H1 Risk Assessment Tool, Available at: https://admlc.com/h1-tool/ version 9.2 [Accessed November 2024]
[2] ETL (2024) H1 Assessment to Support a Bespoke Installation Permit Application: Pattemore's Dairy, Mosterton Road, Misterton, Crewkerne, Somerset, TA18 8NT. Doc ref: ETL886/2024/H1/V1.0/Pattemore's Dairy/Jan2025.

1.2 Site location

The Site lies in the Somerset Council (SC) administrative area. Figure 1 shows the Site location and Figure 2 shows the permit boundary (green line boundary).

The Site is in a rural location with the villages of Misterton approximately 1km to the northwest and South Perrett 1.3km to the southeast. The Site lies to the north of a tributary of the River Parrett and is directly east of (adjacent to) the A3066. The area surrounding the site is used principally for farming and grassland. To the east of the Site there is a solar farm of 2 hectares (5 acres) which is operated by Pattemore's Transport (Holdings) Ltd a which supplies the site with any excess exported to the National Grid.

The boundary of the nearest dwelling is situated approximately 120m northwest of the Site with other isolated dwellings and small settlements within 1km.

There are no Sites of Special Scientific Interest (SSSI) within 2km of the Site. There are two Special Areas of Conservation (SACs), within 10km of the Site the closest of which is Bracket's Coppice that is also designated as SSSI (Bracket's Coppice and Ryewater Farm) situated 4.5km east of the Site. There are 14 No. Local Wildlife Sites and Sites of Nature Conservation Interest (SNCI) within 2km of the Site, the closest of which is Newbridge Meadows SNCI (0.8km east).

Neither the Site nor the surrounding area lie in an Air Quality Management Area (AQMA). South Somerset District Council have declared an AQMA for NO_2 in Yeovil approximately 10km to the northeast of the Site.

1.3 Process summary

A schematic of the Site layout is provided in Figure 3. The operation includes the treatment and processing of cows' milk, namely the production of pasteurised milk, cream and concentrated skimmed milk from cream production. The permit application also makes provision for the proposed pasteurisation and packaging of goats' milk and plant-based milk.

Raw materials are defined by a specification and then delivered to the Pattemore's Dairy. Raw materials are accepted in bulk, stored under controlled conditions on-site in sealed silos and tanks. A proportion of the raw milk is diverted directly to the Pasteurisation Unit. The Pasteurisation Unit uses heat from the Steam Boilers.

The pasteurised cows' milk is then homogenised, then either dispatched in bulk or packaged and sent off site. The milk that is not pasteurised is routed via 3 No. lines to the 3 No. Separators which work using centrifugal force to separate the cream from the milk ('skim'). The resulting cream is either stored in the Cream Holding Tanks, dispatched off site in bulk or packed for dispatch. A proportion of the resulting skim is passed through a clarifier. The resulting skim from the separators is either: dispatched off site in bulk; packaged and dispatched off site; or piped to the skim silo for storage and then to the Evaporators to produce concentrate, which is either dispatched in bulk or packaged.

The proposed processing of goats' milk and plant-based milk will also broadly involve: reception of milk from bulk tankers; pasteurisation; packaging into cartons; storage; and dispatch.

Four on-site boilers, including a standby boiler, all fuelled by gas oil (kerosene), are used to produce steam for pasteurisation and cleaning processes. The steam is used in five 'Cleaning-in-place' (CIP) systems; used for the cleaning of storage and production areas, and associated equipment and vehicles.

Boiler 1 and Boiler 2 produce steam used for heating, cleaning equipment and pasteurisation. Boiler 3 is used for Clean in Place (CIP) set 3 and heating the on-site Office. Standby Boiler 4 is only used for steam production for heating, cleaning equipment and pasteurisation during the servicing/ maintenance of the other boilers. There is an emergency standby diesel generator operated for the purpose of testing for no more than 50 hours per year and no more than 500 hours of operation in an emergency.

1.4 Scope of report

This AQIA assesses the impact on human and ecological receptors from sources that lie within the permit boundary. Emissions to air have been modelled based on the operation of the equipment in normal and abnormal operating scenarios at the specified emission limit values (ELVs) if ELVs exist for the sources; if there are no ELVs, the emission concentrations have been calculated and/or taken from indicative monitoring data from similar plant at other sites.

The ADMS 6[3] dispersion model has been used to calculate concentrations of the pollutants.

While ELVs and the air quality standards for ecological receptors are specified for NOx, standards for human health are for nitrogen dioxide (NO_2) which is emitted as a by-product of combustion and is formed (and consumed) in chemical reactions including NOx and other species.

Predicted concentrations have been compared with relevant AQS (limits, targets, objectives, and assessment levels) to assess their significance, considering background concentration data where relevant.

The pollutants considered in this AQIA are, therefore:

- Oxides of nitrogen (NOx)/Nitrogen dioxide (NO_2)
- Sulphur dioxide (SO_2)

This report describes the: relevant legislation and guidance for industrial emissions, ambient air quality and modelling of emissions to air (Section 2); the assessment methodology used to model concentrations of pollutants and odour (Section 3); assessment criteria including air quality limit values, objectives and Environmental Assessment Levels and significance criteria (Section 4); a baseline assessment of existing air concentrations (Section 5); and results of the dispersion modelling (Sections 6 and 7); before Section 8 provides conclusions.

[3] CERC, Environmental software, Available at: https://www.cerc.co.uk/environmental-software.html [Accessed December 2024]

2 Legislation and guidance

2.1 Overview

This section describes the legislation, policy, and guidance relevant to this assessment which is summarised in Table 2 and described further in Sections 2.2 and 2.3. Throughout the report the guidance is referenced when used.

While the UK has left the European Union (EU), the EU Withdrawal Act 2018[4] brought all EU laws and regulations, made while the UK was a member of the EU, into UK law by creating a new category of UK law: EU retained law. Therefore, the EU Directives described in this section still apply in the UK.

Table 2 Summary of legislation, policy and guidance

Short name	Name	Body	Scope
Legislation			
1995 Act	Environment Act 1995[5]	UK Parliament	Establishes the framework for managing air quality to achieve compliance with air quality objectives.
4th Daughter Directive	Directive 2004/107/EC[6]	European Commission, now EU	Sets limit values for arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air
AAD	Ambient Air Quality Directive 2008/50/EC[7]	EU	Ambient air quality, sets limit and target values
IED	Industrial Emissions Directive, 2010/75/EU[8]	EU	Industrial emissions
MCPD	Medium Combustion Plant Directive, EU/2015/2193[9]	EU	Emission limit values for pollutants from combustion plant greater than 1MWth and less than 50MWth

[4] UK Legislation, European Union (Withdrawal) Act 2018
[5] Environment Act 1995, 1995 Chapter 25, Part IV Air Quality
[6] DIRECTIVE 2004/107/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL, of 15 December 2004, relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air.
[7] DIRECTIVE 2008/50/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 May 2008 on ambient air quality and cleaner air for Europe comment on amendment
[8] DIRECTIVE 2010/75/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 24 November 2010 on industrial emissions (integrated pollution prevention and control)
[9] 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.

Short name	Name	Body	Scope
NECD	National Emissions Ceiling Directive[10]	EU	2020 and 2030 emission reduction commitments
AQSR	Air Quality (Standards) Regulations 2010[11] as amended in 2016[12]	UK Parliament	Ambient air quality, standards for pollutant concentrations. Transposed EU limit values defined in AAD into law in England and Wales
EPR	Environmental Permitting Regulations 2018[13]	UK Parliament	Industrial emissions. Transposed IED into law in England and Wales
Guidance			
Defra/EA permit guidance	Air emissions risk assessment for your environmental permit[14]	Department for Environment, Food & Rural Affairs and Environment Agency	How to undertake an air quality assessment for a permit
Defra SWIP	Specified generators: dispersion modelling assessment[15]	Environment Agency and Natural Resources Wales	Includes reference for conversion of NOx to NO_2
AQTAG06	AQTAG06 Technical guidance on detailed modelling approach for an appropriate assessment for emissions to air[16]	Air Quality Advisory Group	Guidance on calculating deposition
LAQM.TG16	Local Air Quality Management, Technical Guidance (TG16)[17]	Department for Environment, Food & Rural Affairs and the Devolved Authorities	Includes general guidance on dispersion modelling

[10] European Commission, National Emissions Ceiling Directive (2016/2284/EU) (2016), http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016L2284&from=EN
[11] Statutory Instrument: 2010 No. 1001, ENVIRONMENTAL PROTECTION, The Air Quality (Standards) Regulations 2010 comment on amendment
[12] The Air Quality Standards (Amendment) Regulations 2016, Statutory Instrument 2016 No, 1184, Made 6th December 2016
[13] The Environmental Permitting (England and Wales) (Amendment) Regulations 2018, Statutory Instrument 2010 No, 675
[14] Department for Environment, Food & Rural Affairs and Environment Agency, Air emissions risk assessment for your environmental permit, Available at: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit [Accessed December 2024].
[15] Environment Agency and Natural Resources Wales, Specified generators: dispersion modelling assessment, Available at: https://www.gov.uk/guidance/specified-generators-dispersion-modelling-assessment#nosubxsub-to-nosub2sub-conversion-ratios-to-use [Accessed December 2024].
[16] Air Quality Advisory Group, 2014, AQTAG06 Technical guidance on detailed modelling approach for an appropriate assessment for emissions to air
[17] Department for Environment, Food & Rural Affairs and the Devolved Authorities, Local Air Quality Management Technical Guidance (TG16), February 2018

2.2 Legislation and policy

2.2.1 Environment Act

The Environment Act, which established the EA for England and Wales with functions including the control of pollution. Part IV of the Environment Act 1995 establishes the framework for managing air quality to achieve compliance with air quality objectives and for local air quality management (LAQM). Under LAQM local authorities (district councils) are required to monitor, review, assess and improve air quality in their areas; if exceedances are monitored or predicted, they must consider establishing an AQMA. Part IV requires the Secretary of State to prepare a National Air Quality Strategy. The latest published UK Air Quality Strategy was published in 2007.[18]

2.2.2 Ambient Air Quality Directive and 4th Daughter Directive

The Ambient Air Quality Directive and 4th Daughter Directive contain **Limit Values** and **Target Values** with which the UK must comply. The Ambient Air Quality Directive also addresses common methods and criteria; information on ambient air quality to help combat air pollution and nuisance, to monitor long-term trends; and making information and pollution alerts available to the public.

2.2.3 Air Quality Standards Regulations

The Air Quality (Standards) Regulations 2010 is the instrument by which the Ambient Air Quality Direction and the 4th Daughter Directive were transposed into English law.

2.2.4 Industrial Emissions Directive

The IED is the main EU instrument by which pollutant emissions from industrial installations are regulated. It consolidated seven earlier directives including, in particular, the Integrated Pollution Prevention and Control Directive and the Waste Incineration Directive. It defines emissions limit values (ELVs) for some process-fuel combinations but there are no ELVs relevant to the Biogas upgrading stack.

2.2.5 Medium Combustion Plant Directive

The MCPD sets ELVs for pollutants from combustion plant of thermal input greater than 1MWth and less than 50MWth. It regulates emissions of SO_2, NOx and dust to air and requires monitoring of carbon monoxide (CO) emissions to reduce emissions and risks to human and ecological receptors. MCPD ELVs apply from 2025 or 2030 for existing plants, depending on their size.

The relevant ELVs for proposed engines using biogas, which have been used in this assessment, are those defined in Part 2 of Annex II of the MCPD.

[18] The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. Volume 1. July 2007

2.2.6 National Emissions Ceiling Directive

The NECD sets 2020 and 2030 emission reduction commitments for anthropogenic emissions of five main air pollutants: SO_2, NOx, non-methane volatile organic compounds (NMVOCs), NH_3 and $PM_{2.5}$. The NECD Regulations[19] transposed the NECD into UK law. It is supported by the Clean Air Strategy 2019.[20]

2.2.7 Environmental Permitting Regulations

The Environmental Permitting (England and Wales) (Amendment) Regulations 2023 is the latest consolidated version of instrument by which the IED was transposed into national legislation.

2.3 Guidance

2.3.1 Air emissions risk assessment for your environmental permit

The webpage provides Department for Environment, Food & Rural Affairs (Defra) and EA guidance on how to carry an air emissions risk assessment.[21] It includes guidance on the ecological receptors to be assessed, tests on significance on results, relevant air quality Limit Values (from the Ambient Air Directory), objectives from the National Air Quality Strategy and it lists short-term (hourly) and long-term (annual mean) EALs for human health.

2.3.2 Specified generators: dispersion modelling assessment

The webpage provides Defra and EA guidance on how to do detailed air quality modelling for specified generators. This includes the use environmental standards for air, the use of NOx to NO_2 conversion ratios, and guidance on impact assessment.

2.3.3 Technical guidance on detailed modelling approach for an appropriate assessment for emissions to air

This document (AQTAG06) provides guidance on how to carry out a quantitative assessment (Stage 3 appropriate assessment) including guidance on calculating deposition for emissions to air in order to fulfil the requirements of the Habitats Regulations.

2.3.4 Local Air Quality Management, Technical Guidance

This technical guidance (LAQM.TG16) is published to support local authorities in carrying out their duties under the Environment Act 1995, which established the LAQM process. It provides guidance on monitoring and assessing air quality, action planning and reporting. While aimed at local authorities the advice in used more widely by those working in the field, and not just for LAQM.

[19] Statutory Instrument, 2018 No. 129, Environmental Protection, The National Emission Ceilings Regulations 2018
[20] Defra (2019) Clean Air Strategy
[21] Environment Agency (EA) and Department for Environment, Food & Rural Affairs (Defra) Air emissions risk assessment for your environmental permit (last updated 21 May 2024) (https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit). Accessed December 2024.

3 Assessment Methodology

3.1 Introduction

The methodology comprised three parts which are described in more detail in Sections 3 to 5 and Appendix A:

1. Baseline conditions assessment at the Site and the surrounding area:
   - AQMAs and background concentration (Section 5).
2. Modelling
   - Assessment of the likely changes in concentration due to emissions from the sources listed in Table 1 and as shown in Figure 2 Figure 4 excluding the standby generator. Operation of the plant under normal operating conditions and abnormal operating conditions, the latter includes the operation of standby Boiler 4. The assessment was undertaken using the ADMS 6[3] dispersion model (section 3).
   - The modelling assessment included an assessment of the sensitivity of model results and hence, the impacts, to changes in model input.
3. Assessment of significance. Section 4 describes the assessment and significance criteria.

3.2 Modelling of air quality impacts

3.2.1 Model

The dispersion model used to predict ambient concentrations due to the stack emissions was ADMS 6 (version 6.0.0.1). The model is termed a 'new generation' model and is commonly used in the UK for industrial permit applications to the EA.

It requires as input: data on the source of emissions and the mass emission rates of each pollutant (

Table 4), meteorological data and associated parameters, buildings data, terrain data, and receptor locations. Full details of the meteorological, buildings and receptor data are described in Appendix A.

The outputs calculated by the model are the air concentrations of pollutants from the sources modelled for the relevant averaging times and statistics. The contribution from the modelled sources on the Site to air concentration is referred to the Process Contribution (PC), which is then compared with the relevant AQS. When background concentrations are added to the PC, the totals are referred to as Predicted Environmental Concentration (PEC), which have also been compared with the relevant AQS.

3.2.2 Model scenarios

Under normal operation Boiler 1, Boiler 2 and Boiler 3 operate almost continuously throughout the year. Abnormal operation refers to the case when one or more boilers are not operational and therefore standby Boiler 4 will be used to produce steam.

The modelled scenarios are: those which contribute to **long-term impacts** for comparison with long-term AQS (annual mean AQS in Table 5); and those which contribute to **short-term impacts** for comparison with short-term AQS (AQS with averaging times less than or equal to 24 hours in Table 3). They have considered both normal and abnormal operation.

As a conservative approach, long-term impacts have been calculated from an abnormal long-term scenario operation of Boiler 1, Boiler 2 and Boiler 3 operating continuously plus the long-term impact of 'back up' Boiler 4 operating 744 hours per year (8.5% of the time), equivalent to operating all year at 8.5% load.

Short-term impacts have been calculated from the worst case of a normal short-term operating scenario and an abnormal short-term operating scenario. The assessment pessimistically assumed that the sources modelled will operate simultaneously, at full load, all year and that their operation would coincide with all the worst-case meteorological conditions during the year.

- **Modelled Long-term Scenario:** all sources
  - Boiler 1, Boiler 2, Boiler 3 operating continuously, including the simultaneous operation of standby Boiler 4 (8,760 h per year = 100%)
- **Modelled Short-term Scenario: normal and abnormal operating scenarios**
  - **Normal**: Boiler 1, Boiler 2, Boiler 3 operating continuously
  - **Abnormal:** Boiler 1, Boiler 2, Boiler 4 operating continuously

3.2.3 Model options and sensitivity

Full results of the sensitivity tests are given in Appendix B.

The model was run for each of the five years of meteorological data (2019-2023) for three combinations of model options:

- Flat terrain: no buildings and no terrain (hills)
- Buildings: with buildings and no terrain (hills)

- Terrain (hills): with buildings

Modelling buildings led to slightly higher model predictions in general than for flat terrain; modelling terrain had a negligible impact on predicted concentrations.

Results at the receptors were calculated as the maximum value at each receptor from these 15 models runs and are therefore worst-case values across all five years and the three model options. Use of five years' meteorological data in the modelling is to account for intra-annual variation.

3.2.4 Sources and emissions

Boiler 1 and Boiler 2 produce steam used for heating, cleaning equipment and pasteurisation. The new CIP system will also use Boiler 1 and Boiler 2 once installed. Boiler 1 and Boiler 2 run concurrently, each alternating between a 'hire fire' and 'low fire' status respectively and operating almost continuously, approximately 8,400 hours per year, or 96% of the time, accounting for planned and unplanned maintenance. Boiler 2 is the only boiler that has an economiser (heat exchanger) fitted.

Boiler 3 is used for CIP Circuit 3 (i.e. the inside of lorries) and heating the on-site Office. Boiler 3 operates almost continuously, approximately 8,400 hours per year, or 96% of the time) accounting for planned and unplanned maintenance.

Standby Boiler 4 is only used for steam production for heating, cleaning equipment and pasteurisation during the servicing/ maintenance of the other boilers. As a conservative approach, it is assumed that Boiler 4 is used continuously for 1 month (31 days) annually, during servicing or inspection.

The emission sources and modelled operating profiles are summarised in Table 3.

Table 3 Emission sources and modelled operating profiles

Emission Point (Boiler/ Series)	Plant Manufacturer	Rating (MWthi	Operational profile (% Annual hours)	Modelled operational profile (% Annual hours)		
				Long-term scenario	Short-term scenario	Load (%)
A1 (Boiler 1/ YSY5000-25)	Dennis Baldwin & Sons	3.34	8,400 (96%)	8,760 (100%)	8,760 (100%)	100
A2 (Boiler 2/ YSY5000-79)	Byworth	3.33	8,400 (96%)	8,760 (100%)	8,760 (100%)	100
A3 (Boiler 3/ SXA1000-184)	Dennis Baldwin & Sons	0.72	8,400 (96%)	8,760 (100%)	N/A	100
A4 (Boiler 4/ AX2500)	ICI Caldaie	3.27	744 (8.5%)	744 (8.5%)	8,760 (100%)	100
Notes: All boilers are gas oil-fired (kerosene).						

Boiler 1 (emission point **A1**) (3.34MWthi) will be required to meet the MCPD ELVs for NOx for existing plant fired by gas oil (Annex II, Part 1, Table 1)[9] by 1 January 2030. There are no BAT-AELs for SO_2. Emissions test measurements are undertaken on all boilers for NOx and SO_2 using a Testo 340 instrument during periods when the burner status of each boiler is in 'low fire' and 'high fire' modes. The maximum measured concentration, where they exist, for each boiler has been used in the assessment irrespective of whether the burner status is 'low' or 'high':

- 200mg/Nm^3 for NOx (3% O_2), MCP ELV
- No limit set for SO_2; 4.0mg/m^3 (3% O_2), see Appendices C to E

Boiler 2 (emission point **A2**) (3.33MWthi) will meet the MCPD ELV for new plant fired by gas oil (Annex II, Part 2, Table 1).[9] There are no BAT-AELs for SO_2; monitored data has been used for these emissions:

- 200mg/Nm^3 for NOx (3% O_2), MCP ELV
- No limit set for SO_2; 27.6mg/m^3 (3% O_2), see Appendices F to H

Boiler 3 (emission point **A3**) (0.72MWthi) is not an MCP. Its operation is however a Directly Associated Activity – combustion to another Chapter II activity. For assessment purposes, the MCPD ELV for NOx for existing plant fired by gas oil (Annex II, Part 1, Table 1) are applied, together with monitored data for SO_2 and CO for the boiler:

- 200mg/Nm^3 for NOx (3% O_2), MCP ELV
- No limit set for SO_2; 6.08mg/m^3 (3% O_2), see Appendices I and J

Boiler 4 (emission point **A4**) (3.27MWthi) will be required to meet the MCPD ELVs for NOx for existing plant fired by gas oil (Annex II, Part 1, Table 1)[9] by 1 January 2030. For assessment purposes, monitored data was used for emissions of NOx (the measured value of which was greater than the ELV for existing plant fired on gas oil as per Annex II, Part 1, Table 1), SO_2 and CO:

- 236mg/Nm^3 for NOx (3% O_2), see Appendices K and L
- No limit set for SO_2; not monitored/ below detection limit. As a conservative approach, emissions were estimated as based on maximum SO_2 concentrations observed for any boiler at the Site (Boiler 2); 33.6mg/m^3 (3%O_2) see Appendices K and L

Table 4 provides details of the input parameters for the point source emissions.

Table 4 Boiler emission parameters

Parameter	Units	Boiler 1 [1]	Boiler 2 [2]	Boiler 3 [3]	Boiler 4 [4]
Location	Easting, Northing	346015, 107164	346002, 107175	345939, 107181	346002, 107189
Fuel	-	Gas oil	Gas oil	Gas oil	Gas oil
Economiser	-	No	Yes	No	No
Hours of operation	Hours/year	8,400 (96%)	8,400 (96%)	8,400 (96%)	744 (8.5%)
Electrical output	kWe	n/a	n/a	n/a	n/a
Thermal input	kWthi	3,340	3,330	720	3,266
Stack height	m	6	8.5	4.7	5.1
Internal diameter at exit	m	0.48	0.60	0.16	0.52
Volume flow rate (dry)	Nm^3/s	0.92	0.98	0.20	0.97
Volume flow rate (wet)	Am^3/s	2.25	2.17	0.55	2.30
Velocity	m/s	12.4	7.67	27.5	10.8
Temperature	°C	214	213	311	321
Exit concentration SO_2	mg/Nm^3	4.0 (Monitored, 3% O_2)	29.3 (Monitored, 3% O_2)	6.08 (Monitored, 3% O_2)	33.6 (Monitored, 3% O_2)
Exit concentration NOx	mg/Nm^3	200 (ELV, 3% O_2)	200 (ELV, 3% O_2)	200 (ELV, 3% O_2)	236 (Monitored, 3% O_2)
Emission rate SO_2	g/s	0.004	0.03	0.001	0.03 (0.003)
Emission rate NOx	g/s	0.18	0.22	0.04	0.23 (0.019)

Notes: n/a = not applicable

For each source the location, diameter, stack height and hours of operation were advised by Pattemore's or taken from site plans.

Emissions test measurements are undertaken using Testo 340 instrument during periods when the burner status of each boiler is in 'low fire' and 'high fire' modes. Where ELVs do not exist for a pollutant, the maximum measured pollutant concentration for each boiler has been used in the screening assessment irrespective of whether the burner status is 'low' or 'high'.

g/s values shown in brackets are the long-term emission rates considering the number of hours of operation per year of the boilers.

[1]Boiler 1: Average exhaust temperature at 'high fire' (214°C) and average actual O_2 % at 'high fire' (6.99%) content of the exhaust are derived from monitoring data (Appendix E). Actual H_2O content of the exhaust (5.8% H_2O) has been taken from monitoring data of similar plant at other sites.

[2]Boiler 2: Average exhaust temperature at 'high fire' (213°C) and average actual O_2 % at 'high fire' (5.67%) content of the exhaust are derived from monitoring data (Appendix G and Appendix H). Actual H_2O content of the exhaust (5.8% H_2O) has been taken from monitoring data of similar plant at other sites.

[3]Boiler 3: Average exhaust temperature at 'high fire' (311°C) and average actual O_2 % at 'high fire' (6.21%) content of the exhaust are derived from monitoring data (Appendix J). Actual H_2O content of the exhaust (5.8% H_2O) has been taken from monitoring data of similar plant at other sites.

[4]Boiler 4: Exhaust temperature at 'high fire' (321°C) and actual O_2 % at 'high fire' (3.47%) content of the exhaust are derived from monitoring data (Appendix K). Actual H_2O content of the exhaust (5.8% H_2O) has been taken from monitoring data of similar plant at other sites.

Emission rates in this table are shown are for continuous operation; for long-term impact it has been assumed that all boilers, including standby Boiler 4, will operate 100% of the time.

4 Assessment criteria

4.1 Air Quality Standards

European and national legislation, policy, and guidance, as described in Section 2, set various limit values, target values, objectives and environmental assessment levels (EALs) that may apply to human or ecological receptors. These will be collectively referred to throughout this report as AQS.

Annual mean AQS are an example of a long-term AQS, which is defined over a long period of time as the effects of the pollutant on human health or the environment are chronic, that is, due to long-term exposure. Pollutants may also have acute impacts, that is, the effects become apparent after short period of exposure to high values. For these pollutants short-term AQS are defined. Short-term AQS are for time periods of 24-hours or less (8 hours, 1 hour, 15 minutes), for example, a maximum 1-hour concentration that may not be exceeded, or a 15-minute concentration that may only be exceeded a specified number of times per year.

4.2 AQS for human health

Table 5 sets out the AQS for human health for the pollutants relevant to this assessment. The AQS apply where members of the public will be exposed for the relevant time period. Defra guidance states that the following are relevant receptors for long-term AQS: building facades of residential properties, care homes, hospitals and schools. A short-term AQS such as the 1-hour AQS would apply at all locations where longer period AQS apply plus public spaces where the public may spend one hour or more, such as footpaths, kerbside locations and car parks. Workplaces are not relevant receptors for the AQS[22] unless members of the public may be present for the relevant time period.

Table 5 Air Quality Standards for human health

Substance	Emission period	Limit (average)	Standard	Exceedances[1]
Nitrogen dioxide	1 hour	200µg/m^3	AAD Limit Value	Up to 18 1-hour periods
Nitrogen dioxide	Annual	40µg/m^3	AAD Limit Value	None
Sulphur dioxide	15 minutes	266µg/m^3	UK AQS Objective	Up to 35 15-minute periods
Sulphur dioxide	1 hour	350µg/m^3	AAD Limit Value	Up to 24 1-hour periods
Sulphur dioxide	24 hour	125µg/m^3	AAD Limit Value	Up to 3 24-hour periods
Notes: AQS taken from Defra/EA permit guidance[14] [1]number of times a year that you can exceed the limit				

[22] Department for Environment, Food and Rural Affairs (August 2022) Local Air Quality Management Technical Guidance (TG22).

4.2.1 Significance of results

The Defra/EA permit guidance[14] addresses when impacts can be considered insignificant. The guidance considers initial screening and then detailed modelling.

At the initial screening stage, a PC can be screened out from further assessment if:

- the short-term PC is less than 10% of the short-term environmental standard, and
- the long-term PC is less than 1% of the long-term environmental standard.

The second stage of screening considers the background concentration as well as the PC. The Predicted Environmental Concentration (PEC) is the sum of the PC and background concentration. A further assessment is not needed if:

- the short-term PC is less than 20% of the '**headroom**,' where headroom is defined as the short-term environmental standards minus twice the long-term background concentration, and
- the long-term PEC is less than 70% of the long-term environmental standards.

If the PC cannot be screened out on that basis, following detailed modelling, two tests are applied:

- the proposed emissions must comply with Best Available Techniques (BAT) associated emission levels (AELs) or the equivalent requirements where there is no BAT-AEL
- the resulting PECs will not exceed environmental standards.

If those tests are not satisfied it is necessary to consider whether: the PCs could cause the PEC to exceed an AQS; the PEC already exceeds an AQS; or the activity on site is not covered by a BAT reference document. Further action is not required if the following both apply:

- your proposed emissions comply with BAT-AELs or the equivalent requirements where there is no BAT-AEL
- the resulting PECs will not exceed environmental standards.

4.3 AQS for sensitive conservation sites

The Defra/Environment Agency guidance[14] specifies that SACs, SPAs and Ramsar site within 10km should be considered and SSSIs, AWs, LWSs, Local Nature Reserves and National Nature Reserves within 2km should also be considered.

There are no Sites of Special Scientific Interest (SSSI) within 2km of the Site. There are two SACs, within 10km of the Site that are also designated as SSSIs, the closest of which is Bracket's Coppice SAC coincident with Bracket's Coppice and Ryewater Farm SSSI, 4.5km east of the Site.

The EA Nature and Heritage Conservation Screening Reports provided in Appendix M, in addition to data obtained supplied by Somerset Ecological Records Centre (SERC) and Dorset Ecological Records Centre (DERC), confirmed the presence of 14 No. Local Wildlife Sites and SNCI within 2km of the Site, the closest of which is Newbridge Meadows SNCI (0.8km east).

Table 6 presents the sensitive conservation sites, receptors, and habitats in each area. AQS for concentrations of pollutants are referred to as critical levels (CLes) and those for deposition flux of nutrient nitrogen (NDep) and acid deposition due to nitrogen (N) and sulphur (S) (AcidDep) are referred to as critical loads (CLos).

In Table 7 the CLes for the pollutants relevant to this assessment for designated ecological site receptors are summarised, in Table 8 the CLos for NDep are given and in Table 9 the CLos for AcidDep. CLos for AcidDep vary with habitat and location.

Table 6 Sensitive conservation sites

Site	Designation	Receptors	Broad habitat(s) assessed
Bracket's Coppice SAC (Bracket's Coppice and Ryewater Farm SSSI)	SAC	E1(a), E1(b)	Broadleaved, mixed and yew woodland
			Fen, marsh and swamp
	SSSI	E1(a), E1(b)	Broadleaved, mixed and yew woodland
			Calcareous grassland
West Dorset Alder Woods	SAC	E2(a), E2(b)	Broadleaved, mixed and yew woodland
			Calcareous grassland
New Bridge Meadows	SNCI	E3	Calcareous grassland
Ten Acre Copse	SNCI	E4(a), E4(b)	Broadleaved woodland
Langmoor Lane	SNCI	E5(a), E5(b), E5(c)	Road verge
Hawkhems Copse Meadow	SNCI	E6	Broadleaved woodland; fen meadows/rush pasture
Picket Farm Copse	SNCI	E7	Broadleaved woodland
Ten Acre Field	LWS	E8	Purple moor-grass and rush-pasture with Lowland meadow.
Misterton Plantation	LWS	E9	Ancient broadleaved plantation with stream
Picket Plantation	SNCI	E10	Broadleaved & wet woodland
Crondle Hill Plantation	LWS	E11	Ancient semi-natural broadleaved woodland lining a stream
Kithill	LWS	E12(a), E12(b)	Complex of semi-natural broadleaved woodland, scrub, unimproved calcareous, neutral and marshy grassland
Cathole Bridge Meadow	LWS	E13	Unimproved calcareous grassland, stream, scrub and marshy area with areas of semi-improved calcareous grassland
Crondle Hill Coppice	LWS	E14	Ancient semi-natural broadleaved woodland, conifer plantation and unimproved calcareous grassland
River Parrett	LWS	E15	Section of river with species rich bank flora and important fauna populations
Crondle Hill Field	LWS	E16	Unimproved neutral grassland
Information supplied by: EA Nature and Heritage Conservation Screening Reports provided in Appendix M, Somerset Ecological Records Centre and Dorset Ecological Records Centre.			

Table 7 Environmental standards for protected conservation areas

Substance	Target	Emission period
Sulphur dioxide[1]	10 µg/m^3 where lichens or bryophytes are present. 20 µg/m^3 where they are not present	Annual
Nitrogen oxide (expressed as nitrogen dioxide)[2]	30 µg/m^3	Annual
Nitrogen oxide (expressed as nitrogen dioxide)[3]	75 µg/m^3 200 µg/m^3 for detailed assessments where the ozone is below the AOT40 critical level[4,5] and sulphur dioxide is below the lower critical level of 10 µg/m^3	Daily
Nutrient nitrogen deposition	Depends on location, use www.apis.ac.uk[23]	Annual
Acidity deposition	Depends on location, use www.apis.ac.uk	Annual

Notes: Environmental standards taken from https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

[1]20 µg/m^3 is an AAD Limit Value if you have nature or conservation sites in the area.

[2]30 µg/m^3 is an AAD Limit Value

[3]The lower (stricter) value of 75 µg/m^3 has been used throughout this assessment.

[4]The sum of difference between hourly ozone concentration and 40ppb for each hour when the concentration exceeds 40ppb during a relevant growing season (May to July) averaged over five years Available at: AOT40 — European Environment Agency (europa.eu) [Accessed 11 November 2024].

[5]AOT40 is calculated from accumulated hourly ozone concentrations. The long-term crucial level is of 6000µg/m^3. AOT40 at the Site exceeds the critical level so this AQS is not applicable.

Table 8 shows whether sites were modelled as grass or forest for the calculation of deposition flux.

[23] UK Air Pollution Information System (APIS) (http://www.apis.ac.uk/) Accessed December 2024.

Table 8 Nutrient nitrogen deposition critical loads

ID	Site	Nitrogen critical load class	Critical load (kg/ha/yr)	Forest / Grass
E1a, E1b	Bracket's Coppice SAC	Broadleaved deciduous woodland Moist or wet mesotrophic to eutrophic hay meadow	10 – 15 15 - 25	Forest Grass
E1a, E1b	Bracket's Coppice and Ryewater Farm SSSI	Carpinus and Quercus mesic deciduous forest Non-mediterranean dry acid and neutral closed grassland	15 – 20 6 - 10	Forest Grass
E2a, E2b	West Dorset Alder Woods SAC	Acidophilous Quercus forest Euphydryas (Eurodryas, Hypodryas) aurinia	10 – 15 6 - 10	Forest Grass
E3	New Bridge Meadows	Arctic-alpine calcareous grassland	5 – 10	Forest
E4a, E4b	Ten Acre Copse	Broadleaved deciduous woodland	10 – 15	Forest
E5	Langmoor Lane	Low and medium altitude hay meadows	10 – 20	Grass
E6	Hawkhems Copse Meadow	Broadleaved deciduous woodland	10 – 15	Forest
E7	Picket Farm Copse	Broadleaved deciduous woodland	10 – 15	Forest
E8	Ten Acre Field	Temperate and boreal moist and wet oligotrophic grasslands	10 – 20	Grass
E9	Misterton Plantation	Broadleaved deciduous woodland	10 – 15	Grass
E10	Picket Plantation	Broadleaved deciduous woodland	10 – 15	Grass
E11	Crondle Hill Plantation	Broadleaved deciduous woodland	10 – 15	Forest
E12	Kithill	Broadleaved deciduous woodland	10 – 15	Forest
E13	Cathole Bridge Meadow	Arctic-alpine calcareous grassland	5 – 10	Grass
E14	Crondle Hill Coppice	Broadleaved deciduous woodland	10 – 15	Forest
E15	River Parrett	Low and medium altitude hay meadows	10 – 20	Forest
E16	Crondle Hill Field	Low and medium altitude hay meadows	10 – 20	Forest
Note: Values from www.apis.ac.uk				

Table 9 Acid deposition critical loads

ID	Site	Forest / Grass	Acidity critical load class (feature)	Critical loads (keq/ha/yr)
E1a, E1b	Bracket's Coppice SAC	Forest	Unmanaged Broadleafed/Coniferous Woodland (Myotis bechsteini)	CLmaxS: 2.535 CLminN: 0.357 CLmaxN: 2.892
		Grass	Not sensitive	None listed
E1a, E1b	Bracket's Coppice and Ryewater Farm SSSI	Forest	Unmanaged Broadleafed/Coniferous Woodland (Fraxinus Excelsior - Sorbus Aucuparia - Mercurialis Perennis Woodland)	CLmaxS: 2.535 CLminN: 0.357 CLmaxN: 2.892
		Grass	Calcareous grassland (using base cation) (Eurodryas aurinia)	CLmaxS: 4 CLminN: 1.071 CLmaxN: 5.071
E2a, E2b	West Dorset Alder Woods SAC	Forest	Unmanaged Broadleafed/Coniferous Woodland (Old acidophilous oak woods with Quercus robur on sandy plains)	CLmaxS: 0.805 CLminN: 0.142 CLmaxN: 1.162
		Grass	Calcareous grassland (using base cation) (Euphydryas (Eurodryas, Hypodryas) aurinia)	CLmaxS: 4 CLminN: 0.856 CLmaxN: 4.856
E3	New Bridge Meadows	Grass	Calcareous grassland (using base cation)	CLmaxS: 4 CLminN: 0.856 CLmaxN: 4.856
E4a, E4b	Ten Acre Copse	Forest	Broadleafed/Coniferous unmanaged woodland	E4(a) CLmaxS: 2.783 CLminN: 0.357 CLmaxN: 3.14 E4(b) CLmaxS: 1.226 CLminN: 0.142 CLmaxN: 1.368
E5	Langmoor Lane	Grass	Calcareous grassland (using base cation)	CLmaxS: 4 CLminN: 1.071 CLmaxN: 5.071
E6	Hawkhems Copse Meadow	Forest	Broadleafed/Coniferous unmanaged woodland	CLmaxS: 2.783 CLminN: 0.357 CLmaxN: 3.14
E7	Picket Farm Copse	Forest	Broadleafed/Coniferous unmanaged woodland	CLmaxS: 1.246 CLminN: 0.142 CLmaxN: 1.388
E8	Ten Acre Field	Grass	Acid grassland	CLmaxS: 0.49 CLminN: 0.223 CLmaxN: 0.713
E9	Misterton Plantation	Forest	Broadleafed/Coniferous unmanaged woodland	CLmaxS: 1.226 CLminN: 0.142 CLmaxN: 1.368
E10	Picket Plantation	Forest	Broadleafed/Coniferous unmanaged woodland	CLmaxS: 1.246 CLminN: 0.142 CLmaxN: 1.388
E11	Crondle Hill Plantation	Forest	Broadleafed/Coniferous unmanaged woodland	CLmaxS: 2.759 CLminN: 0.357 CLmaxN: 3.116
E12	Kithill	Forest	Broadleafed/Coniferous unmanaged woodland	CLmaxS: 2.742 CLminN: 0.142 CLmaxN: 2.884
E13	Cathole Bridge Meadow	Grass	Calcareous grassland (using base cation)	CLmaxS: 4 CLminN: 0.856 CLmaxN: 4.856
E14	Crondle Hill Coppice	Forest	Broadleafed/Coniferous unmanaged woodland	CLmaxS: 2.759 CLminN: 0.357 CLmaxN: 3.116
E15	River Parrett	Grass	Calcareous grassland (using base cation)	CLmaxS: 4 CLminN: 1.071 CLmaxN: 5.071
E16	Crondle Hill Field	Grass	Calcareous grassland (using base cation)	CLmaxS: 4 CLminN: 1.071 CLmaxN: 5.071
Note: Values from www.apis.ac.uk				

4.3.1 Significance of results

For nationally designated sites (Bracket's Coppice SAC/ Bracket's Coppice SSSI and West Dorset Alder Woods SAC) tests on significance are the same as for human receptors (as given in section 4) with the exception that PC as a percentage of Headroom is not assessed for short-term impacts (daily NOx).

For locally designated sites such as LWS and SNCIs, impacts can be screened out as insignificant if the short-term and long-term PCs are less than 100% of the relevant AQS.

5 Background concentrations

5.1 Local authority air quality monitoring

On 1st April 2023, South Somerset District Council was replaced by a new unitary district for the area known as Somerset Council (SC).

Non-automatic (passive) monitoring of NO_2 using diffusion tubes is undertaken by SC at 20 locations in 2022 all of which were within the Yeovil Air Quality Management Area (AQMA), which includes the whole of the built-up area of Yeovil, the airfield and the main road network in and around the town.[24] The main source of NO_2 pollution is road traffic emissions from the A37 and A30; the main routes into and through Yeovil. There are also two automatic monitors within Yeovil. Yeovil AQMA is located approximately 10km northeast of the Site. All the monitoring locations were either roadside or urban background monitoring locations and therefore would not be representative of background concentrations around the Site.

There is an Automatic Urban and Rural Network (AURN) national monitoring site located in Charlton Mackrell (X, Y: 352196, 128768), a rural background monitoring location for NO_2 and Ozone (O_3). The monitoring site is situated 22.5km to the north northeast of the Site; in 2022 it measured an annual average of NO_2 concentration of 4.9µg/m^3.

5.2 Defra modelled background concentrations

Defra provides maps of 2024 background concentrations of NOx and NO_2 that have been projected from a base year of 2021, and SO_2 for 2001. The maps and factors have been used to determine 2024 background concentrations at each of the human receptors which are shown in Table 10.

The 2024 Defra spatially varying background concentrations of NO_2 (3.7 – 4.5µg/m^3) are slightly lower than the 2022 rural background concentration of 4.9µg/m^3 in Charlton Mackrell. The rural NO_2 background concentration monitored at Charlton Mackrell is consistent with the Defra background concentrations and therefore for NO_2 and SO_2 the Defra background data given in Table 10 is applied.

[24] Somerset Council, 2023 LAQM Annual Status Report (ASR), March 2024

Table 10 2024 Annual mean background concentrations (µg/m^3)

ID	Annual mean concentration (µg/m^3)		
	NOx	NO_2	SO_2
R1	5.1	4.1	1.9
R2	5.1	4.1	1.9
R3	5.1	4.1	1.9
R4	5.1	4.1	1.9
R5	4.6	3.7	1.9
R6	4.6	3.7	1.9
R7	5.1	4.1	1.9
R8	5.6	4.5	2.1
R9	5.1	4.1	1.9
R10	4.6	3.7	1.9
R11	4.8	3.9	1.7

5.3 Background concentration and deposition at sensitive conservation sites

Background concentrations of NOx, SO_2 and deposition of NDep at all the ecological receptors have been obtained from APIS maps which provide the data on a 1 km grid cell basis (Table 11). The NDep values depend on whether the habitat is forest (woodland) or grass (moorland) as deposition rates vary according to the nature of the vegetation.

Table 8 shows which receptors have been modelled as forest and which as grass. The background values are the latest available and are an average for the years 2020-2022 and are shown in Table 11.

Table 11 Background concentrations and deposition at ecological receptors

Receptor ID	NOx (µg/m³)	SO_2 (µg/m³)	NDep Forest (kgN/ha/yr)	NDep Grass (kgN/ha/yr)	AcidSDep (keqS/ha/yr)	AcidNDep (keqN/ha/yr)
E1(a)	5.60	0.60	30.8	17.3	0.16	2.20
E1(b)	5.60	0.60	30.2	16.9	0.16	2.16
E2 (a)	5.20	0.50	28.6	16.0	0.15	2.04
E2(b)	5.30	0.50	30.4	17.5	0.18	2.17
E3	6.08	0.73	/	18.0	0.12	1.29
E4(a)	6.00	0.72	32.2	/	0.17	2.30
E4(b)	5.91	0.82	32.2	/	0.17	2.30
E5(a)	5.83	0.69	/	18.0	0.12	1.28
E5(b)	5.89	0.72	/	17.9	0.12	1.28
E5(c)	5.83	0.69	/	18.0	0.12	1.28
E6	5.89	0.72	32.0	/	0.16	2.29
E7	5.74	0.68	31.9	/	0.16	2.28
E8	5.91	0.82	/	18.1	0.12	1.29
E9	5.91	0.82	32.2	/	0.17	2.30
E10	5.74	0.68	31.9	/	0.16	2.28
E11	5.98	0.72	32.7	/	0.16	2.34
E12(a)	6.65	1.27	32.4	/	0.17	2.31
E12(b)	6.65	1.27	32.4	/	0.17	2.31
E13	6.65	1.27	/	18.1	0.13	1.29
E14	5.98	0.72	32.7	/	0.16	2.34
E15	6.25	0.83	/	18.1	0.12	1.30
E16	5.98	0.72	/	18.2	0.12	1.30
Source: APIS (2020 – 2022)						

6 Impact assessment results

Section 6.1 presents the long-term results of operational impacts of emissions on human health, Section 6.2 presents the short-term impact. Predicted impacts of each pollutant at each human receptor are given in Appendix N. In this section the highest results are presented, that is, the impacts at the worst-case receptor. Impacts have been compared to the screening thresholds given in Section 4.2. Table 12 shows the maximum annual mean (long-term) concentration and Table 13 shows the maximum predicted short-term impacts, from averaging times of 15 minutes to 24 hours. The predicted concentrations have been compared with the relevant AQS.

6.1 Long-term AQS

Maximum long-term impacts for NO_2 are predicted at the nearest residential receptor, R1, Owls Barton, the boundary of which lies 100m to the northwest of the Site boundary. NO_2 PC/AQS exceeds the first screening threshold of 1%; PEC/AQS is much less than the screening threshold of 70% described in Section 4.2. The long-term impacts can therefore be screened out as **not significant** and there is no need for further assessment.

Table 12 Results, long-term AQS

Pollutant	AQS (µg/m³)	PC (µg/m³)	PC/AQS (%)	PEC (µg/m³)	PEC/AQS (%)	Receptor
NO_2	40	0.66	**1.7**	4.8	12	R1
Notes: bold font indicates an exceedance of the screening threshold. Data on each row is for one receptor, the receptor at which the percentage of PC/AQS is greatest.						

6.2 Short-term AQS

The maximum short-term concentrations for each AQS, are given in Table 13. Maximum short-term impacts for all pollutants are predicted at receptor R1, Owls Barton, the boundary of which lies 100m to the northwest of the Site boundary. For all the pollutants, PC/AQS does not exceed the screening threshold of 10%. Short-term impacts can therefore be screened out as **not significant** and there is no need for further assessment.

Table 13 Results, short-term AQS

Pollutant	Statistic	AQS (µg/m³)	PC (µg/m³)	PC/AQS (%)	Headroom (µg/m³)	PC/ Headroom (%)	PEC/ AQS (%)	Receptor
NO_2	99.79th 1h	200	11	5.7	192	6.0	10	R1
SO_2	99.9th 15min	266	4.5	1.7	262	1.7	3.1	R1
SO_2	99.73rd 1h	350	3.6	0.01	346	1.0	2.1	R1
SO_2	99.18th 24h	125	1.9	1.5	121	1.6	4.5	R1
Notes: *Maximum daily 8h running. Bold font indicates an exceedance of the screening threshold. Data on each row is for one receptor, the receptor at which the percentage of PC/AQS is greatest.								

7 Impact assessment of air quality on ecological receptors

Predicted impacts of each pollutant at each ecological receptor are given in Appendix O. In this section the highest results are presented, that is, the impacts at the worst-case receptor across all meteorological years, and the worst with and without buildings and terrain. Impacts have been compared to the screening thresholds given in Section 4.

7.1 Nationally designated sites

Considering the closest area of the nationally designated site, represented as receptor E1(a), Bracket's Coppice SAC/ SSSI, Table 14 shows that the predicted long-term and short-term concentration PCs are below the respective 1% and 10% screening thresholds; Table 16 and Table 17 show that the predicted contributions to NDep and AcidDep are below 1%.

Impacts at E1(a), Bracket's Coppice SAC/ SSSI can therefore be screened out as **not significant**.

7.2 Locally designated sites

Considering the locally designated sites, LWSs and SNCI, Table 15 shows that predicted PCs do not exceed any of the screening thresholds (section 4.3). Maximum long-term and short-term concentrations were predicted at E3 representative of New Bridge Meadows SNCI.

Table 16 and Table 17 show that the maximum impacts are predicted at E3 New Bridge Meadows SNCI. Predicted contributions to NDep and AcidNDep are less than 100% of the relevant Clos.

Impacts at LWSs and SNCIs can therefore be screened out as **not significant**.

Table 14 Results at SAC/ SSSI, long-term and short-term AQS, worst case impact

Pollutant	AQS (µg/m^3)	Averaging time	Statistic	LT or ST AQS*	PC (µg/m^3)	PC/AQS (%)	PEC (µg/m^3)	PEC/AQS (%)	Receptor
NOx	30	Annual	mean	LT	0.03	0.11	5.6	19	E1(a)
SO_2	20	Annual	mean	LT	0.003	0.01	0.6	3.0	E1(a)
SO_2	10	Annual	mean	LT	0.003	0.03	0.6	6.0	E1(a)
Pollutant	**AQS (µg/m^3)**	**Averaging time**	**Statistic**	**LT or ST AQS***	**PC (µg/m^3)**	**PC/AQS (%)**	**PEC (µg/m^3)**	**PEC/ AQS (%)**	**Receptor**
NOx	75	24-hour	100th percentile	ST	0.61	0.81			E1(a)
Notes: *LT= long-term, ST = short-term; Bold font indicates an exceedance of the screening threshold (long-term PC/AQS = 1%, short-term PC/AQS = 10%). Data on each row is for one receptor, the receptor at which the percentage of PC/AQS is greatest.									

Table 15 Results at LWS and SNICs - long-term and short-term AQS, worst case impact

Pollutant	AQS (µg/m^3)	Averaging time	Statistic	LT or ST AQS*	PC (µg/m^3)	PC/AQS (%)	Receptor
NOx	30	Annual	mean	LT	0.36	1.18	E3
SO_2	20	Annual	mean	LT	0.03	0.15	E3
SO_2	10	Annual	mean	LT	0.03	0.30	E3
Pollutant	**AQS (µg/m^3)**	**Averaging time**	**Statistic**	**LT or ST AQS***	**PC (µg/m^3)**	**PC/AQS (%)**	**Receptor**
NOx	75	24-hour	100th percentile	ST	6.39	8.52	E3
Notes: *LT= long-term, ST = short-term; Bold font indicates an exceedance of the screening threshold (long and short-term PC/AQS = 100%). Data on each row is for one receptor, the receptor at which the percentage of PC/AQS is greatest.							

Table 16 Worst-case nutrient nitrogen deposition

Habitat	PC (kg/ha/y)	CLomin (ka/ha/y)	CLomax (ka/ha/y)	PC/CLomin (%)	PC/CLomax (%)	PEDR/CLomin (%)	PEDR/CLomax (%)	Receptor
SAC	0.006	10	15	0.06	0.04	308	205	E1(a)
LWS, SNIC	0.036	5	10	0.72	0.36	361	181	E3
Notes: Bold font indicates an exceedance of the screening threshold; data on each row is for one receptor, the receptor at which the percentage of PC/CLo is greatest.								

Table 17 Worst-case acid deposition

Habitat	PC_N (keqN/ha/yr)	PC_S (keqN/ha/yr)	PC/CLo (%)	Background/CLo (%)	PEDR/CLo (%)	Receptor
SAC[1]	0.0005	0.0006	0.0	81.6	81.6	E1(a)
LWS, SNIC	0.0026	0.0036	0.2	29.0	29.2	E3
Notes: Bold font indicates an exceedance of the screening threshold; data on each row is for one receptor, the receptor at which the percentage of PC/CLo is greatest. [1] %PC of minimum critical load determined using the Critical Load Function tool, available at www.apis.co.uk.						

8 Conclusion

This AQIA has been prepared to support an application for a bespoke installation permit at Pattemore's Dairy site, Mosterton Road, Misterton, Crewkerne, Somerset, TA18 8NT, operated by Pattemore's Transport (Crewkerne) Limited.

An H1 risk assessment[2] concluded that the following pollutants and averaging time required detailed modelling for comparison with the following EALs or AQS:

- Sulphur Dioxide (15-min mean)
- Sulphur Dioxide (24-hour mean)
- Nitrogen Dioxide (annual and 1-hour mean)
- Nitrogen Dioxide (ecological – annual mean and daily mean)

Baseline background concentrations have been established.

Detailed modelling of emissions from the 3No. gas oil boilers (Boiler 1, Boiler 2, Boiler 3) and the standby gas-oil boiler (Boiler 4) has been carried out using the ADMS 6 dispersion model and numerical modelled meteorological data for the Site location. Conservative assumptions have been made throughout the assessment, for instance using the worst-case results from 15 model runs (meteorological data years, modelling with and without buildings and with and without terrain).

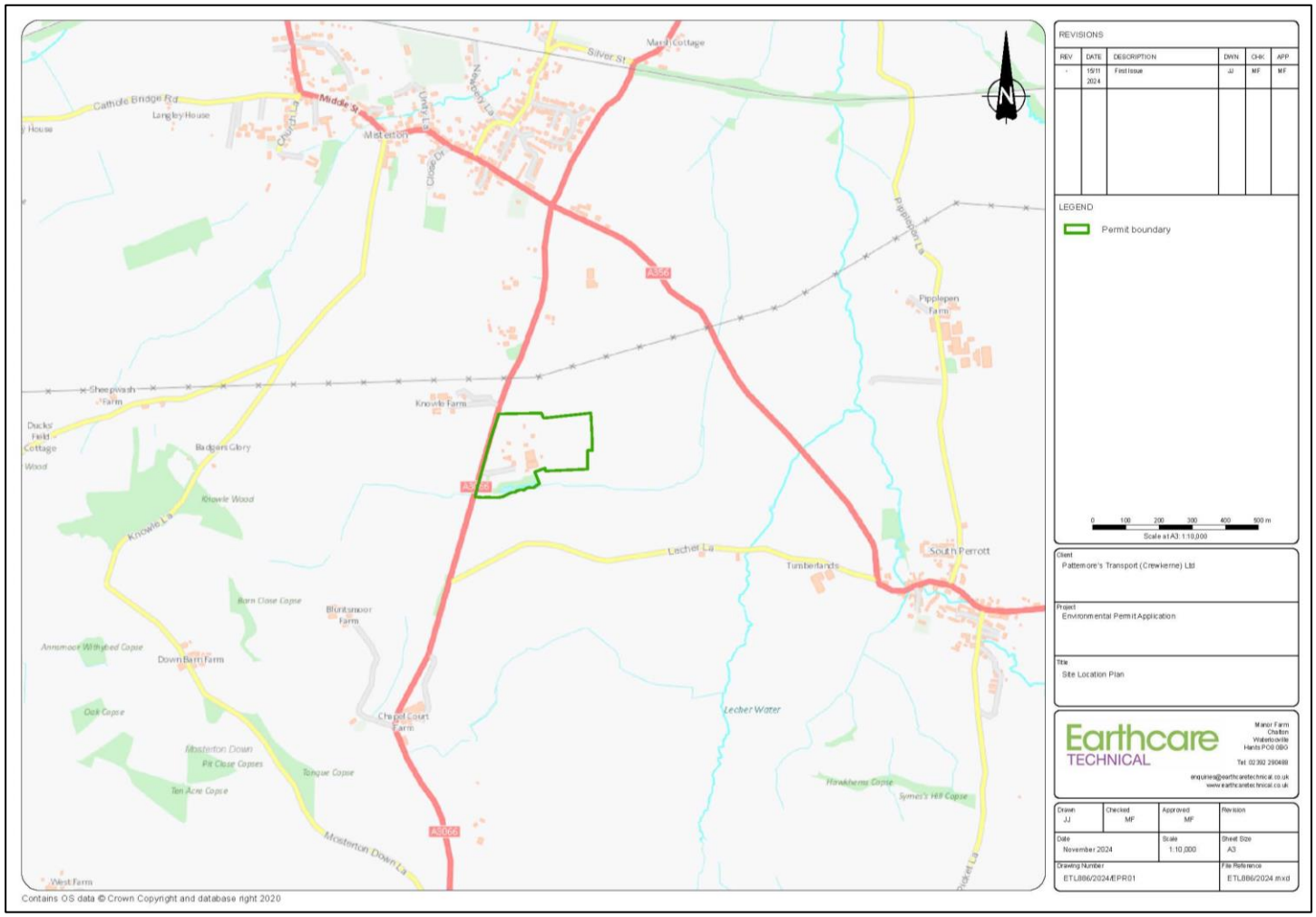
Three modelling scenarios were considered for the assessment of long and short-term impacts respectively. Short-term impacts were calculated based on either a normal short-term operating scenario; Boiler 1, Boiler 2, Boiler 3 operating continuously, or an abnormal short-term operating scenario; Boiler 1, Boiler 2, Boiler 4 operating continuously at full load, all year.

This is a conservative approach as it assumes that all boilers may be operating at full load during all the worst-case meteorological conditions, whereas the boilers are expected to operate for no more than 96% of the year, and Boiler 4 no more than 8.5% and therefore their infrequent hours of operation are unlikely to coincide with all the worst-case conditions.

The long-term and short-term impacts at all receptors can be screened out as **not significant** and there is no need for further assessment.

Figures

Figure 1 Site location



Legend

Permit boundary

Figure 2 Emissions point and permit boundary plan

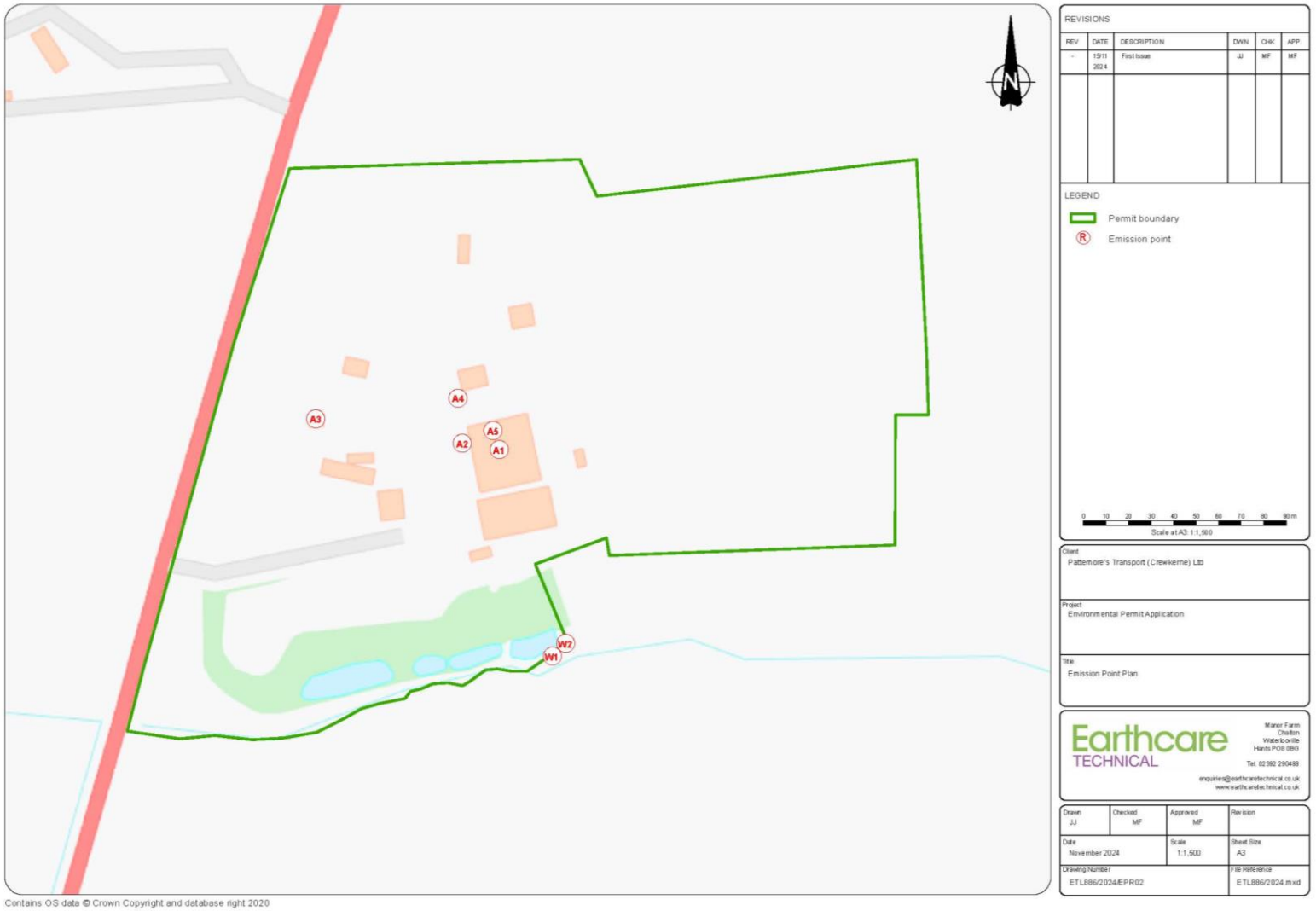
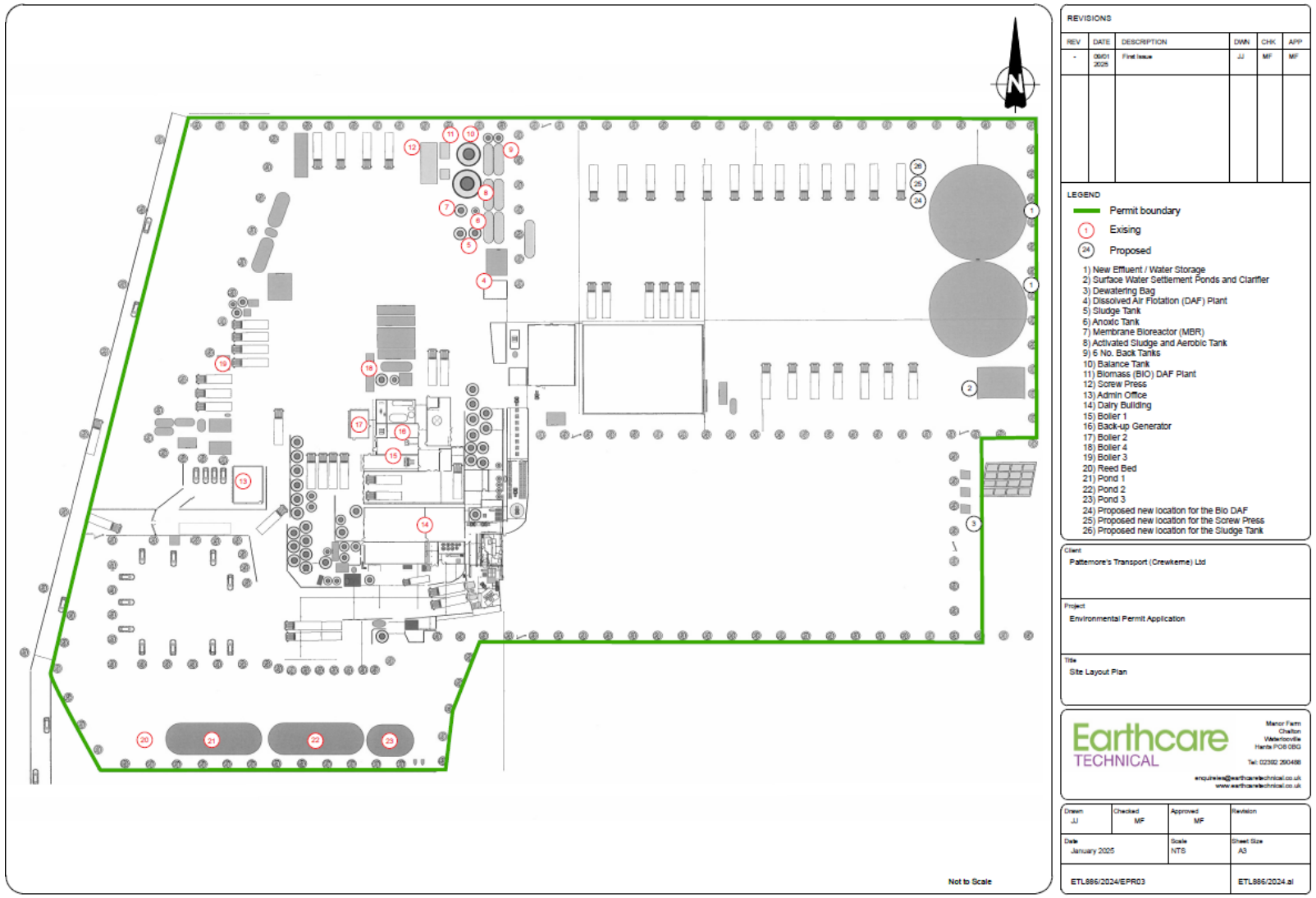


Figure 3 Site layout schematic

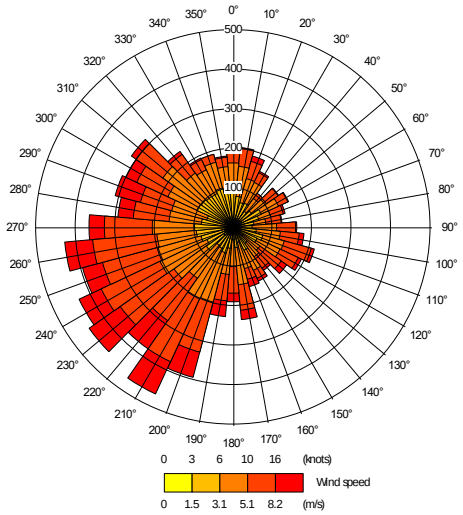
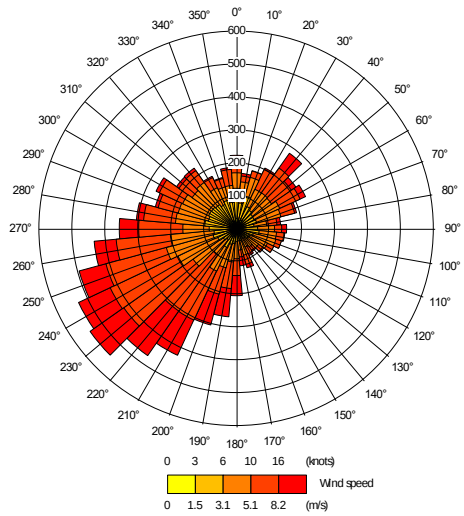
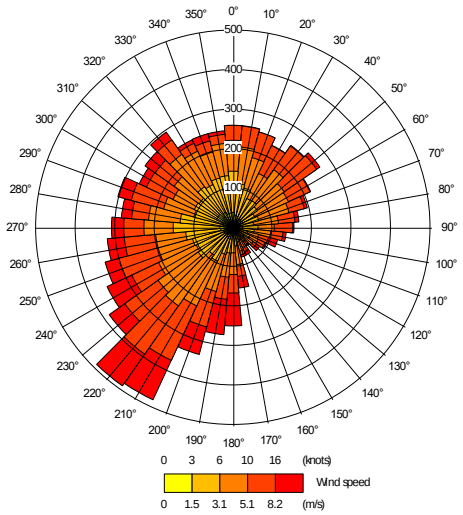
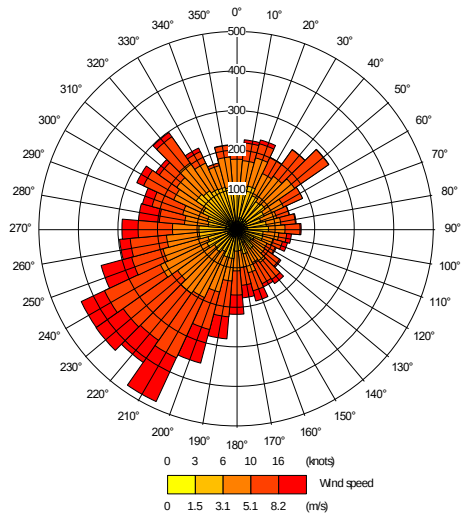
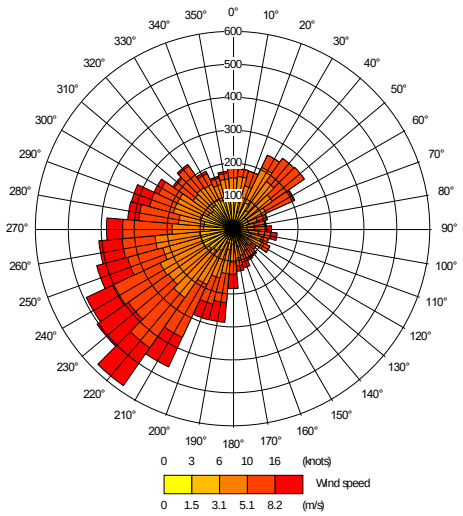
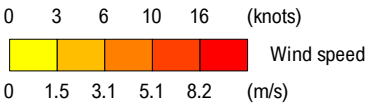


Background image taken from 'Pattemores Transport Limited, Pattemores Site Layout Plan' (November 2024)

Figure 4 Modelled point sources

Background image: ©Bluesky International Limited

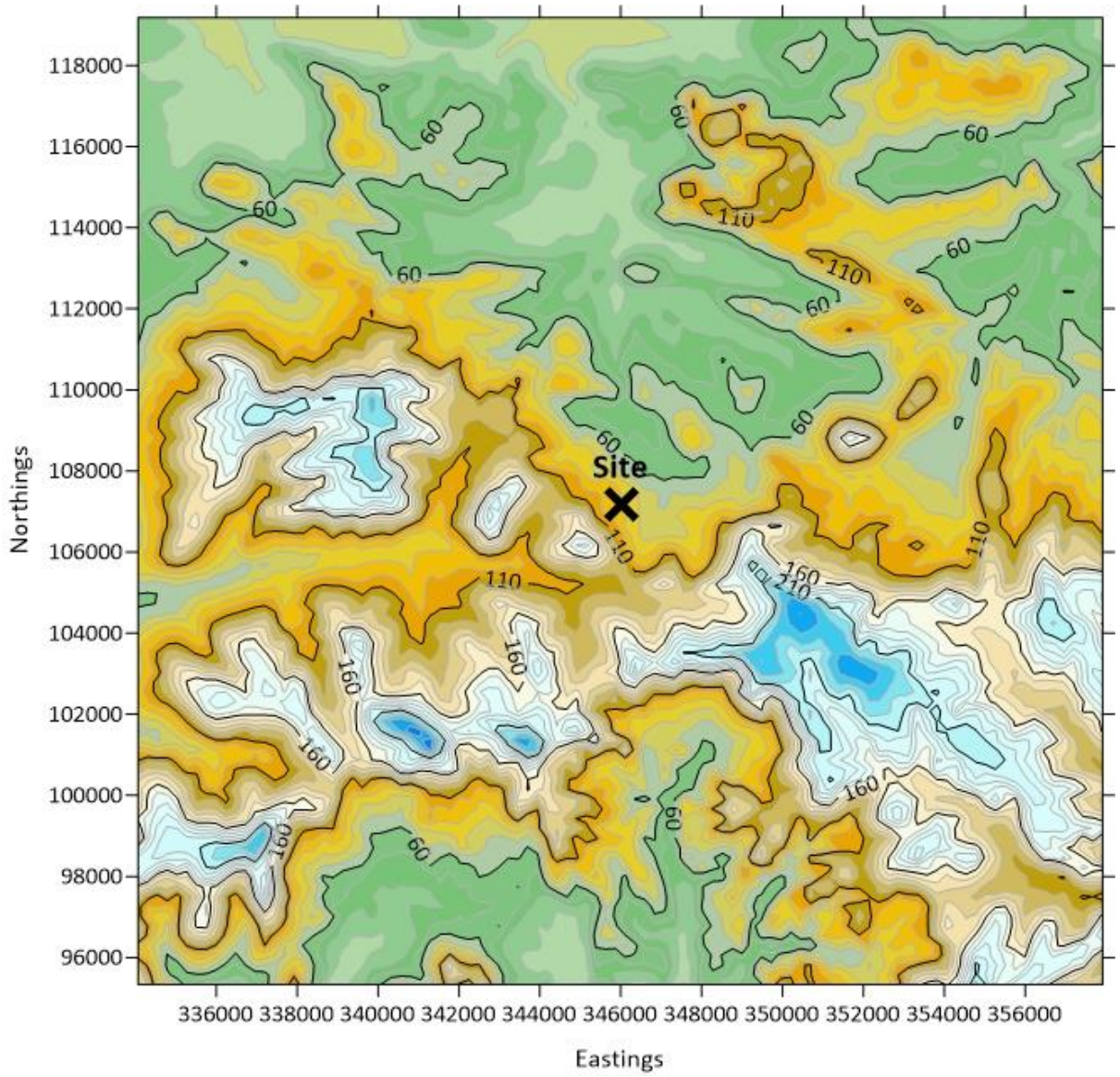
Figure 5 GFS meteorological data (50.861°, -2.767°) windroses 2019-2023

2019	2020
	
2021	**2022**
	
2023	**Legend**
	

Data source: AS Modelling & Data

Figure 6 Modelled buildings

Figure 7 Terrain data



Elevation (m)

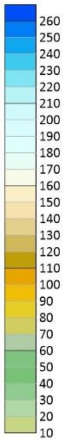
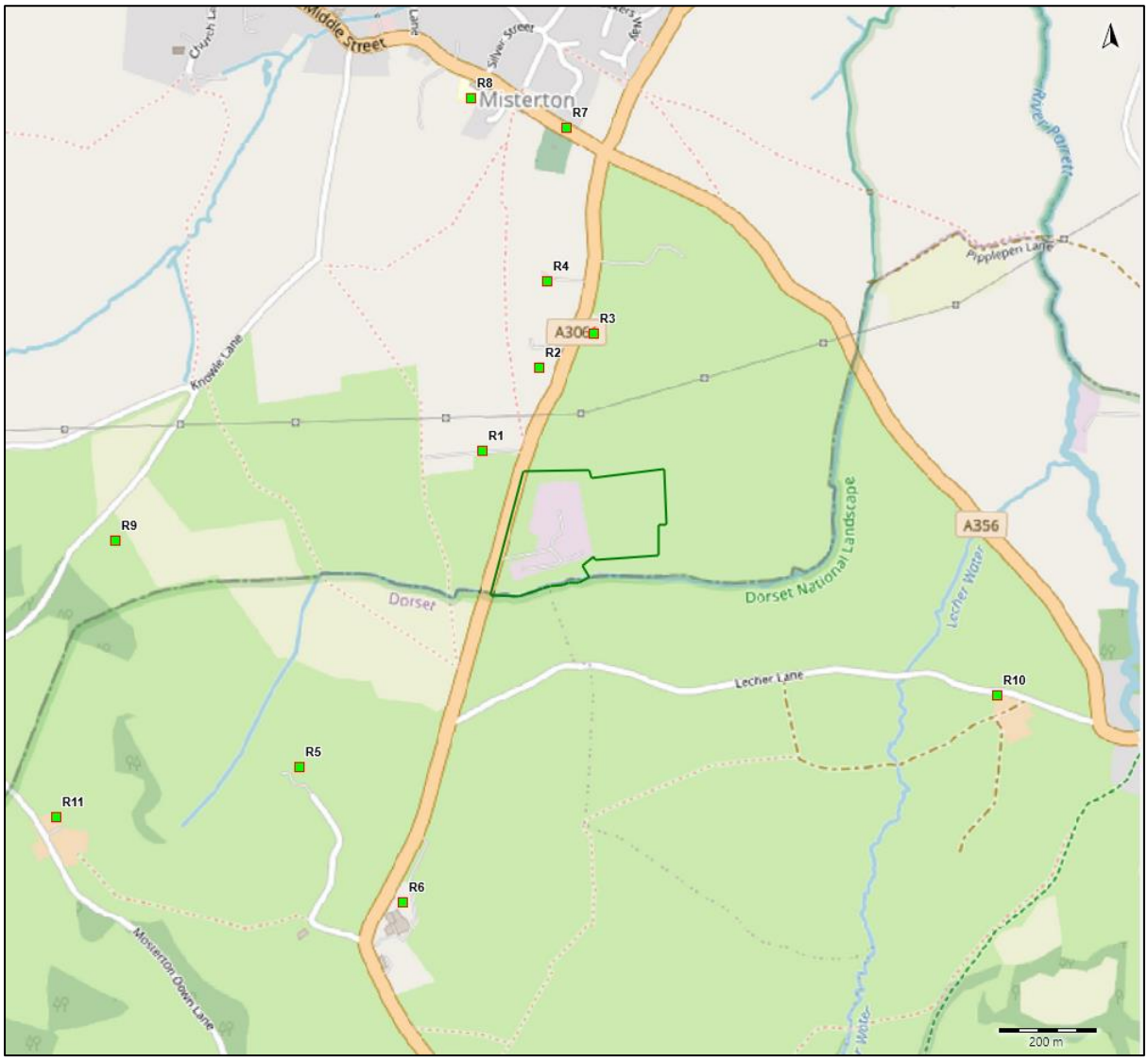


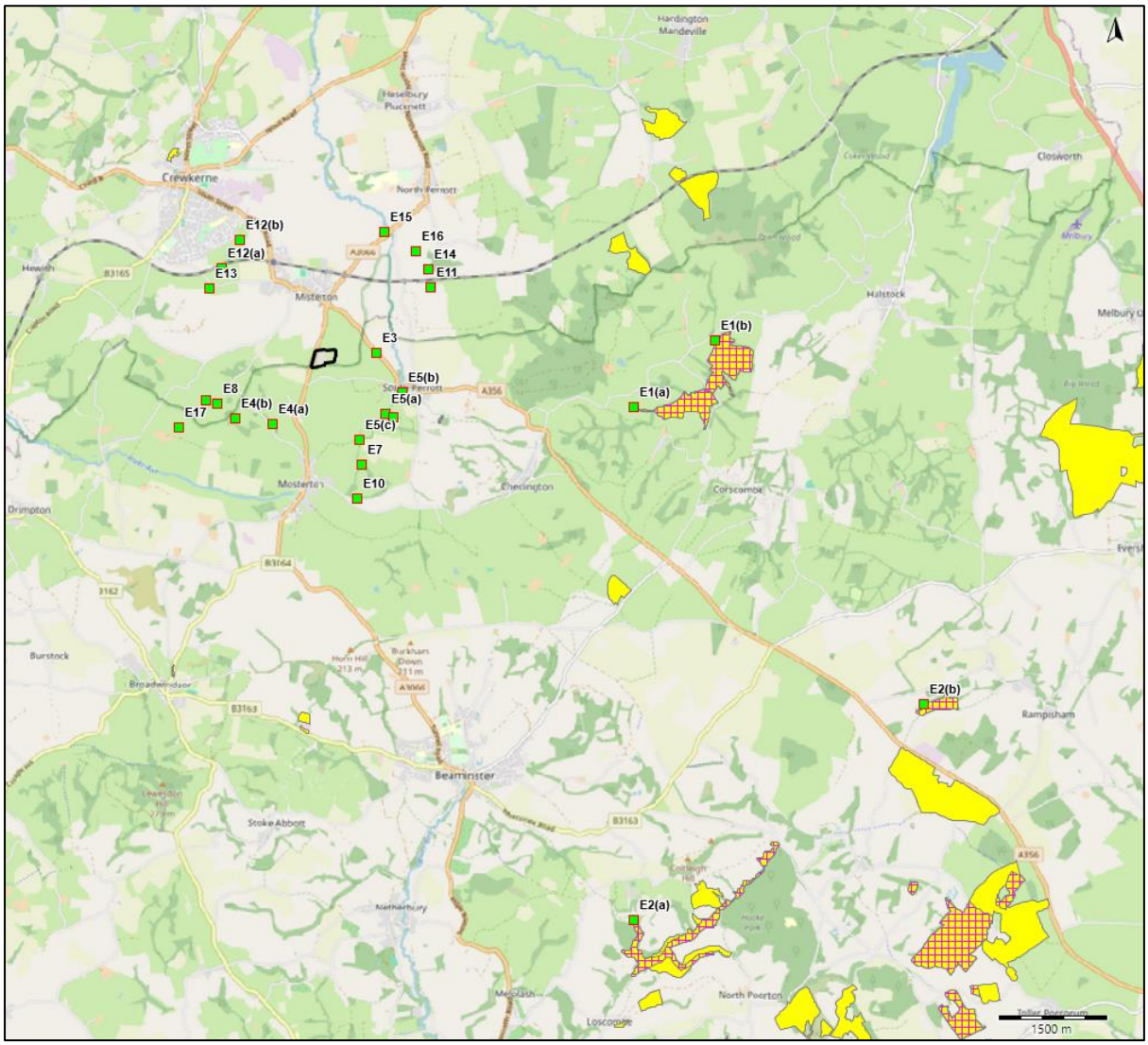
Figure 8 Modelled human receptors



Legend

Human receptors

Figure 9 Modelled ecological receptors



Background image ©OpenStreetMap contributors www.openstreetmap.org/copyright

Legend

Ecological Receptor (23)

Special_Areas_of_Conservation_England

Sites_of_Special_Scientific_Interest_England

Appendix A Model and model set-up

A.1 Meteorology and associated parameters

A.1.1 Hourly meteorological data

The model uses hourly data of surface meteorology parameters that are typically measured at a synoptic station or are generated by a numerical model. In this assessment, five years' meteorological data were obtained for the period 2019-2023 for the area surrounding the Site location (Latitude 50.861°, Longitude -2.767°), from a Numerical Weather Prediction system known as the Global Forecast System (GFS).

The GFS is a spectral model and data are archived at a horizontal resolution of 0.5 degrees longitude, or approximately 50 km over the UK (latterly 0.25 degrees, or approximately 25km). The GFS resolution captures major topographical features and the broad-scale characteristics of the weather over the UK. The use of NWP data has advantages over traditional meteorological records as:

- Calm periods in traditional records may be over-represented.
- Traditional records may include local deviations from the broad-scale wind flow that would not necessarily be representative of the site being modelled
- Information on the state of the atmosphere above ground level which would otherwise be estimated by the meteorological pre-processor may be included explicitly.

Figure 5 shows windroses for each year of data. The prevailing wind direction is southwesterly. The data were used with the dispersion model's calms option with default values. Table 18 shows the number of lines of usable data each year with and without calms option. With the calms options 100% of data each year was usable.

Defra's LAQM TG16[17] contains cautionary guidance on use of data with less than 85% usable data in calculating for comparison with short-term AQS. The minimum values of usable data were far above this threshold.

Table 18 Meteorological station data for calm conditions

Year of data	Number of hours with calm conditions (modelled as calm)	Number of hours with inadequate data (excluding calms)	Hours used (%)
2019	16	0	100%
2020	17	0	100%
2021	22	0	100%
2022	20	0	100%
2023	17	0	100%
Notes: Meteorological parameters supplied are: wind speed, wind direction, near-ground air temperature, cloud cover			

A.1.2 Meteorological parameters

The dispersion model uses various meteorological parameters to represent the area at the meteorological station and the site of the Site. The key parameters that have been defined are the surface roughness and minimum Monin-Obuhkov length which are defined at the site of the meteorological data measurement and the Site.

- Surface roughness: this is related to land-use and the height of obstacles on the ground which give rise to mechanically generated turbulence; and
- Minimum Monin-Obuhkov length: this is used to model the extent to which the urban heat island effect limits the most stable atmospheric conditions. Heat released from the urban area prevents the atmospheric boundary layer becoming very stable.

Table 19 shows the values of the parameters that can be selected in the model from a drop-down menu. Other, intermediate, values can be entered directly. The values selected for the meteorological data site and the Site are given in Table 20. A value of 2m for minimum Monin-Obuhkov length reflects the rural nature of the surrounding area; the value of 0.1m for surface roughness at the meteorological data site reflects the low vegetation; 0.3m for surface roughness at the Site reflects the buildings and structures around the Site.

The dispersion model sets a higher value of minimum turbulence when modelling terrain, therefore, a value of 0.01m/s was set in the additional input file (*.aai*) so that the value used when modelling terrain would be the same as that calculated by the model for flat terrain as a function of Monin-Obuhkov length (ADMS 6 User Guide, section 4.15.3[3]).

Table 19 Dispersion model meteorological parameter values

Surface roughness	
Descriptor	**Value (m)**
Large urban areas	1.5
Cities, woodland	1.0
Parkland, open suburbia	0.5
Agricultural areas (max)	0.3
Agricultural areas (min)	0.2
Root crops	0.1
Open grassland	0.02
Short grass	0.005
Sea	0.0001

Minimum Monin-Obuhkov length	
Descriptor	**Value (m)**
Large conurbations >1million	100m
Cities and large towns	30m
Mixed urban/industrial	30m
Rural areas (max) [1]	20m
Small towns < 50,000	10m
Rural areas (min)[1]	2m

Table 20 Meteorological site and Site met parameters

Parameter	**Meteorological data site**	**Site**
Surface roughness	0.1m	0.3m
Minimum Monin-Obhukov length	2m	2m

A.2 Buildings

The presence of buildings close to an emission point can affect the dispersion from a source, bringing the plume centreline down towards the ground in the lee of a building and entraining pollutant into the cavity (or, recirculation) region in the lee of a building. In the cavity, concentrations are assumed to be uniform, and it may be a region of high concentrations depending on the amount of pollutant entrained. The presence of buildings may increase or decrease concentrations at a location compared with the no buildings scenario.

The dispersion model allows up to 25 buildings to be included as input and the model combines the relevant input buildings into one effective building; the effective building is calculated for each line of meteorological data. Buildings can only be circular or rectangular in cross-section, so the buildings entered are simplified geometries. Buildings less than one third of the height of the stack will be ignored by the dispersion model. Smaller Site structures such as containers and tanks with smaller diameters than larger tanks have been neglected as their effect will be limited compared with the larger structures: tanks, buildings.

The building height entered into the model is the height to the eaves plus a proportion (50%) of roof height. The roof height is the height to the apex minus the height to the eaves.

Table 21 shows the (simplified) parameters of the buildings on site used as input to the model; they are shown in Figure 6. In the dispersion model, for each stack a 'main' building must be specified; the option to allow the dispersion model to automatically select the main building for each source was selected.

Table 21 Modelled buildings

Building name	Building centre X	Building centre Y	Height to eaves (m)	Height to apex (m)	Height modelled (m)	Length/ Diameter (m)	Width (m)	Orientat-ion (°)
Tank Farm 1*	345989	107150	12.0	15.0	13.5	4.65	25.4	80.72
Relocated screw press	346181	107276	8.3	8.3	8.30	4.82	14.7	178.9
Balance tank (future AS)	346016	107259	5.8	5.8	5.80	7.75	7.75	-
AS & aerobic tank	346018	107249	6.4	6.4	6.40	9.55	9.55	-
MBR	346018	107239	6.4	6.4	6.40	4.26	4.26	-
DAF Plant	346030	107227	6.6	9.2	7.90	9.75	10.6	77.15
New maintenance bldg	346089	107206	5.9	9.8	7.90	35.9	27.9	81.58
Dairy building	346027	107141	5.9	9.8	7.85	32.7	19.4	78.13
Boiler 1 bldg	346023	107160	3.9	6.0	4.95	29.5	18.3	78.24
Boiler 2 bldg	346002	107173	4.4	4.5	4.45	6.77	9.72	79.87
Boiler 3 bldg	345939	107181	3.2	3.7	3.45	7.18	6.29	85.29
Boiler 4 bldg	346002	107189	5.0	5.0	5.00	2.64	13.5	78.18
No.23 unused Silo	346006	107190	10.5	10.5	10.5	4.06	4.06	-
Tank Farm 2	346000	107132	6.0	12.0	9.00	22.0	12.6	80.12
Tank Farm 3	346038	107182	12.0	15.0	13.5	7.31	30.4	77.40
Workshops	346008	107201	3.7	4.7	4.20	11.6	11.4	79.16
Generator bldg	346018	107177	3.9	6.0	4.95	24.3	16.2	78.13
Diesel refuelling canopy	345957	107205	5.6	5.6	5.58	10.0	7.50	104.2
Box stores	346051	107140	5.0	5.9	5.45	11.9	7.72	78.13
Lorry loading bay	346053	107130	5.0	5.9	5.45	11.9	12.8	78.13
No24 vertical soft water tank	346011	107190	8.5	8.5	8.50	2.92	2.92	-
Evaporator	346026	107178	15.0	15.0	15.0	2.65	2.65	-
Anoxic tank	346023	107240	6.6	6.6	6.60	3.25	3.25	-
Relocated sludge tank	346181	107282	6.6	6.6	6.60	3.30	3.30	-
Managers office	345959	107164	6.1	6.1	6.10	12.0	4.16	88.04

Notes: Buildings with circular cross-section, such as the digesters, do not have a width and orientation specified.
*For the 'Tank farms', the 'height to eaves' represents the minimum tank height within the tank farm; 'height to apex' is the maximum tank height.

A.3 Terrain

The effect of terrain is not usually modelled when terrain gradients in the modelled domain are below the 1:10 threshold usually applied. However, when using numerical weather data, it is recommended to consider the dispersion model predictions with and without terrain. Within the 10km x 10km terrain domain, the terrain varied by 261m from 15.3m to 277m, and as reported in the model sensitivity analysis, the effect of terrain on the results was not significant.

Figure 7 shows the terrain data modelled.

A.4 Receptors

A.4.1 Human receptors

The impact of stack emissions at relevant human receptors has been modelled. A relevant receptor is defined in Defra's LAQM TG16[17] as:

> *A location representative of human (or ecological) exposure to a pollutant, over a time period relevant to the objective that is being assessed against, where the Air Quality Strategy objectives are considered to apply*.

Table 22 shows the locations and type of the receptors selected to be representative of the relevant human receptors. All the receptors have been modelled at a height of 1.5m, representative of inhalation height (nose level) at ground level. Their locations are shown in Figure 8.

Table 22 Human receptors

ID	Location	Type	NGR X	NGR Y	Distance and direction from green line boundary	
					Distance (m)	Direction
R1	Owls Barton	Residential	345843	107331	100	NW
R2	Knowle Farm & NS Used Car Dealer	Residential & Commercial	345956	107494	200	N
R3	Houses off A3066 south of Misterton	Residential	346066	107563	280	N
R4	R V S Accident Repair	Commercial	345972	107666	380	N
R5	Bluntsmoor Farm	Residential	345479	106701	510	SW
R6	Chapel Court Farm including plant hire company	Residential & Commercial	345685	106433	635	SW
R7	Misterton village	Residential	346011	107973	670	N/ NW
R8	Misterton Church of England First School	School	345820	108030	735	NNW
R9	Badgers Glory	Residential	345114	107152	790	W
R10	Tumberlands, Lecher Lane	Agricultural & Residential	346868	106844	845	SE
R11	Downbarn Farm – Dairy Farm	Residential & Agricultural	344995	106602	945	SW

A.4.2 Ecological receptors

The Defra/Environment Agency guidance specifies that SACs, SPAs and Ramsar site within 10km should be considered and SSSIs, AWs, LWSs, Local Nature Reserves and National Nature Reserves within 2km should also be considered.

Ecological receptors were placed in the designated areas at the nearest locations to the Site and additional locations. Table 6 in section 4.3 lists the sensitive conservation sites identified within the specified distance, their designation and main habitat. Table 23 lists the ecological receptors modelled, their locations are shown in Figures 9 to 11. All the ecological receptors have been modelled at a height of 1.5m. Their locations are shown in Figure 9.

Table 23 Ecological receptors

ID	Location	Type	NGR X	NGR Y	Distance and direction from main AD Plant site boundary	
					Distance (m)	Direction
E1(a)	Bracket's Coppice	SAC/ SSSI	350393	106494	4,396	ESE
E1(b)	Bracket's Coppice	SAC/ SSSI	351536	107425	5,489	E
E2(a)	West Dorset Alder Woods	SAC	350387	99286	9,015	SSE
E2(b)	West Dorset Alder Woods	SAC	354471	102313	9,730	SE
E3	New Bridge Meadows	SNCI	346781	107257	732	E
E4(a)	Ten Acre Copse (a)	SNCI	345311	106258	1,191	SW
E4(b)	Ten Acre Copse (b)	SNCI	344794	106330	1,524	SW
E5(a)	Langmoor Lane (a)	SNCI	346900	106400	1,159	SE
E5(b)	Langmoor Lane (b)	SNCI	347137	106700	1,191	ESE
E5(c)	Langmoor Lane (c)	SNCI	346538	106036	1,252	SSE
E6	Hawkhems Copse Meadow	SNCI	347010	106345	1,277	SE
E7	Picket Farm Copse	SNCI	346562	105675	1,599	SSE
E8	Ten Acre Field	LWS	344540	106530	1,650	SW
E9	Misterton Plantation	LWS	344380	106590	1,776	SW
E10	Picket Plantation	SNCI	346500	105200	2,040	SSE
E11	Crondle Hill Plantation	LWS	347530	108170	1,773	NE
E12(a)	Kithill (a)	LWS	344600	108440	1,916	NW
E12(b)	Kithill (b)	LWS	344850	108830	2,033	NNW
E13	Cathole Bridge Meadow	LWS	344430	108160	1,890	NW
E14	Crondle Hill Coppice	LWS	347510	108430	1,914	NE
E15	River Parrett	LWS	346890	108940	1,940	NNE
E16	Crondle Hill Field	LWS	347330	108670	1,955	NE
Notes: Sites listed on the Provisional Inventory of Ancient Woodland						

A.5 Post-processing

A.5.1 Use of background data

Considering long-term AQS, it is a straightforward matter to add the annual mean contribution from the source, (annual mean PC) to the annual mean background concentration to predict the total concentration (annual mean PEC).

For comparison with short-term AQS the addition of background is not so straightforward. The dispersion model allows for the calculation of percentiles from hourly background and process concentrations, but hourly background concentrations are not commonly available, and not for all pollutants. The approach used was that described in the Defra/EA guidance:

> *When you calculate background concentration, you can assume that the short-term background concentration of a substance is twice its long-term concentration*.

This has been used for all for short-term AQS for averaging times for 15 minutes to 24 hours.

A.5.2 Conversion of NOx to NO_2

The dispersion model includes a NOx chemistry model, but the conversion of primary NOx emissions to NO_2 is usually undertaken as a post-processing step for both planning and industrial permitting applications. For primary NO_2 to NO_x ratios of 10% or less, which is likely to be the case for the stack emissions, the EA and Natural Resources Wales recommend use of the following conversion ratios:

- 35% for short term assessment
- 70% for long term assessment.

These ratios have been used in main part of this assessment.

Appendix B Sensitivity assessment

The impact of buildings, terrain and meteorological data year have been assessed. The eight cases modelled, A-H, are shown in Table 24. Long-term and short-term scenarios have been modelled as described in section 3.1.

Results of the sensitivity tests were the maximum concentration predicted at any human receptor. For each AQS, the predicted maximum was divided by (normalised) the AQS value, or if the AQS is expressed as a number of exceedances of threshold value, by the threshold value. These normalised values have been expressed as a percentage and are shown in Table 25. The comparison is expressed this way to show the relative importance of the change in terms of exceedance of the AQS. If all the results are a very small percentage of the AQS, the variation in results is unlikely to affect the conclusions of the study.

For human receptors, comparing the results for tests A, B and C, it can be seen that modelling buildings led to higher model predictions than for flat terrain. Modelling terrain as well buildings had a negligible impact. The variance in the sensitivity testing results was greater for the short-term 'abnormal' operating scenario, than for the short-term 'normal' operating scenario.

Comparing the results for tests A, D, E, F and G shows that the variation due to meteorological data year is generally less significant than the impact of modelling buildings for human receptors. For ecological receptors the variation due to the meteorological year was more significant than the impact of buildings and terrain.

Table 24 Sensitivity tests

Sensitivity test	Flat/Buildings/Terrain model options	Meteorological data year
A	Flat	2019
B	Buildings	2019
C	Terrain & buildings	2019
A	Flat	2019
D	Flat	2020
E	Flat	2021
F	Flat	2022
G	Flat	2023

Table 25 Sensitivity tests: results as a percentage of the AQS or threshold (%)

Pollutant	Scenario	Value, EAL or threshold, (µg/m^3)	A	B	C	A	D	E	F	G	H
Human receptors											
NOx	LT	40	1.6%	1.7%	1.5%	1.6%	1.6%	1.1%	1.3%	1.6%	1.2%
NOx	ST Abnormal	200	5.3%	5.7%	4.8%	5.3%	5.3%	5.1%	5.0%	5.4%	5.2%
NOx	ST Normal	200	3.7%	3.9%	3.3%	3.7%	3.7%	3.6%	3.5%	3.7%	3.4%
SO2	ST Abnormal 15-min	266	1.5%	1.7%	1.5%	1.5%	1.5%	1.4%	1.4%	1.5%	1.4%
SO2	ST Normal 15-min	266	0.8%	0.8%	0.7%	0.8%	0.8%	0.7%	0.7%	0.8%	0.7%
SO2	ST Abnormal 1-hr	350	1.0%	1.0%	0.9%	1.0%	1.0%	0.9%	0.9%	1.0%	0.9%
SO2	ST Normal 1-hr	350	0.5%	0.5%	0.4%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
SO2	ST Abnormal 24-hr	125	1.5%	1.5%	1.2%	1.5%	1.5%	1.2%	0.9%	1.5%	1.1%
SO2	ST Normal 24-hr	125	0.8%	0.8%	0.7%	0.8%	0.8%	0.6%	0.5%	0.7%	0.6%
Ecological receptors											
NOx	LT	30	1.2%	1.2%	1.0%	1.2%	1.2%	1.2%	1.0%	0.9%	1.2%
NOx	ST abnormal	75	6.1%	6.1%	6.1%	6.1%	6.1%	4.6%	7.9%	5.0%	5.5%
NOx	ST normal	75	4.4%	4.4%	4.4%	4.4%	4.4%	3.3%	5.7%	3.7%	4.1%
SO2	LT	20	0.2%	0.1%	0.1%	0.2%	0.2%	0.2%	0.1%	0.1%	0.2%
SO2	LT	10	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.2%	0.2%	0.3%
Notes: Long-term (LT) or Short-term (ST)											

Appendix C Boiler Combustion Analysis

Source: Pattemore's Transport Limited

BOILER COMBUSTION ANALYSIS

9TH AUG '23

WESTON HEATING SERVICES LTD

NO 1

testo 340
V1.16 61940305/GB

KD
PATTEMORE
Start: 09.08.23 10:58:16

187.0	°C	FlueGas temp
31.1	°C	Ambient temp
7.10	%	O2
10.26	%	CO2
0	ppm	CO
50	ppm	NO
139	mgm³	NOx
4	mgm³	SO2
91.0	%	Effn
85.6	%	Effg
.0000		ratio
1	ppm	SO2
-----	hPa	Diff.Press.2

LOW FIRE

Fuel:	Light Oil
O2cal.:	3.0%
CO2max:	15.5%
Heat carrier temp.:	----- °C
Oil derivative	---
Smoke number:	- - -
Mean:	-

BOILER 2

testo 340
V1.16 61940305/GB

KD
PATTEMORE
Start: 09.08.23 09:54:21

184.4	°C	FlueGas temp
28.3	°C	Ambient temp
10.01	%	O2
8.11	%	CO2
34	ppm	CO
34	ppm	NO
120	mgm³	NOx
0	mgm³	SO2
88.8	%	Effn
83.7	%	Effg
.0004		ratio
0	ppm	SO2
-----	hPa	Diff.Press.2

LF

NEW DIESEL INJECTOR ORDERED

Fuel:	Light Oil
O2cal.:	3.0%
CO2max:	15.5%
Heat carrier temp.:	----- °C
Oil derivative	---
Smoke number:	- - -
Mean:	-

NO 3

testo 340
V1.16 61940305/GB

KD
PATTEMORE
Start: 09.08.23 09:12:55

289.4	°C	FlueGas temp
25.8	°C	Ambient temp
8.77	%	O2
9.02	%	CO2
10	ppm	CO
54	ppm	NO
171	mgm³	NOx
0	mgm³	SO2
83.2	%	Effn
78.3	%	Effg
.0001		ratio
0	ppm	SO2
-----	hPa	Diff.Press.2

BOILER 3 HIGH FIRE

Fuel:	Light Oil
O2cal.:	3.0%
CO2max:	15.5%
Heat carrier temp.:	----- °C
Oil derivative	---
Smoke number:	- - -
Mean:	-

testo 340
V1.16 61940305/GB

KD
PATTEMORE
Start: 09.08.23 10:59:09

212.2	°C	FlueGas temp
31.1	°C	Ambient temp
6.94	%	O2
10.38	%	CO2
0	ppm	CO
61	ppm	NO
168	mgm³	NOx
4	mgm³	SO2
89.7	%	Effn
84.4	%	Effg
.0000		ratio
1	ppm	SO2
-----	hPa	Diff.Press.2

HIGH FIRE

Fuel:	Light Oil
O2cal.:	3.0%
CO2max:	15.5%
Heat carrier temp.:	----- °C
Oil derivative	---
Smoke number:	- - -
Mean:	-

testo 340
V1.16 61940305/GB

KD
PATTEMORE
Start: 09.08.23 09:55:31

208.1	°C	FlueGas temp
28.2	°C	Ambient temp
6.26	%	O2
10.88	%	CO2
1	ppm	CO
60	ppm	NO
158	mgm³	NOx
3	mgm³	SO2
90.1	%	Effn
84.9	%	Effg
.0000		ratio
1	ppm	SO2
-----	hPa	Diff.Press.2

HF

Fuel:	Light Oil
O2cal.:	3.0%
CO2max:	15.5%
Heat carrier temp.:	----- °C
Oil derivative	---
Smoke number:	- - -
Mean:	-

testo 340
V1.16 61940305/GB

KD
PATTEMORE
Start: 09.08.23 09:44:15

198.7	°C	FlueGas temp
26.2	°C	Ambient temp
6.86	%	O2
10.44	%	CO2
0	ppm	CO
54	ppm	NO
148	mgm³	NOx
0	mgm³	SO2
90.2	%	Effn
84.9	%	Effg
.0000		ratio
0	ppm	SO2
-----	hPa	Diff.Press.2

LOW FIRE

Fuel:	Light Oil
O2cal.:	3.0%
CO2max:	15.5%
Heat carrier temp.:	----- °C
Oil derivative	---
Smoke number:	- - -
Mean:	-

Appendix D Boiler 1, Performance Data

Source: Byworth boilers

YORKSHIREMAN MODEL			YS	5000	IE
Boiler working pressure		barg	13.8	200.1	psig
Saturation Temperature		degC	197.6		
Ambient Air Temp		degC	25		
REQUIRED BOILER DUTY 5000	Percentage Load	%	100	70	60	23
	Heat Output	kw	3135.3	2194.7	1881.2	721.12
	F&A 100DegC	kg/h	5000	3500	3000	1150
		lb/h	11025	7717.5	6615	2535.8
Actual Boiler Output with Feed Water Temperature of 85		kg/hr	4634.4	3244.1	2780.6	1065.9
		degC	lb/hr	10219	7153.2	6131.3	2350.3

FUEL HEATING VALUES		
Bio Gas		
GCV	20.96 Mj/kg	24.7 MJ/Ncu mtre
NCV	18.87 Mj/kg	22.3 MJ/Ncu mtre
ClassA2 and D-Fuel Oil		
GCV	46.89 Mj/kg	
NCV	43.98 Mj/kg	

BOILER PERFORMANCE		ClassA2 and D-Fuel Oil				Bio Gas				
Percentage Load	%	100	70	60	23	100	70	60	23	
Nett Heat Release	mw/m^3	1.44	1.07	0.92	0.36	1.46	1.13	0.97	0.38	
Nett Heat Input	mw	3.34	2.49	2.14	0.83	3.38	2.61	2.24	0.87	
Front Smoke BoxTemperature	deg C	400	363	350	279	433	391	377	295	
Boiler Outlet Temperature	deg C	236	226	223	207	244	232	228	209	
ECONOMISER FITTED TO BOILER ROWS 6										
Economiser Gas Outlet Temperature	degC	138	134	132	129	139	134	132	129	
Econ Feed Water Outlet Temperature	degC	113	112	113	110	118	117	118	114	
Economiser Duty	kW	157	107	94	33	157	107	94	33	
Total Gas Weight	kg/h	5004	3642	3252	1319	5535	4079	3669	1457	
Max CO_2 Emissions	kg/hr	855				1047				
Boiler Efficiency on GCV with Econ	%	88.52	88.31	88.09	86.66	84.34	84.11	83.86	82.58	BS845
Boiler Efficiency on NCV with Econ	%	93.91	93.69	93.45	91.94	92.91	92.66	92.38	90.95	BS845
Boiler Efficiency on GCV with Econ	%	90.20	90.08	89.94	88.86	86.96	86.86	86.74	85.99	EN12953
Boiler Efficiency on NCV with Econ	%	94.60	94.41	94.20	92.82	93.90	93.70	93.47	92.24	EN12953
Total Draught Loss	inchwg	5.24	2.75	2.18	0.36	6.54	3.50	2.81	0.45	
	mbar	13.11	6.88	5.46	0.91	16.37	8.76	7.04	1.11	
Combustion air volume	Sm^3/s	1.07	0.78	0.70	0.28	1.11	0.82	0.74	0.30	
Exit Gas Volume from Economiser	Am^3/s	1.62	1.16	1.04	0.42	1.79	1.31	1.17	0.46	
Fuel consumption	kg/h	271.98	190.83	163.99	63.89	638.56	448.22	385.33	150.00	kg/h
	litre/h	316.79	222.28	191.01	74.42	570.00	400.09	343.96	133.90	Sm^3/h
						540.89	379.66	326.39	127.06	Nm^3/h
	kWhr Gross	3543.0	2485.9	2136.3	832.3	3718.6	2610.2	2244.0	873.5	kWhr Gross

TYPICAL FUEL COSTS		
Annual Boiler Loading		
Average boiler Load	15000	kg/hr
No. Hours/Day	24	hr
No days /week	7	days
No weeks	50	wks
Average Load greater than boiler duty		
ClassA2 and D-Fuel Oil	80	p/litre
Cost per day	£ 6562	
Cost per Week	£ 45937	
Cost per Year	£ 2296872	
Cost per tonne of Steam	**£54.69**	
Bio Gas	12	p/kWh
Cost per day	£ 11555	
Cost per Week	£ 80882	
Cost per Year	£ 4044107	
Cost per tonne of Steam	**£ 96.29**	

Steam Release Area	m^2	6.22	Duct / chimney size @ velocity of 12 m/s	mm	414	inside diameter
Steam Release Rate	m/sec	0.0276	Duct / chimney size @ velocity of 15 m/s	mm	370	inside diameter

Yorkshireman Boiler Performance Data

Appendix E Boiler 1, Emissions Test Data

Source: Pattemore's Transport Limited

BOILER 1 Burner Combustion Analysis Report

Date	Time	Who	Fuel	Burner status	O2 Cal %	CO2 Max %	Flue Gas Temp	% O2	% CO2	CO (ppm)	NO (ppm)	SO2 (ppm)	NOx (mgm^3)	% Effn	% Effg
17/02/2022	10:03	Weston	Light Oil	Low fire	3	15.5	185.9°C	7.51	9.95	0	54	0	155	90.0	84.4
				High Fire	3	15.5	210.9°C	6.98	10.35	0	65	0	180	89.0	83.8
02/02/2023	16:34	Weston	Light Oil	Low Fire	3	15.5	203.4°C	7.32	10.10	0	60	0	170	89.3	84.1
				High Fire	3	15.5	218.3°C	7.14	10.23	0	62	0	173	88.6	83.4
09/08/2023	10:58	Weston	Light Oil	Low Fire	3	15.5	187.0°C	7.10	10.26	0	50	1	139	91.0	85.6
				High Fire	3	15.5	212.2°C	6.94	10.38	0	61	1	168	89.7	84.4
													changed to (ppm)		
09/04/2024	08:45	Steam Pickett	Light Oil	Low Fire	3	15.5	197.3°C	7.40	10.00	45	63		66		84.2
				High Fire	3	15.5	215.0°C	6.90	10.04	52	68		71		83.7

Appendix F Boiler 2, Performance Data

Source: Byworth boilers

YORKSHIREMAN LOW NOX MODEL	YSLN	5000	IE

Boiler working pressure	barg	13.8	200.1 psig
Saturation Temperature	degC	197.6	
Ambient Air Temp	degC	25	

REQUIRED BOILER DUTY 5000			100	75	50	20
	Percentage Load	%	100	75	50	20
	Heat Output	kw	3135.3	2351.5	1567.7	627.07
	F&A 100DegC	kg/h	5000	3750	2500	1000
		lb/h	11025	8268.8	5512.5	2205
Actual Boiler Output with Feed Water		kg/hr	4634.4	3475.8	2317.2	926.9
Temperature of 85	degC	lb/hr	10219	7664.1	5109.4	2043.8

FUEL HEATING VALUES

Natural Gas		
GCV	52.97 *Mj/kg*	40.5 MJ/Ncu mtre
NCV	47.75 *Mj/kg*	36.6 MJ/Ncu mtre
Heavy ClassG-Fuel Oil		
GCV	43.83 *Mj/kg*	
NCV	41.41 *Mj/kg*	

BOILER PERFORMANCE		Heavy ClassG-Fuel Oil				Natural Gas				
Percentage Load	%	100	75	50	20	100	75	50	20	
Nett Heat Release	mw/m^3	**1.16**	**0.87**	**0.58**	**0.24**	**1.17**	**0.88**	**0.59**	**0.24**	
Nett Heat Input	mw	**3.33**	**2.50**	**1.68**	**0.68**	**3.35**	**2.52**	**1.69**	**0.69**	
Gross Heat Release Rate	mw/m^3	**1.22**				**1.28**				
Front Smoke BoxTemperature	deg C	340	317	290	246	379	351	318	262	
Boiler Outlet Temperature	deg C	219	214	209	202	225	219	212	203	
ECONOMISER FITTED TO BOILER ROWS 6		Exhaust Temp approaching Acid Dew Pnt								
Economiser Gas Outlet Temperature	degC	132	129	127	127	134	131	128	127	
Econ Feed Water Outlet Temperature	degC	110	110	110	110	110	110	111	110	
Economiser Duty	kW	141	106	71	28	141	106	71	28	
Total Gas Weight	kg/h	5033	3921	2724	1179	4906	3852	2728	1195	
Max CO_2 Emissions	kg/hr	898				667				
Boiler Efficiency on GCV with Econ	%	89.43	89.20	88.80	87.02	85.09	84.86	84.42	82.63	BS845
Boiler Efficiency on NCV with Econ	%	94.25	94.01	93.59	91.71	93.63	93.37	92.88	90.90	BS845
Boiler Efficiency on GCV with Econ	%	90.85	90.69	90.37	88.87	87.68	87.58	87.27	86.00	EN12953
Boiler Efficiency on NCV with Econ	%	94.85	94.63	94.25	92.48	94.68	94.48	94.04	92.28	EN12953
Total Draught Loss	inchwg	5.10	2.87	1.38	0.26	5.23	3.07	1.52	0.29	
	mbar	12.77	7.18	3.46	0.66	13.09	7.67	3.81	0.73	
Combustion air volume	Sm^3/s	1.08	0.84	0.58	0.25	1.05	0.83	0.59	0.26	
Exit Gas Volume from Economiser	Am^3/s	1.60	1.24	0.86	0.37	1.57	1.22	0.86	0.38	
Fuel consumption	kg/h	288.00	216.56	145.01	59.19	250.46	188.37	126.23	51.58	kg/h
	litre/h	291.83	219.43	146.94	59.98	345.38	259.75	174.06	71.13	Sm^3/h
						327.24	246.11	164.92	67.39	Nm^3/h
	kWhr Gross	3507.1	2637.1	1765.9	720.8	3685.8	2772.0	1857.6	759.1	kWhr Gross

TYPICAL FUEL COSTS

Annual Boiler Loading

Average boiler Load	5600	kg/hr
No. Hours/Day	24	hr
No days /week	7	days
No weeks	50	wks

Average Load greater than boiler duty

Heavy ClassG-Fuel Oil p/litre

Cost per day	£ 0
Cost per Week	£ 0
Cost per Year	£ 0
Cost per tonne of Steam	**£ 0.00**

Natural Gas 2.6 p/kWh

Cost per day	£ 2481
Cost per Week	£ 17370
Cost per Year	£ 868487
Cost per tonne of Steam	**£ 20.68**

Steam Release Area	m^2	6.85	Duct / chimney size @ velocity of 12 m/s	mm	412	inside diameter
Steam Release Rate	m/sec	0.0251	Duct / chimney size @ velocity of 15 m/s	mm	369	inside diameter

Yorkshireman Boiler Performance Data

Appendix G Boiler 2, Emissions Test Data

Source: Pattemore's Transport Limited

BOILER 2 Burner Combustion Analysis Report

Date	Time	Who	Fuel	Burner status	O2 Cal %	CO2 Max %	Flue Gas Temp	% O2	% CO2	CO (ppm)	NO (ppm)	SO2 (ppm)	NOx (mgm^3)	% Effn	% Effg
02/02/2023	16:04	Weston	Light Oil	Low fire	3	15.5	194.8°C	8.26	9.40	5	43	0	131	88.9	83.7
				High Fire	3	15.5	217.3°C	6.03	11.05	0	67	0	173	89.2	84.0
09/08/2023	09:54	Weston	Light Oil	Low fire	3	15.5	184.4°C	10.01	8.11	34	34	0	120	88.8	83.7
				High Fire	3	15.5	208.1°C	6.26	10.88	1	60	1	158 changed to (ppm)	90.1	84.9
09/10/2023	15:27	Weston	Light Oil	Low fire	3	15.5	200.3°C	6.80	10.48	1	55	6	58	90.3	85.0
				High Fire	3	15.5	221.7°C	4.25	12.36	1	71	9	75	90.6	85.3
09/04/2024	09:42	Steam Pickett	Light Oil	Low Fire	3	15.5	169.5°C	8.70	9.10	29	43		45		85.1
				High Fire	3	15.5	206.0°C	5.30	11.60	56	70		73		85.1

Appendix H Boiler 2, Emissions testing report, 21 August 2024

Stack Emissions Monitoring Report

commissioned by Pattemore's Transport (Crewkerne) Limited

Job Reference: JOB-1203

Operator Name
Pattemore's Transport (Crewkerne) Limited | Pattemores

Operator Address
Mosterton Road
Crewkerne, Somerset
TA18 8NT
EPR Permit EPR/NP3124SP

Release Point
Boiler 2

Monitoring Organisation Name & Address
Atesta Ltd
Unit 2, Asher Court, Lyncastle Way
Appleton, Warrington
WA4 4ST

Monitoring Report Written By
Ben Metcalfe | Team Leader
MCERTS Level 2 | MM 21 1659 | TE1 TE2 TE3 TE4 | expires on 29/10/2026

Monitoring Report Approved By
Chris Rhodes | Senior Team Leader
MCERTS Level 2 | MM 02 117 | TE1 TE2 TE3 TE4 | expires on 18/05/2026

Report Date | Version Number
22/08/2024 | Version 1

Dates of the Monitoring Campaign
21/08/2024

Atesta Ltd Primary Contact
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Report Contents and Monitoring Objectives

Report Contents

Monitoring Objective

The monitoring objective was to conduct stack emissions monitoring to demonstrate compliance against a set of emission limit values (ELVs) as specified in the Site's Environmental Permit.

Special Requirements

There were no special requirements for this monitoring campaign.

Opinions and Interpretations

Any opinions or interpretations contained within this test report are outside the scope of Atesta's MCERTS / ISO 17025 accreditation.

Part 1: Executive Summary - Monitoring Results Summary

Monitoring Results - Summary

	EXPRESSED AS A CONCENTRATION				EXPRESSED AS A MASS EMISSION					
test parameter	**result**	**uncertainty in result +/-**	**limit** (ELV)	**units**	**result**	**uncertainty in result +/-**	**limit** (ELV)	**units**	**reference conditions**	**accreditation status**
Oxides of Nitrogen (as NO_2)	133	5.9	200	mg/m³				g/hr	STP, dry, 3% O_2	MCERTS
Carbon Monoxide	6.7	0.30		mg/m³				g/hr	STP, dry, 3% O_2	MCERTS
Oxygen	6.5	0.22		% v/v					dry	MCERTS

The uncertainty in the result is reported at a 95% Confidence Interval in the same units as the monitoring result. In practice, this means that 95 times out of 100, the true result will lie within the stated range.

Part 1: Executive Summary - Monitoring Results Further Details

Monitoring Results - Further Details

		EXPRESSED AS A CONCENTRATION				EXPRESSED AS A MASS EMISSION							
test parameter	**run**	**result**	**uncertainty in result +/-**	**limit** (ELV)	**units**	**result**	**uncertainty in result +/-**	**limit** (ELV)	**units**	**sampling date | times**	**run time** (mins)	**H_2O** (% v/v)	**reference conditions**
Oxides of Nitrogen (as NO_2)	R1	133	5.9	200	mg/m³				g/hr	21/08/2024 | 15:51 - 16:51	60		STP, dry, 3% O_2
Carbon Monoxide	R1	6.7	0.30		mg/m³				g/hr	21/08/2024 | 15:51 - 16:51	60		STP, dry, 3% O_2
Oxygen		6.5	0.22		% v/v					N/A - Concurrent Testing			dry

The uncertainty in the result is reported at a 95% Confidence Interval in the same units as the monitoring result. In practice, this means that 95 times out of 100, the true result will lie within the stated range.

Part 1: Executive Summary - Monitoring and Analytical Methods

Monitoring and Analytical Methods

where analysis not required	MONITORING						
test parameter	**laboratory**	**accreditation number**	**technical procedure**	**reference method**	**monitoring status**	**measurement technique & equipment**	**accreditation status**
Oxides of Nitrogen (as NO_2)	ATA	10706	TP-22a	EN 14792	MCERTS	Chemiluminescence using Horiba PG-350E	MCERTS
Carbon Monoxide	ATA	10706	TP-22b	EN 15058	MCERTS	NDIR using Horiba PG-350E	MCERTS
Oxygen	ATA	10706	TP-22d	EN 14789	MCERTS	Paramagnetism using Horiba PG-350E	MCERTS

Summary of Monitoring Deviations (from Appendix 2)

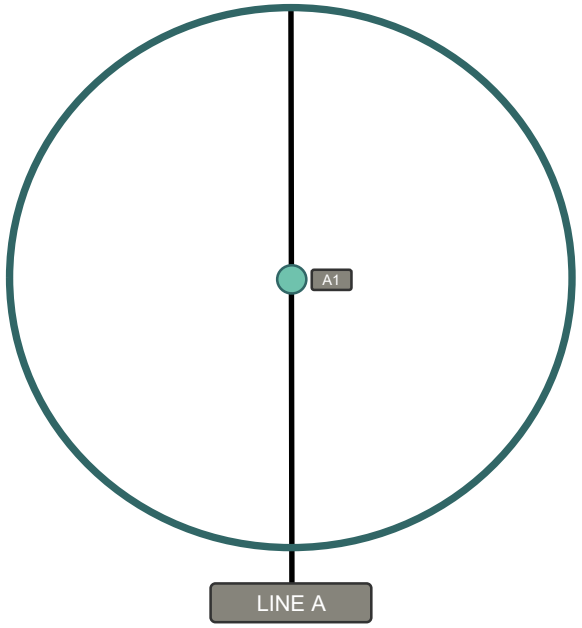
test parameter	run	details of monitoring deviation
All	1	There were no deviations associated with the monitoring employed.

Part 1: Executive Summary - Monitoring Location

Monitoring Location Photos

Identification of Sampling Points on a Duct Diagram

refer to Appendix 2 - Raw Data to see how the points on this diagram relate to the points used for each test



Part 1: Executive Summary - Duct and Sampling Platform Information

Duct Characteristics | Sampling Ports

parameter	units	value
shape	-	Circular
dimensions	-	Diameter = 0.70 m
area	m^2	0.38
orientation	-	Vertical

parameter	value
primary sample port size	1" BSP
primary sample port depth | cm	4
primary sample ports number of sampling lines available	1

summary of all sample ports available
1" BSP

Sampling Location General Information

general information	details
type | location | access	Floor Level | Inside | On Ground Level

CEMS | Abatement Systems

parameter	details
abatement system/s	N/A
CEMS installed on the stack	N/A

Sampling Plane Validation Criteria Summary (EN 15259) from Stack Traverse/s

criteria in EN 15259	units	value	allowed	compliant
lowest differential pressure	Pa	-7.6	> 5 Pa	No
lowest traverse velocity	m/s	1.9	-	-
highest traverse velocity	m/s	4.0	-	-
mean traverse velocity	m/s	3.0	-	-
ratio traverse velocities	: 1	2.12	< 3 : 1	Yes
angle of swirl compliance	°	≥ 15	< 15°	No
no local negative flow	-	No	-	No

Part 1: Executive Summary - Sampling Location and Operating Information

Process Details

process detail	details
plume appearance on day of monitoring	No visible plume
type of process	Combustion
batch or continuous process	On Demand
fuel type	Gas Oil
feedstock	N/A
typical load / throughput of plant	3.60 MWth
details of any unusual process occurrences	None

Part 2: Supporting Information - Appendix 1: Monitoring Personnel, Analysis Laboratories and Test Equipment Used

Monitoring Personnel

Analysis Laboratories

Test Equipment Used

equipment type	A-EQ ID
Source sampling console	
Low flow sampling MFCs	
ThermoFID / iFID mobile	
Horiba PG-350E multigas analyser	140
Gasmet DX4000 FTIR	
Gasmet PSS	
Protea AtmosFIR	
Protea PIB Pump	
Gasmet syringe calibrator	
M&C PSS5-C conditioning unit	183
Digital thermomanometer	
Top pan balance kit	

equipment type	A-EQ ID
Pitot	
Calipers	
Barometer	240
Timer	399
Tape measure	111
Heated head filter	186
Heated tee	
10m heated line	220
1.5m heated line	
Odour barrel	
Vacuum chamber	
Dilution probe	

equipment type	A-EQ ID
10m umbilical	
30m umbilical	
Heated probe	
Filter oven	
Ambient thermocouple	
Stack thermocouple	
Exit thermocouple	
Condenser thermocouple	
Tubes kit thermocouple	
2-way heater controller	
Air sampling pump	
5-figure analytical balance	1

Part 2: Supporting Information - Appendix 2: Oxides of Nitrogen (as NO_2) | Run 1

Results

reference conditions are: STP, dry, 3% O_2

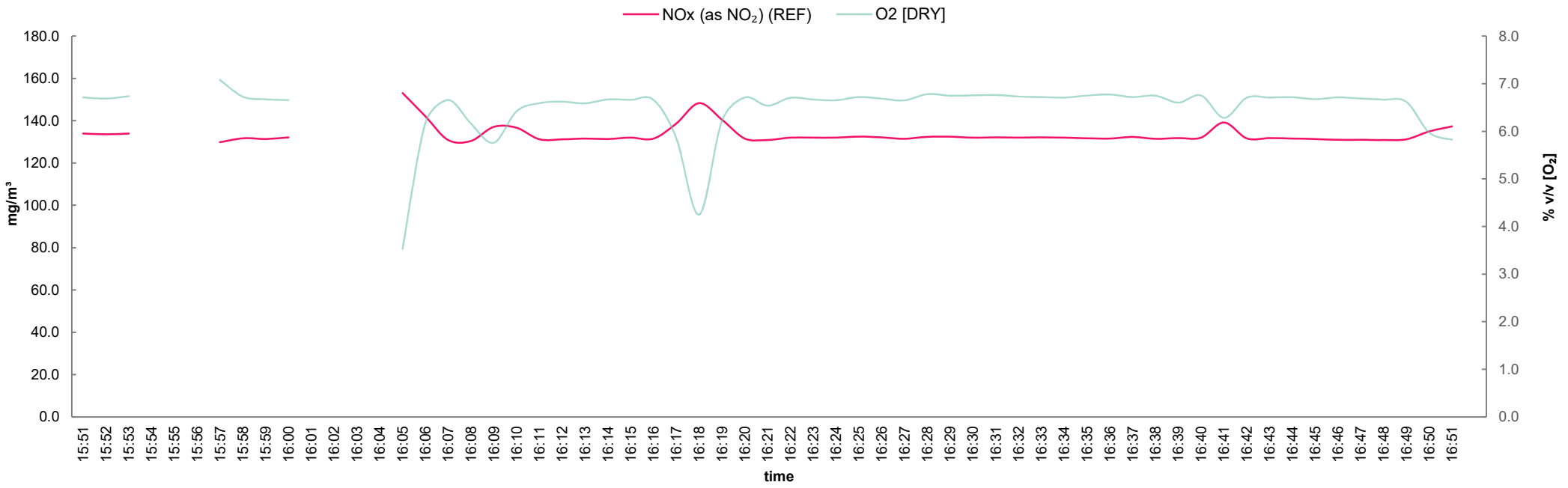
parameter	units	result ± MU (95% CI)	units	result ± MU (95% CI)
Oxides of Nitrogen (as NO_2)	mg/m³	133 ± 5.9	g/hr	

General Information

parameter	details
sampling start date & time	21/08/2024 15:51
sampling end date & time	21/08/2024 16:51
test time | mins	60
testing team	BM | CM
standard | technical procedure	EN 14792 | TP-22a
analyser type	Horiba PG-350E
heated head & line temperature	180°C

parameter	details
probe material	Titanium
filter size, material & location	Filter Element PTFE | Within Heated Head
number sampling lines available	1
number sampling lines used	1
number sampling points ideal per line	1
number sampling points used per line	1
sampling point IDs	A4

Plot of Emissions Over Time



Part 2: Supporting Information - Appendix 2: Oxides of Nitrogen (as NO_2) | Run 1

Analyser Calibration Information with QA checks

where [A] = at analyser, [L] = down sampling line

	pre-test calibration events								post-test calibration events			quality assurance					
CAL ID	date & time	zero [A] [ppm]	span [A] [ppm]	zero [L] [ppm]	span [L] [ppm]	T_{90} [s]	leak [%]		date & time	zero [A] [ppm]	span [A] [ppm]	zero drift [%]		span drift [%]		allowable [%]	temp [°C]
1	21/08/24 15:40	0.00	201.16	0.40	201.00	24	0.1	P	21/08/24 16:57	0.10	201.00	-0.3	P	0.2	P	±5	23.5

Analyser Calibration Extended Information

CAL ID	performed by	drift corr. applied	log period [s]	CYL ID	CYL conc. [ppm]	CYL expiry	CYL MU [%]	zero gas type	span [CYL] gas type	span target [ppm]	range [ppm]	LOD [ppm]
1	BM	No	60	A-CYL-86	201.16	27/12/2025	1.3	Nitrogen 5.2	10l 200ppm NO | 160ppm CO | 16% CO2 in Nitrogen	201.16	250	0.09

Part 2: Supporting Information - Appendix 2: Oxides of Nitrogen (as NO_2) | Run 1

Measurement Uncertainty (MU) Calculations

general information	units	value
emission limit value (ELV) (REF)	mg/m³	200
measured concentration (REF)	mg/m³	133

MU budget			
parameter	units	min	max
ambient temp	°C	22.0	25.0
voltage	V	90.0	130.0

overall MU for O_2 correction
3.4%

MU factor O_2 correction
0.04

	MU budget input parameters				MU budget		
performance characteristics	symbol	units	value	source	symbol	units	value
repeatability at zero	rz	% of value	0	MCERTS certificate MC130223	U_{rz}	mg/m³	0
repeatability at span	rs	% of value	0.1	MCERTS certificate MC130223	U_{rs}	mg/m³	0.13
lack of fit	lof	% of value	2	maximum allowable	U_{lof}	mg/m³	1.5
maximum short term zero drift (ABS) [after drift correction]	dz	% of value	0.3	day of testing	U_{dz}	mg/m³	0.23
maximum short term span drift (ABS) [after drift correction]	ds	% of value	0.22	day of testing	U_{ds}	mg/m³	0.17
influence of sample gas flow	f	% of value	0.1	MCERTS certificate MC130223	U_f	mg/m³	0.077
influence of sample gas pressure	p	% of value	0	MCERTS certificate MC130223	U_p	mg/m³	0
influence of ambient temperature zero point (/ 35k)	tz	% of value	0	MCERTS certificate MC130223	U_{tz}	mg/m³	0
influence of ambient temperature span point (/ 35k)	ts	% of value	1.8	MCERTS certificate MC130223	U_{ts}	mg/m³	0.069
influence of supply voltage (/ 60V)	v	% of value	0.4	MCERTS certificate MC130223	U_v	mg/m³	0.21
cross sensitivity at zero	iz	% of value	0.63	MCERTS certificate MC130223	U_{iz}	mg/m³	0.49
cross sensitivity at span	is	% of value	-0.52	MCERTS certificate MC130223	U_{is}	mg/m³	-0.4
maximum leak	L	% of value	0.08	day of testing	U_L	mg/m³	0.061
uncertainty associated with calibration gas	adj	% of value	1.3	span gas calibration certificate	U_{adj}	mg/m³	0.87
		combined MU with O_2 correction				mg/m³	3
		expanded MU with O_2 correction (k = 1.96)				mg/m³	5.9
		expanded MU 95% CI with O_2 correction (k = 1.96) as percentage of measured value				%	4.5
		expanded MU 95% CI (k = 1.96) as percentage of measured value for mass emission				%	2.8
		expanded MU with O_2 correction (k = 1.96) as percentage of ELV [allowable 10.6%]				%	3

result
Pass

method and sampling deviations
Sampling was performed in full compliance with the Standard, technical procedure and regulatory requirements.

Part 2: Supporting Information - Appendix 2: Carbon Monoxide | Run 1

Results

reference conditions are: STP, dry, 3% O_2

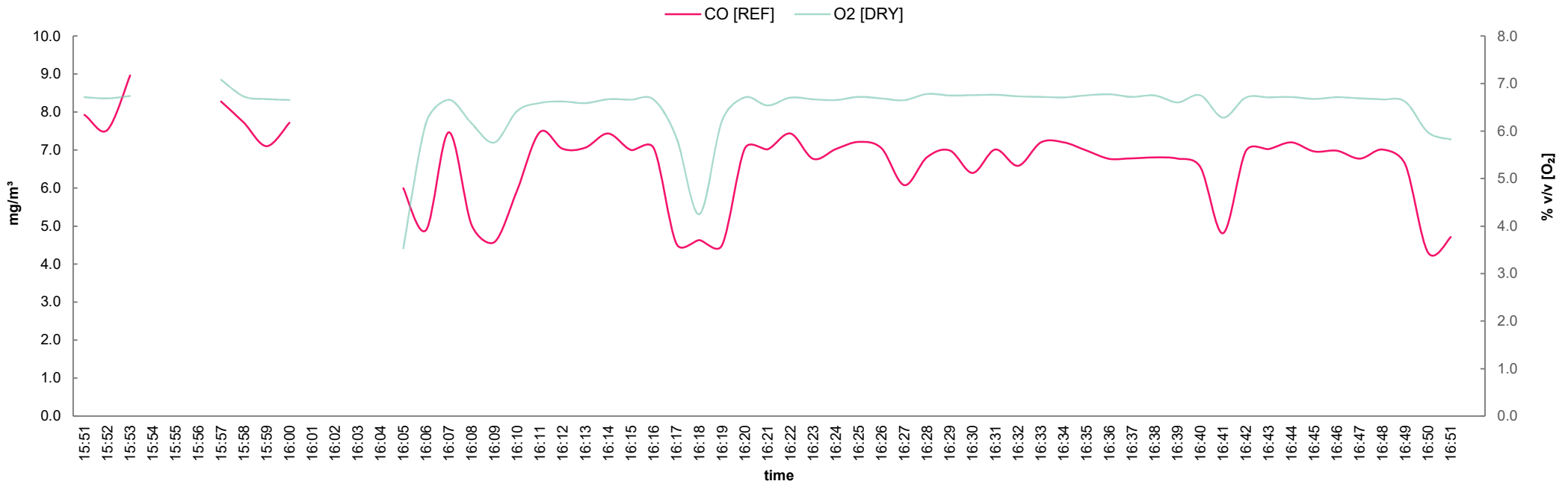
parameter	units	result ± MU (95% CI)	units	result ± MU (95% CI)
Carbon Monoxide	mg/m³	6.7 ± 0.3	g/hr	

General Information

parameter	details
sampling start date & time	21/08/2024 15:51
sampling end date & time	21/08/2024 16:51
test time | mins	60
testing team	BM | CM
standard | technical procedure	EN 15058 | TP-22b
analyser type	Horiba PG-350E
heated head & line temperature	180°C

parameter	details
probe material	Titanium
filter size, material & location	Filter Element PTFE | Within Heated Head
number sampling lines available	1
number sampling lines used	1
number sampling points ideal per line	1
number sampling points used per line	1
sampling point IDs	A1

Plot of Emissions Over Time



Part 2: Supporting Information - Appendix 2: Carbon Monoxide | Run 1

Analyser Calibration Information with QA checks

where [A] = at analyser, [L] = down sampling line

	pre-test calibration events								post-test calibration events			quality assurance					
CAL ID	date & time	zero [A] [ppm]	span [A] [ppm]	zero [L] [ppm]	span [L] [ppm]	T_{90} [s]	leak [%]		date & time	zero [A] [ppm]	span [A] [ppm]	zero drift [%]		span drift [%]		allowable [%]	temp [°C]
1	21/08/24 15:40	0.00	162.36	-0.30	163.00	22	0.0	P	21/08/24 16:57	-0.70	161.40	-0.6	P	0.0	P	±5	23.5

Analyser Calibration Extended Information

CAL ID	performed by	drift corr. applied	log period [s]	CYL ID	CYL conc. [ppm]	CYL expiry	CYL MU [%]	zero gas type	span [CYL] gas type	span target [ppm]	range [ppm]	LOD [ppm]
1	BM	No	60	A-CYL-86	162.36	27/12/2025	1.1	Nitrogen 5.2	10l 200ppm NO | 160ppm CO | 16% CO2 in Nitrogen	162.36	200	0.32

Part 2: Supporting Information - Appendix 2: Carbon Monoxide | Run 1

Measurement Uncertainty (MU) Calculations

general information	units	value
emission limit value (ELV) (REF)	mg/m³	N/A
measured concentration (REF)	mg/m³	6.7

MU budget			
parameter	units	min	max
ambient temp	°C	22.0	25.0
voltage	V	90.0	130.0

overall MU for O_2 correction
3.4%

MU factor O_2 correction
0.04

	MU budget input parameters				MU budget		
performance characteristics	symbol	units	value	source	symbol	units	value
repeatability at zero	rz	% of value	0.1	MCERTS certificate MC130223	U_{rz}	mg/m³	0.0067
repeatability at span	rs	% of value	0.2	MCERTS certificate MC130223	U_{rs}	mg/m³	0.013
lack of fit	lof	% of value	2	maximum allowable	U_{lof}	mg/m³	0.077
maximum short term zero drift (ABS) [after drift correction]	dz	% of value	0.56	day of testing	U_{dz}	mg/m³	0.021
maximum short term span drift (ABS) [after drift correction]	ds	% of value	0.037	day of testing	U_{ds}	mg/m³	0.0014
influence of sample gas flow	f	% of value	0.1	MCERTS certificate MC130223	U_f	mg/m³	0.0038
influence of sample gas pressure	p	% of value	0	MCERTS certificate MC130223	U_p	mg/m³	0
influence of ambient temperature zero point (/ 35k)	tz	% of value	-0.2	MCERTS certificate MC130223	U_{tz}	mg/m³	-0.00038
influence of ambient temperature span point (/ 35k)	ts	% of value	2	MCERTS certificate MC130223	U_{ts}	mg/m³	0.0038
influence of supply voltage (/ 60V)	v	% of value	0.5	MCERTS certificate MC130223	U_v	mg/m³	0.013
cross sensitivity at zero	iz	% of value	-0.48	MCERTS certificate MC130223	U_{iz}	mg/m³	-0.018
cross sensitivity at span	is	% of value	-0.87	MCERTS certificate MC130223	U_{is}	mg/m³	-0.033
maximum leak	L	% of value	0	day of testing	U_L	mg/m³	0
uncertainty associated with calibration gas	adj	% of value	1.1	span gas calibration certificate	U_{adj}	mg/m³	0.036
		combined MU with O_2 correction				mg/m³	0.15
		expanded MU with O_2 correction (k = 1.96)				mg/m³	0.3
		expanded MU 95% CI with O_2 correction (k = 1.96) as percentage of measured value				%	4.5
		expanded MU 95% CI (k = 1.96) as percentage of measured value for mass emission				%	2.9

method and sampling deviations
Sampling was performed in full compliance with the Standard, technical procedure and regulatory requirements.

Part 2: Supporting Information - Appendix 2: Oxygen | QA Concurrent Testing

Results

parameter	units	result ± MU (95% CI)
Oxygen	% v/v	6.5 ± 0.22

General Information

parameter	details
sampling start date & time	N/A - Concurrent Testing
sampling end date & time	N/A - Concurrent Testing
testing team	BM | CM

parameter	details
standard | technical procedure	EN 14789 | TP-22d
analyser type	Horiba PG-350E

Analyser Calibration Information with QA checks

where [A] = at analyser, [L] = down sampling line

	pre-test calibration events								post-test calibration events			quality assurance						
CAL ID	date & time	zero [A] [% v/v]	span [A] [% v/v]	zero [L] [% v/v]	span [L] [% v/v]	T_{90} [s]	leak [%]		date & time	zero [A] [% v/v]	span [A] [% v/v]	zero drift [%]		span drift [%]		allowable [%]	temp [°C]
1	21/08/24 15:40	0.00	21.36	0.02	21.00	14	1.7	P	21/08/24 16:57	0.05	21.31	0.5	P	-0.7	P	±5	23.5

Analyser Calibration Extended Information

CAL ID	performed by	drift corr. applied	log period [s]	CYL ID	CYL conc. [% v/v]	CYL expiry	CYL MU [%]	zero gas type	span [CYL] gas type	span target [% v/v]	range [% v/v]	LOD [% v/v]
1	BM	No	60	A-CYL-128	21.36	25/06/2029	1.2	Nitrogen 5.2	10l Synthetic Air	21.36	25	0.03

Part 2: Supporting Information - Appendix 2: Oxygen | QA Concurrent Testing

Measurement Uncertainty (MU) Calculations

general information	units	value
measured concentration (dry)	% v/v	6.5

MU budget			
parameter	units	min	max
ambient temp	°C	22.0	25.0
voltage	V	90.0	130.0

	MU budget input parameters				MU budget		
performance characteristics	symbol	units	value	source	symbol	units	value
repeatability at zero	rz	% of value	0.02	MCERTS certificate MC130223	U_{rz}	% v/v	0.0013
repeatability at span	rs	% of value	0.02	MCERTS certificate MC130223	U_{rs}	% v/v	0.0013
lack of fit	lof	% of value	2	maximum allowable	U_{lof}	% v/v	0.075
maximum short term zero drift (ABS) [after drift correction]	dz	% of value	0.47	day of testing	U_{dz}	% v/v	0.018
maximum short term span drift (ABS) [after drift correction]	ds	% of value	0.7	day of testing	U_{ds}	% v/v	0.026
influence of sample gas flow	f	% of value	-0.01	MCERTS certificate MC130223	U_{f}	% v/v	-0.00037
influence of sample gas pressure	p	% of value	0	MCERTS certificate MC130223	U_{p}	% v/v	0
influence of ambient temperature zero point (/ 35k)	tz	% of value	-0.4	MCERTS certificate MC130223	U_{tz}	% v/v	-0.00074
influence of ambient temperature span point (/ 35k)	ts	% of value	-0.15	MCERTS certificate MC130223	U_{ts}	% v/v	-0.00028
influence of supply voltage (/ 60V)	v	% of value	0.02	MCERTS certificate MC130223	U_{v}	% v/v	0.0005
cross sensitivity at zero	iz	% of value	0	MCERTS certificate MC130223	U_{iz}	% v/v	0
cross sensitivity at span	is	% of value	0	MCERTS certificate MC130223	U_{is}	% v/v	0
maximum leak	L	% of value	1.7	day of testing	U_{L}	% v/v	0.063
uncertainty associated with calibration gas	adj	% of value	1.2	span gas calibration certificate	U_{adj}	% v/v	0.039
		combined MU				% v/v	0.11
		expanded MU 95% CI (k = 1.96)				% v/v	0.22
		expanded MU 95% CI (k = 1.96) as percentage of measured value				%	3.3

method and sampling deviations
Sampling was performed in full compliance with the Standard, technical procedure and regulatory requirements.

Appendix I Boiler 3, Performance Data

Source: Byworth boilers

MX MODEL				MX	1000	
Boiler working pressure		barg	10.34	149.93	psig	
Saturation Temperature		degC	185.4			
Ambient Air Temp		degC	25			
REQUIRED BOILER DUTY 1000	Percentage Load		%	100	75	50	15
	Heat Output		kw	627.065	470.2988	313.533	94.0598
	F&A 100DegC		kg/h	1000	750	500	150
			lb/h	2205	1653.75	1102.5	330.75
Actual Boiler Output with Feed Water Temperature of	85	degC	kg/hr	930.5	697.9	465.3	139.6
			lb/hr	2051.8	1538.88	1025.9	307.78

FUEL HEATING VALUES			
Natural Gas			
GCV	52.97	Mj/kg	40.55 MJ/Ncu mtre
NCV	47.75	Mj/kg	36.55 MJ/Ncu mtre
Kerosene A1			
GCV	46.91	Mj/kg	
NCV	44.02	Mj/kg	

BOILER PERFORMANCE		Kerosene A1				Natural Gas				
Percentage Load	%	100	75	50	15	100	75	50	20	
Nett Heat Release	mw/m^3	1.38	1.04	0.69	0.22	1.40	1.05	0.70	0.22	
Nett Heat Input	mw	0.72	0.54	0.36	0.11	0.73	0.55	0.37	0.12	
Tube Pass Inlet Gas Temperature	deg C	1016	912	824	612	1124	1010	912	679	
Boiler Outlet Temperature	deg C	265	251	236	208	273	259	241	211	
Flue Gas Temperature to Stack	degC	265	251	236	208	273	259	241	211	
Feed Water Temperature	degC	85	85	85	85	85	85	85	85	
Total Gas Weight	kg/h	1122	875	610	198	1119	885	626	216	
Max CO_2 Emissions	kg/hr	185				145				
Boiler Efficiency on GCV	%	82.22	82.11	81.78	78.15	78.22	78.04	77.64	73.71	BS845
Boiler Efficiency on NCV	%	87.15	87.04	86.69	82.82	86.00	85.80	85.37	81.00	BS845
Boiler Efficiency on GCV	%	83.83	83.80	83.55	80.24	81.55	81.45	81.06	77.71	EN12953
Boiler Efficiency on NCV	%	88.09	88.02	87.72	84.03	87.42	87.26	86.82	82.71	EN12953
Total Draught Loss	inchwg	0.87	0.51	0.23	0.02	0.92	0.55	0.26	0.03	
	mbar	2.19	1.27	0.58	0.05	2.30	1.37	0.64	0.06	
Combustion air volume	Sm^3/s	0.25	0.20	0.14	0.05	0.26	0.20	0.14	0.05	
Exit Gas Volume fi Boiler	Am^3/s	0.47	0.36	0.24	0.07	0.48	0.37	0.25	0.08	
Fuel consumption	kg/h	58.50	43.93	29.41	9.23	54.46	40.94	27.43	8.67	kg/h
	litre/h	68.00	51.07	34.18	10.73	75.10	56.45	37.83	11.95	Sm^3/h
						71.15	53.49	35.84	11.33	Nm^3/h
	kWhr Gross	762.4	572.6	383.3	120.3	801.4	602.5	403.7	127.6	kWhr Gross

TYPICAL FUEL COSTS		
Annual Boiler Loading		
Average boiler Load	800	kg/hr
No. Hours/Day	24	hr
No days /week	7	days
No weeks	50	wks
Kerosene A1		p/litre
Cost per day	£ 0	
Cost per Week	£ 0	
Cost per Year	£ 0	
Cost per tonne of Steam	£ 0.00	
Natural Gas	2.6	p/kWh
Cost per day	£ 430	
Cost per Week	£ 3013	
Cost per Year	£ 150650	
Cost per tonne of Steam	£ 22.42	

Steam Release Area	m^2	1.55	Duct / chimney size @ velocity of 10 m/s	mm	246	inside diameter
Steam Release Rate	m/sec	0.0288	Duct / chimney size @ velocity of 12 m/s	mm	224	inside diameter

MX Boiler Performance Data

Appendix J Boiler 3, Emissions Test Data

Source: Pattemore's Transport Limited

BOILER 3 Burner Combustion Analysis Report

Date	Time	Who	Fuel	Burner status	O2 Cal %	CO2 Max %	Flue Gas Temp	% O2	% CO2	CO (ppm)	NO (ppm)	SO2 (ppm)	NOx (mgm^3)	% Effn	% Effg
17/02/2022	09:09	Weston	Light Oil	Low fire	3	15.5	238.8°C	8.03	9.57	24	43	0	128	86.5	81.4
				High Fire	3	15.5	308.2°C	7.22	10.17	2	67	0	188	83.3	78.5
09/08/2023	09:44	Weston	Light Oil	Low fire	3	15.5	198.7°C	6.86	10.44	0	54	0	148	90.3	84.9
				High Fire	3	15.5	289.4°C	8.77	9.02	10	54	0	171	83.2	78.3
													changed to (ppm)		
13/12/2023	10:50	Weston	Light Oil	Low fire	3	15.5	288.1°C	6.06	11.03	3	71	0	75	85.5	80.5
				High Fire	3	15.5	353.3°C	3.04	13.26	7	90	2	94	84.9	79.9
09/04/2024	07:55	Steam Pickett	Light Oil	Low Fire	no measurements taken as Engineer identified smaller flame nozzle needed										
				High Fire	3	15.5	294.9°C	5.80	11.20	55	79		82		80.3

Appendix K Boiler 4, Emissions Test Data

Source: Byworth boilers

BOILER 4 Burner Combustion Analysis Report

Date	Time	Who	Fuel	Burner status	O2 Cal %	CO2 Max %	Flue Gas Temp	% O2	% CO2	CO (ppm)	NO (ppm)	SO2 (ppm)	NOx (mgm^3)	% Effn	% Effg
17/02/2022	09:30	Weston	Light Oil	Low fire	3	15.5	244.0°C	10.91	7.45	7	55	0	211	82.9	78.1
				High Fire	3	15.5	320.7°C	3.47	12.94	52	107	0	236	86.0	81.0

Appendix L Boiler 4, Example Technical Specification

TECHNICAL MANUAL

GB

AX

STEAM GENERATOR

1 TECHNICAL CHARACTERISTICS

1.1 GENERAL

The AX series steam boilers are type semi-fixed, horizontal smoke-tube type, complete with accessories. The boilers are suitable for operation with pressurised burners for gas, fuel oil or heavy oil.
Safety, reliability, high efficiency and high quality saturated steam are the characteristics of our boilers. Please consult the instructions with attention.

This high-pressure steam (12-15 kgf/cm^2) generator uses a combustion chamber with flue gas inversion. For operation at up to 3000 kg/h of steam generated there is partial exoneration (in Italy) in the employment of specialist boiler operators. Local requirements as to personnel qualification MUST be taken into account for the country where the unit is installed.

1.2 CHARACTERISTICS

- **Working pressure switches** for operation (controlling the 1st and 2nd burner flame).
- **Locking pressure switches** (stops the burner on reaching the maximum steam pressure; the boiler is manually reset from the control panel).
- **Automatic level regulator** (2 probes connected to an electronic conductivity relay maintain the water level between the set levels).
- **Water level limits** (2 probes connected to two independent electronic conductivity relays stop the burner if the water level falls below the safe minimum; reset is manual on the control panel).

1.3 TECHNICAL DATA

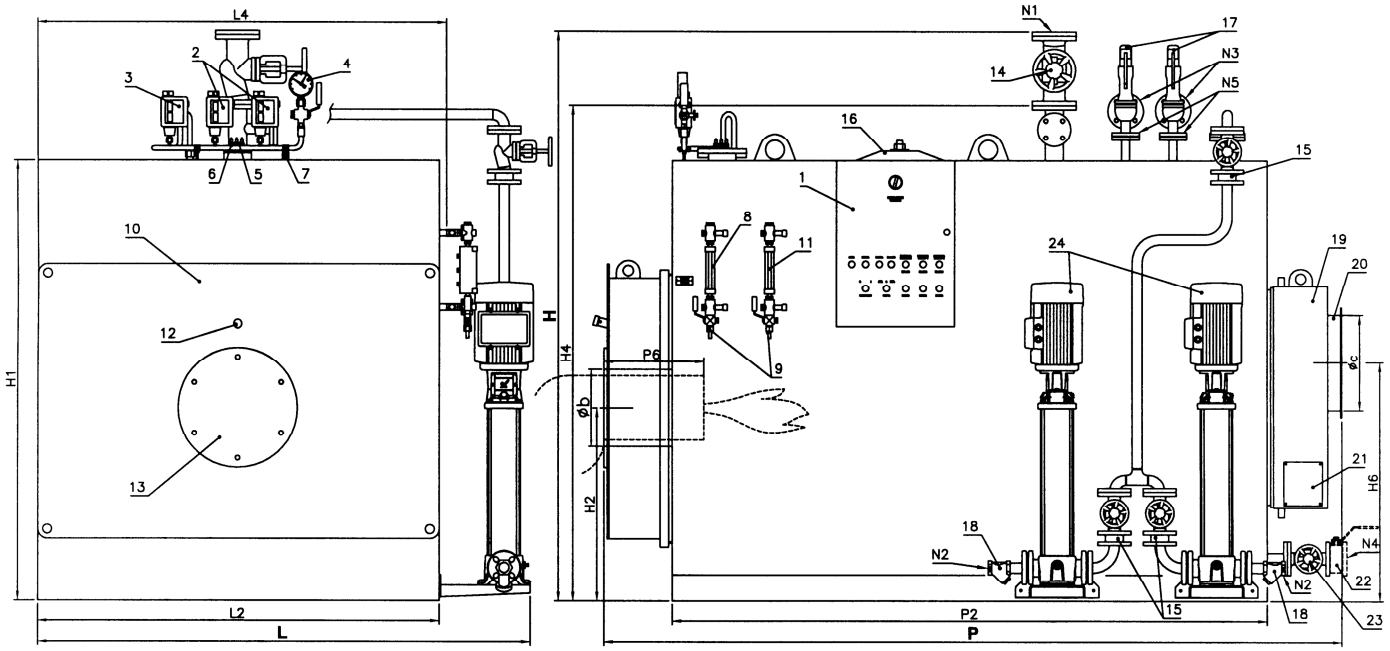


Fig. 1

LEGEND

1 Switchboard
2 Control pressure switches
3 Safety pressure switch
4 Pressure gauge
5 1st safety level probe
6 Level control probes
7 2nd safety level probe
8 1st level gauge
9 Level gauge drain
10 Front plate
11 2nd level gauge
12 Flame inspection hole
13 Burner plate
14 Steam take-off
15 Non return valve
16 Inspection door
17 Safety valves
18 Feed filter
19 Back smokebox
20 Smokestack connection
21 Cleaning door
22 Rapid exhaust valve
23 Exhaust valve
24 Feed pumps

N1 Steam intake
N2 Feed
N3 Safety valves exhaust
N4 Boiler exhaust
N5 Safety valves fitting

Characteristics	Heat output		Pressure losses flue gas side	Design Pressure	Total capacity	Steam capacity*	Total weight	Electric supply	Frequency	Insulation class	Electric power	Fuel			
	kW	kcal/h	mbar	bar	l	kg/h	kg	Volt ~	Hz	IP	W	Nat. gas	Lpg	Gasoil	Heavy oil
AX 200	**233**	200.000	3,5	12	730	340	1500	3/N 400	50,0	IP55	4000	X	X	X	X
AX 300	**349**	300.000	3,5	12	940	510	1800	3/N 400	50,0	IP55	4000	X	X	X	X
AX 400	**465**	400.000	5,0	12	1090	680	2100	3/N 400	50,0	IP55	4000	X	X	X	X
AX 500	**581**	500.000	4,5	12	1380	850	2600	3/N 400	50,0	IP55	4000	X	X	X	X
AX 600	**698**	600.000	6,0	12	1585	1020	3000	3/N 400	50,0	IP55	4000	X	X	X	X
AX 800	**930**	800.000	5,5	12	2030	1360	3600	3/N 400	50,0	IP55	4000	X	X	X	X
AX 2000	**1163**	1.000.000	7,0	12	2330	1700	4300	3/N 400	50,0	IP55	4000	X	X	X	X
AX 1200	**1395**	1.200.000	8,0	12	2860	2040	4700	3/N 400	50,0	IP55	10000	X	X	X	X
AX 1500	**1744**	1.500.000	6,5	12	3630	2560	6000	3/N 400	50,0	IP55	10000	X	X	X	X
AX 1750	**2035**	1.750.000	7,5	12	4020	3000	6500	3/N 400	50,0	IP55	10000	X	X	X	X
AX 2000	**2326**	2.000.000	8,0	12	4570	3410	7500	3/N 400	50,0	IP55	15000	X	X	X	X
AX 2500	**2907**	2.500.000	9,0	12	6220	4270	10000	3/N 400	50,0	IP55	15000	X	X	X	X

Dimensions	H	H1	H2	H4	H6	L	L2	L4	P	P2	P6	Øb	Øc	N1	N2	N3	N4	N5
	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	DN/in	DN/in	DN/in	DN/in	DN/in
AX 200	**1600**	1240	575	1440	720	**1480**	1080	1130	**2060**	1508	280-330	180	250	32	1à1/4	40	32	25
AX 300	**1780**	1400	640	1600	815	**1640**	1240	1290	**2092**	1511	310-360	225	250	32	1à1/4	40	32	25
AX 400	**1800**	1400	640	1620	815	**1640**	1240	1290	**2342**	1761	310-360	225	250	40	1à1/4	40	32	25
AX 500	**1980**	1560	700	1780	900	**1800**	1400	1450	**2381**	1760	350-400	280	300	40	1à1/4	40	32	25
AX 600	**2010**	1560	700	1780	900	**1800**	1400	1450	**2631**	2010	350-400	280	300	50	1à1/4	40	32	25
AX 800	**2160**	1710	735	1930	950	**1950**	1550	1600	**2661**	2010	370-420	280	350	50	1à1/4	40	32	25
AX 1000	**2220**	1710	735	1940	950	**1950**	1550	1600	**2961**	2310	370-420	280	350	65	1à1/4	40	32	25
AX 1200	**2370**	1850	810	2080	1000	**2100**	1680	1730	**3163**	2512	370-420	320	400	65	1à1/4	40	32	25
AX 1500	**2550**	1990	850	2240	1080	**2260**	1840	1890	**3413**	2710	420-470	360	450	80	1à1/4	40	32	25
AX 1750	**2550**	1990	850	2240	1080	**2260**	1840	1890	**3713**	3010	420-470	360	450	80	1à1/4	50	32	32
AX 2000	**2710**	2150	880	2390	1240	**2450**	1950	2000	**3785**	3013	480-530	360	500	80	1à1/4	50	32	32
AX 2500	**2900**	2300	950	2550	1240	**2600**	2100	2150	**4283**	3504	480-530	400	550	100	40	50	40	32

* 80°C feeding water

2 ACCESSORIES

AX steam boilers are fitted with a series of accessories that can be subdivided as follows:
Å Safety accessories (safety valves, water level limits, safety pressure switches).
Å Observation accessories (level gauge, pressure gauge, flame inspection).
Å Control accessories (level ad pressure switches).
Å Feed water accessories (centrifugal pump, injector or alternating steam pump).
Å Manual operation accessories (stop valves, purge valve).

In the following description the accessories are subdivided as to the physical parameter they control (pressure and level).

2.1 PRESSURE

2.1.1 Pressure gauge (Fig. 2)

The pressure gauge is Bourdon type consisting of a flat elliptical section metal tube, bent to an arc. One end of the tube is open and communicates with the boiler where the pressure is to be measured; the other end, closed and free to move is connected by a lever system to a toothed arc and to the gauge indicator hand.
The gauge shows in red the design pressure.

The gauge is carried on a three-way valve to allow the following operations:

- Communication between boiler and gauge (normal operation position).
- Communication between gauge and the atmosphere (position necessary to purge the siphon).
- Communication between the boiler, the gauge and a test gauge (position necessary to verify the gauge).

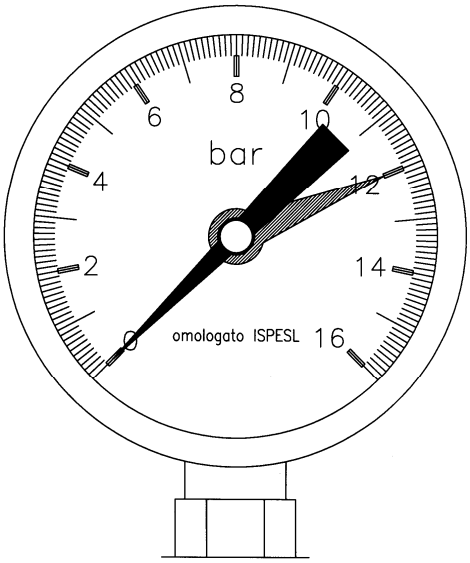


Fig. 2

2.1.2 Operation pressure switch

Device that controls the boiler pressure and holds the pressure between the set maximum and minimum values.

Instructions for adjustment.
The electric switch has three screws (2-1-3 from right to left).
On reaching the set pressure, the contact 2-1 switches to 2-3.

Adjustment of the pressure switch (Fig. 3):

a) Turn the knob (1) until the scale indicator (2) reaches the pressure at which the burner shall restart.
b) Remove the cover of the pressure switch and position the drum (3) at the value selected for the pressure differential (stopping the burner) as to the diagram Fig. 4.

Example:
* Type of pressure switch: RT 5
* Scale indicator 9 bar
* Drum indicator: 4 corresponding to 2,1 bar
* Burner start: 9 bar
* Burner stop: 11,1 bar

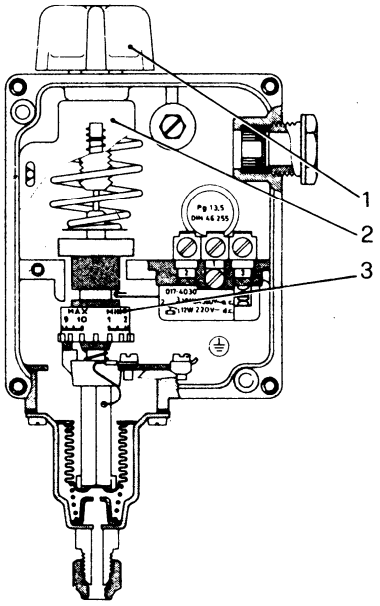


Fig. 3

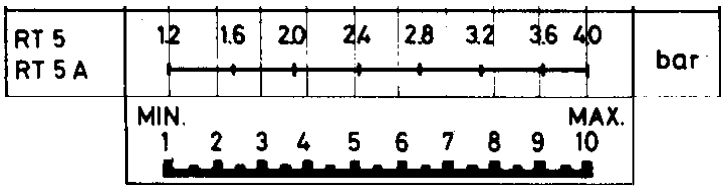


Fig. 4

2.1.3 Safety pressure switch

This switch is set at a higher pressure than the maximum of the control pressure switch, but always lower than the opening pressure of the safety valves.

The safety pressure switch acts in the case of a fault to the control pressure switch and stops the burner permanently. Restarting the burner can only occur after the steam pressure has fallen and after a manual reset on the switchboard.
This pressure switch is adjusted in a similar manner to that of the control pressure switch, with the only precaution that the drum indicator is set to 1 so that the differential is effectively nil.

2.1.4 Safety valves

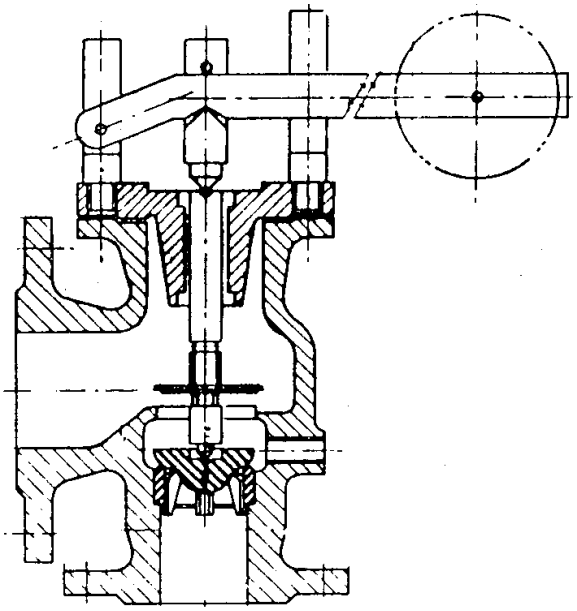


Fig. 5

These valves have the function of discharging steam when the maximum design pressure of the boiler is reached.
The valves used on boilers can be of the type **Lever and weight** (Fig. 5) or **Spring** (Fig. 6).
The boiler operator must pay much attention to the safety valves and carry out careful and diligent maintenance. The safety valve is the most important and sensitive accessory on the boiler and represents the best guarantee that the internal pressure of the boiler does not exceed the design pressure.
As during normal operation of a boiler, the safety valve never acts, it is **good practice to check that the valve is free, i.e. that the valve plug is not stuck to the seat,** by acting on the side lever (spring valves) or on the horizontal lever carrying the weight (lever and weight valves) until the valve starts to discharge steam.

WARNING
On first start-up, you must verify that safety valve adjustment is made to the boiler design pressure. Generally the spring safety valve is supplied already adjusted, while the lever and weight type must be adjusted by moving the weight along the lever until the opening pressure value corresponds to the boiler design pressure.
The safety valve installed on steam boilers must have the discharge piped to outside the boiler room. Particular care must be taken in designing the discharge line; we show some here.

- The discharge line should e of diameter at least equal to that of the discharge flange on the safety valve.
- Only wide radius curves must be used in the discharge line.
- The entire discharge line must be built to avoid the formation of condensation locks. There must be therefore adequate slopes to ensure complete drainage.

Particular care must be taken if the valve seat and plug are to be ground; if this operation becomes necessary due to leaks, use abrasives based on silicon carbide or oil based carborundum. Carry out the first grinding operation using fine grain abrasive, finishing with a very fine grain abrasive.

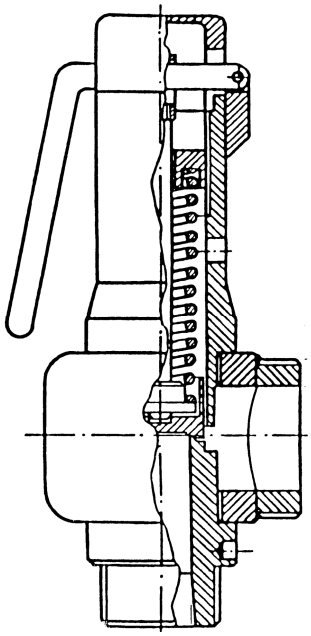


Fig. 6

2.2 LEVEL

2.2.1 Level indicator gauge

The level indicator consists of a pair of valves connected to a sight glass box containing a prismatic glass. This device is connected to the boiler both above and below the normal water level, while the lower part is fitted with a purge valve so that any sludge can be removed, to keep the glass clean. Using these valves, the efficiency of the level control system can be verified periodically by carrying out the following operations:

- Open for a few seconds and then close the purge valve. If the water disappears from the sight glass and then appears again with ample level oscillation, then it can be considered that the level operates correctly. If on the other hand the water returns slowly or stops at a level differing form the preceding level, then on of the communications may be obstructed. To make sure which of the two is obstructed, and to attempt a purge, close the steam valve leaving the water valve open, then open the purge valve. This valve must release water taking with it any sludge formed in the pipes. Then close the water valve and open the steam valve: steam should be released from the purge valve. Closing the purge valve and leaving the two water and steam valves open, the water should return to the initial level. If this does not occur, the communication pipes between the level and the boiler must be cleaned.

2.2.2 Automatic level regulator and water level limits (Fig. 7)

The physical principle employed to detect and control the water level is based on the electrical conductivity of the water. The control device consists of a part sited in the control panel (electronic relays) and of probes of differing lengths immersed in the boiler shell.
Operation of the system provides for:

- **Automatic pump start and stop**: Two probes inserted in the boiler, of which the longer starts, and the shorter stops the pump, connected to a single control relay in the control panel.
- **Burner stop at low water level**: two probes of the same length, inserted in the boiler and connected to two distinct control relays in the control panel, stop the burner permanently if the water level drops below the admissible level.

Boiler probes:

6 Pump stop
7 Pump start
8 1st safety burner stop and alarm on.
9 2nd safety burner stop and alarm on.

N.B.: we suggest that as well as the acoustic alarm in the boiler room, a further acoustic alarm be provided in an area where personnel is normally present.

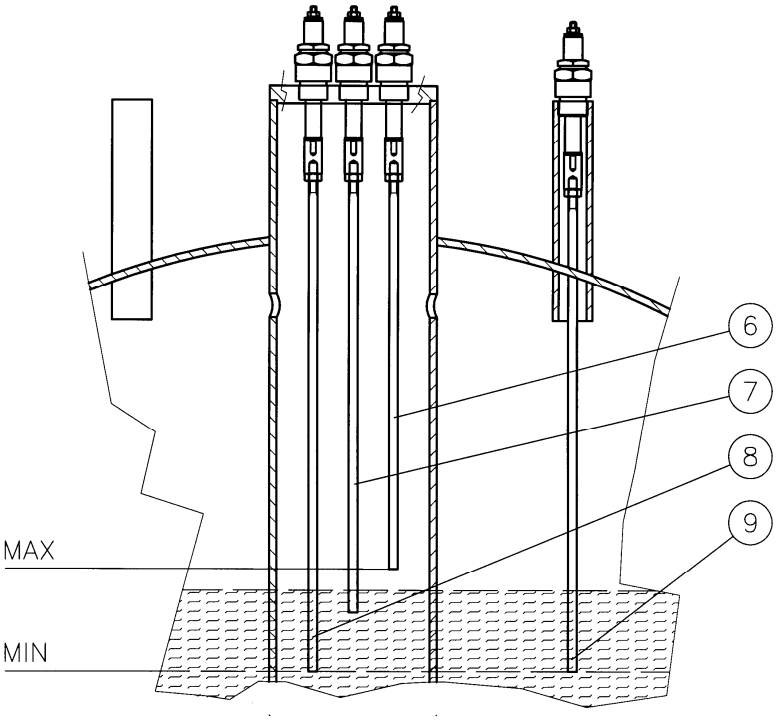


Fig. 7

2.3 FEED WATER

An electric centrifugal pump supplies the water. The inlet side of the pump must never be under suction pressure, but always under positive pressure due to the difference in height between the pump itself and the feed water tank. While a pump can operate under suction head from a cold water tank (up to 5-6 m), if the water is hot the pump cannot operate and indeed needs the water to be delivered under a certain pressure. The height of the feed water tank varies with the temperature, as shown in the following table:

Feed water temperature (Celsius)	**Positive water head** (metres)
60	1
70	2
80	3
90	4,5

WARNING

- **Avoid the use of feed water at temperatures lower than 60 Celsius, being rich in Oxygen and therefore such as to cause corrosion.**
- **To avoid pump cavitation problems, the feed water temperature should not be higher than 90 Celsius.**

3 INSTALLATION

3.1 SITING

Our steam boilers are supplied as units and do not need any foundation work. A flat even floor only is needed, that can be raised by 5-10 cm.

3.2 WATER CONNECTIONS

The steam boilers once positioned are connected to the system as follows (Fig. 9):

Water

From the condensate collection tank (10) (if existing; otherwise from the treated water tank) to the suction side of the feed water pump (9).

Steam

From the main steam take-off valve (3) to the user services (distributor or others), from the safety valve outlets (6) to outside the boiler room in a safe position.

Drains

From the level indicator drains (16), the boiler drain (17) to the drainage network.

Fuel

Connection to the burner foreseen for fuel oil or natural gas.

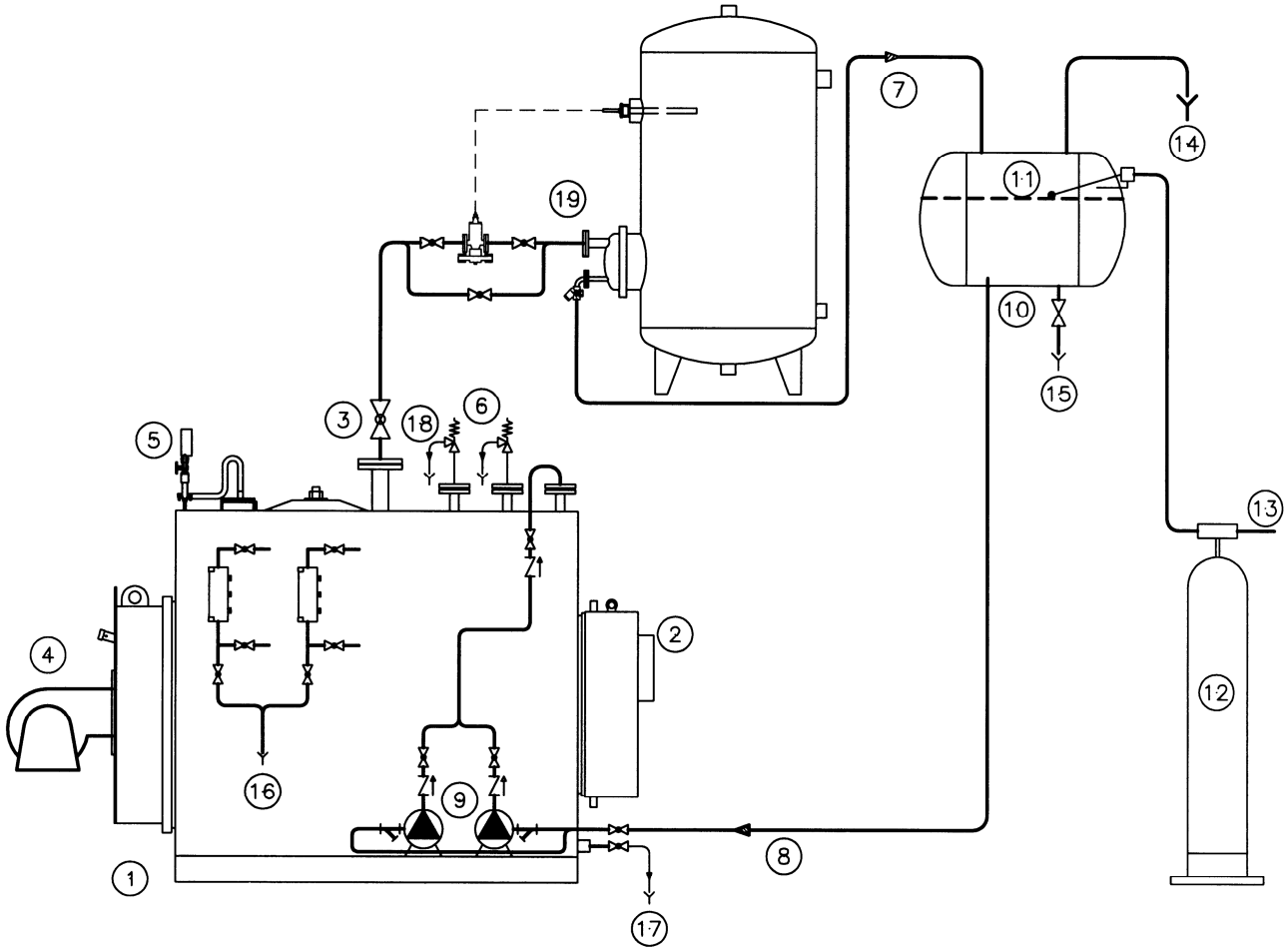


Fig. 9 ï System diagram

LEGEND

1. Boiler
2. Smokestack
3. Steam take-off
4. Burner
5. Pressure switches
6. Safety valves
7. Condensate return
8. Electric pump supply
9. Feed water pumps
10. Condensate collection tank
11. Water level
12. Water treatment
13. Water supply
14. Breather
15. Condensate tank drain
16. Level indicator drain
17. Boiler drain
18. Safety valve drain
19. Example of user service

3.3 ELECTRIC CONNECTIONS

The boilers are provided with a switchboard (protection level IP 55) completely assembled to the various boiler accessories. Before connecting the switchboard, make sure that the electric system has been correctly installed, checking in particular the efficiency of the earthing system.

Wiring diagram
Refer to the diagram supplied with the specific switchboard.

3.4 SMOKESTACK

The connection from the boiler to the base of the smokestack must slope upwards in the direction of the gas flow, with a slope that should be at least 10%. The path should be as short and as possible and the bends and connections designed as to the rules used in the design of air ducts.

For lengths of up to 2 metres, the same diameter as the boiler flue gas outlet can be used (see the technical specification table). For more tortuous paths, the diameter must be suitable increased.

The smokestack must in any case be dimensioned as to applicable regulations. It is advisable to pay great attention to the inside diameter, insulation, gas tightness, ease of cleaning and to the fitting required for taking flue gas samples for combustion analysis.

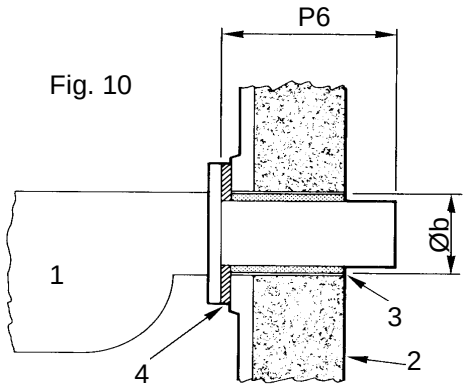
3.5 BURNER

To better answer to steam demand, it is advisable to install a **two-stage burner** or **a modulating burner;** this avoids large pressure variations consequent on sudden stream demands.
Further, and above all with natural gas, every burner start-up is preceded by a long period of preventilation of the combustion chamber, with consequent loss of heat to the smokestack.

3.5.1 Boiler - Burner coupling

Verify that the spaces between the burner sleeve and the boiler door are suitable filled with flame-resistant ceramic insulation (Fig. 10).

Fig. 10



KEY:
1. Burner
2. Manhole
3. Thermoinsulating material
4. Flange

All details on the draught tube lenght (**P6**), the diameter of the burner hole (**Øb**) and the pressurization are included in the par. Technical Specifications.

4 BOILER OPERATION

4.1 FIRST START-UP

WARNING: Before start up insert all the turbolators into the smoke tubes ensuring that there is a space of at least 100 mm at the front after they have been pushed fully inside.

Å Verify that all fittings are tight.

Å Verify that the feed water pipes are clean, carrying out a series of washing operations with drainage to waste before final boiler filling.

Å Close the drain valves, the steam take-off valve and the level drains.

Å Open the level control valves and the feed water valve (upstream of the feed water pump).

Å Check that the upper man-way is correctly closed.

Å Start the boiler as follows:

1) Switch on the control panel by turning the main switch.

2) Check that the drive shaft of the feed water pump is free to turn. By starting the pump manually for an instant, check that the shaft turns in the correct direction.

3) Set the pump switch to AUT and verify that burner cannot start before the attainment of the minimum level;

4) Check that the pump stops when the maximum level is reached by observing the level indicators and checking the positions of the indicator valves.

5) Press and keep pressed the safety water level reset button for at least 10 seconds, the conductivity relay being of the delayed type.

6) Open the boiler drain and check on the level indicator at what level the pump-start probe acts.

7) Set the pump switch to ñ0ò leaving the drain open and check the actuation level of the safety probes with respect to the minimum level reference plate.

8) Close the drain and set the pump switch to AUT

9) Switch on the burner and bring the boiler up to pressure adjusting the operation pressure.

WARNING: On boilers with a man-way, during the first start-up it is important to tighten progressively the nuts on the man-way cover as the pressure increase. Otherwise a hazardous situation is created due to steam leaks that quickly deteriorate the gasket creating a dangerous situation for the boiler room personnel.

4.2 NORMAL OPERATION

With cold start-ups, verify that:

- The boiler is full of water to the minimum level;
- The increase of the water volume due to heating does not raise the water level too far: if necessary drain the boiler at regular intervals to bring the visible level back to the centre of the water level sight glasses;
- On reaching the set pressure, the steam take-off valve can be opened very gradually in order to heat the steam delivery lines eliminating any condensate that may be present in the pipework;
- The man-way gasket does not leak.

5 MAINTENANCE

5.1 ORDINARY

- Periodically purge the level gauges, probe holder if fitted and the boiler, to avoid the accumulation of sludge;
- Check the efficiency of the control and regulation instruments, examining carefully the electrical parts (connections included) and the mechanical parts (pressure switches); it is advisable to replace every year the ceramic probe-holders;
- Carry out burner maintenance (as to the specific instructions);
- Check the tightness of flange bolts and the state of the gaskets;
- Check the conditions of the boiler door internal covering;
- Clean the flue-gas tube bundle and the turbolators;
- Carry out correct maintenance to the pump (bearings, mechanical seal),
- Check for wear to the discharge valves; these tend to wear more quickly, due to the abrasive effect of the sludge during blow-down.

5.2 PERIODIC

5.2.1 Periodic control (every 6 hours of use)

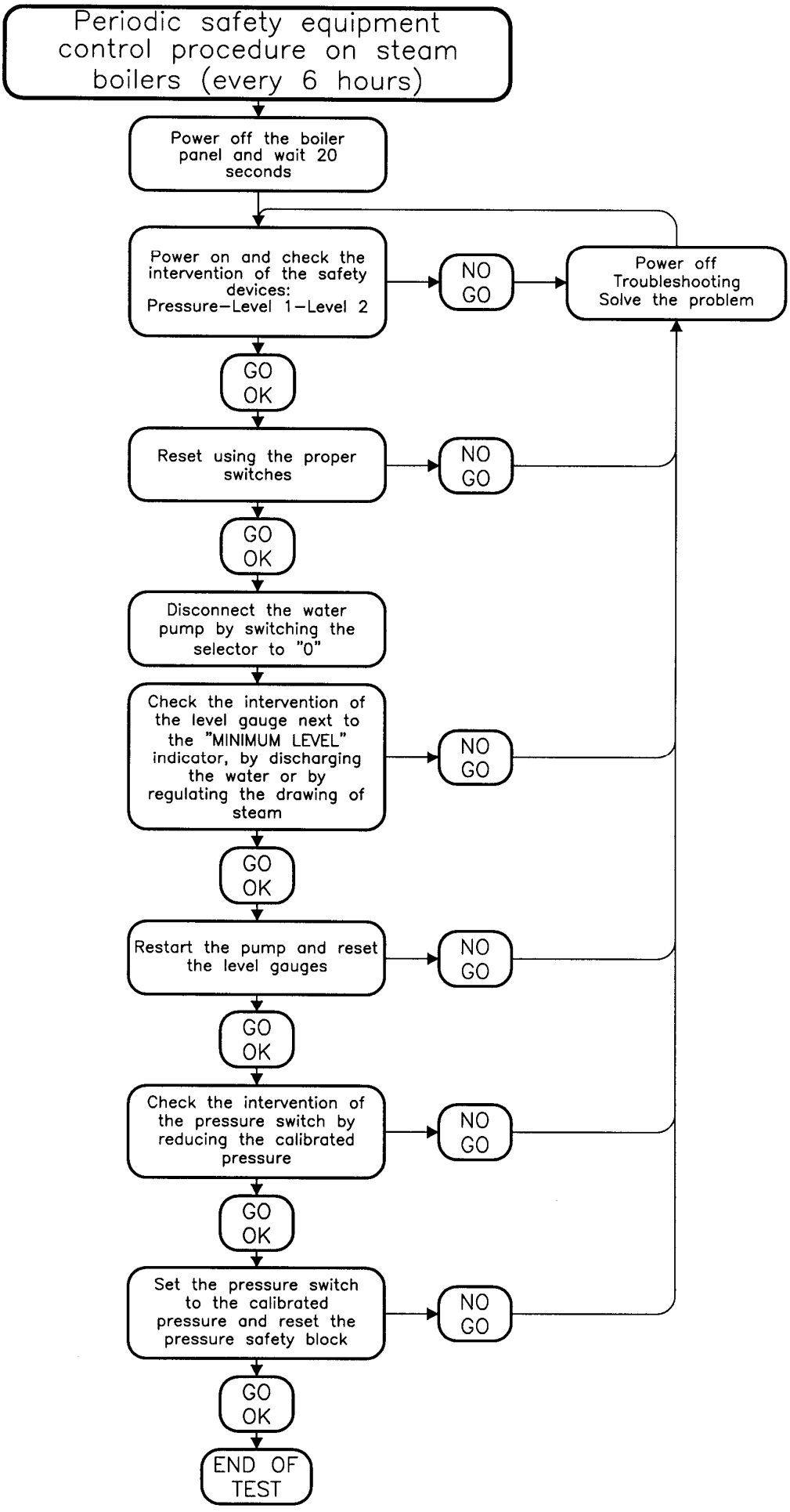
From time to time (every 6 hours of use) the thermal plant must be inspected by qualified personnel to check the efficiency of all safety accessories:

- Safety pressure switch

- Water level limits

The system can be reset if no anomalies have been encountered: power off the panel for approx. 20 seconds, power on the main switch and press the reset buttons.

For further details follow the flow chart below:


Periodic safety equipment control procedure on steam boilers (every 6 hours)
Power off the boiler panel and wait 20 seconds
Power on and check the intervention of the safety devices: Pressure–Level 1–Level 2
NO GO
Power off Troubleshooting Solve the problem
GO OK
Reset using the proper switches
NO GO
GO OK
Disconnect the water pump by switching the selector to "0"
Check the intervention of the level gauge next to the "MINIMUM LEVEL" indicator, by discharging the water or by regulating the drawing of steam
NO GO
GO OK
Restart the pump and reset the level gauges
NO GO
GO OK
Check the intervention of the pressure switch by reducing the calibrated pressure
NO GO
GO OK
Set the pressure switch to the calibrated pressure and reset the pressure safety block
NO GO
GO OK
END OF TEST

5.3 SCHEDULED

All boilers must be periodically stopped for careful inspection and maintenance: the time interval between stops is established by experience, by the operating conditions, by the quality of the feed water and by the type of fuel used.
Before entering the boiler shell for inspection or for cleaning, check carefully that there is no possibility of entry of water or steam via the pipework to which the boiler is connected. Every valve must be locked and if necessary isolated by removing a piece of pipework or by inserting a blind flange.
The parts under pressure must be carefully examined internally to identify any encrustation, **corrosion** and other potential **sources of danger linked to the feed water**.
All deposits must be removed mechanically or chemically and **the effective thickness of the structures must be verified using suitable instruments to determine that they are equal to or greater than the design values**. All pustules or other types of corrosion must be scraped and cleaned with a steel wire brush to white metal. Leaks between fire tubes and tube plates must be carefully examined: any welding must be done in all cases observing legal obligations, without forgetting that a steam boiler is a pressure vessel with danger of explosion and subject to control by competent authorities.
During inspection also verify all the accessories, with priority to safety valves, level probes and pressure switches.

5.4 CONSERVATION DURING WHEN OUT OF SERVICE

Often during periods of disuse the worst cases of corrosion appear. The operations to be carried out to guarantee correct conservation of the boiler depend essentially on the duration of the stop.
The boiler can be subjected to dry conservation if the period of disuse is long, or to a wet conservation for short stops or if the boiler has a back-up function and must be ready to come on-line in a short time.
In both cases, the necessary operations tend to eliminate the causes of possible corrosion.

5.4.1 Dry conservation

The boiler must be drained and dried carefully, then placing in the boiler shell a hygroscopic substance (for example lime or silica gel etc)

5.4.2 Wet conservation

The boiler must be filled completely, given that corrosion is a phenomenon that appears due to the simultaneous presence of water and Oxygen. Therefore all traces of Oxygen must be removed from the water, also avoiding the successive infiltration of air. There are substances that absorb Oxygen, such as hydrazine and Sodium Sulphite, but after their use the water alkalinity must be checked.

6 WATER CHARACTERISTICS

For steam generators with heating surface over 15 sqm, **there are some regulations that require limit values for water characteristics.** These values are listed in the tables below.
However, limits should be adopted for all generators as stated by qualified companies that recommend the type of treatment to be carried out basing on careful analysis of the available water. **Many faults and sometimes serious accidents are caused by the use of water with non-conforming features.**

6.1 FEEDWATER - LIMIT VALUES (entering the boiler)

Tab.1

Characteristics	**Unit of measurement**	**Pressure [15 bar**	**Pressure [25 bar**
pH		7 ÷ 9,5	7 ÷ 9,5
Total hardness	mg/l $CaCo_3$	10	5
Oxygen (1)	mg/l O_2	0,1	0,05
Free Carbon Dioxide (1)	mg/l CO_2	0,2	0.2
Iron	mg/l Fe	0,1	0,1
Copper	mg/l Cu	0,1	0.1
Oily substances	mg/l	1	1
Aspect	Clear, limpid, no persistent foam.		

(1) These values are valid to have a thermo degassing device. Without degassing device, the temperature of the tank water must be increased to at least 80 Celsius (see chapter 2.3. - Feeding) to reduce the content of dissolved gasses (O_2 and CO_2). Chemical deoxygenators must be used to remove completely the oxygen from the feed water and reduce as much as possible CO_2 corrosive effects.

6.2 OPERATING WATER - LIMITING VALUES

Tab.2

Characteristics	**Unit of measurement**	**Pressure [15 bar**	**Pressure [25 bar**
pH		9 ÷ 11	9 ÷ 11
Total alkalinity	mg/l $CaCo_3$	1000	750
Total hardness	mg/l $CaCo_3$	10	5
Maximum conductivity (4)	μS/cm	8000	7000
Silica	mg/l SiO_2	150	100
STD (4)	mg/l	3500	3000
Conditioner (2)			
Aspect	Clear, limpid, no persistent foam		

(1) To maintain in the boiler the parameters of alkalinity and silica within the prescribed or recommended limits, the boiler must be purged, if possible continuously. The values of the concentrations in the feedwater and in the boiler water are linked to the continuous purge by the following relationship:

$$S\% = 100\frac{Ca}{Cc}$$

Where

S% = Percentage of purge with respect to the feed water supplied to the boiler;
Ca = Real concentration of a certain salt or ion in the feed water
Cc = Maximum allowed concentration in the boiler for the same salt.

(2) Correct management presupposes normally the use of conditioners, whose dosages and limits are in relation to the nature and characteristics of the additives themselves.
(3) Determined on a filtered sample
(4) The two parameters have the same physical meaning but the values can be correlated only if the chemical composition of the water is known.

6.3 FREQUENCY OF THE ANALYSES

The frequency of analysis is determined evidently as a function of the use of the boiler and of the quality of the water used; it is advisable in any case to check the pH, the total hardness and the alkalinity of the feed and boiler waters at least every two days. Once a month, especially under conditions of variable operation, it is advisable to subject meaningful samples of the boiler and feed waters to complete analysis.
It is also advisable to inspect the return condensate for traces of any highly contaminating oily substances (reduction of evaporation from the water surface in the boiler caused by a layer of oil).

7 TROUBLESHOOTING

FAULT	PROBABLE CAUSE	SUGGESTED REMEDY
Safety valve/s opening	Maximum pressure exceeded, as set on the valve. Must be equal to the boiler design pressure.	Adjust the safety pressure switches and / or limit switches.
	Loss of the adjustment of the safety valve	Check and then adjust the valve using a reference gauge
Small leaks from the safety valve/s	Dirt on the valve seat	Clean the seat by opening the valve manually a few times
	Marks on the valve seat	Dismantle the valve and regrind the valve seat with very fine abrasive.
Pump stopped	Pump overload relay has acted	Check the motor current
		Check the relay setting
	Pump shaft seized	Maintenance to the pump
Pressure safety switch operates	Pressure limit switch set too high	Adjust the pressure limit switch
	Pressure limit switch faulty	Replace the pressure limit switch
	Pressure switch pipe coil blocked	Clean or replace the pipe coil
Safety level 1 or 2 operates	Water level detection interrupted	Steel probe encrusted Connection cable interrupted
	Safety level relay faulty	Temporary replacement of the safety electronic relay with one of the two relays in the panel. If the problem disappears, replace the faulty relay.
	No water feed	See faults "feed water"
Feed water insufficient	Pump seized	See faults "Pump stopped"
	Pump suction filter blocked	Clean the filter
	Level control faulty	Temporary replacement of the electronic control relay with one of those present in the panel. If the problem disappears, replace the faulty relay.
	Level probes short circuited	Dismantle the control probes for inspection of the ceramic insulation
	Pump cavitation	Suction head (difference in height between supply tank and pump) insufficient in relation to the water temperature
		Clean the pump suction filter
		Reduce the head loss in the pipe between collector tank and the pump by increasing the pipe section
	Pump rotation direction	Invert two phases (three-phase pump)
Burner always ON	Erroneous electrical connection to the panel	Consult the wiring diagram
	Safety level relays faulty	See ñIntervention safety level 1 or 2ò
	Control and/or safety pressure switches inactive	Check the adjustment of the pressure switches
		Check the pressure switch connections to the control panel
Burner always OFF	Problems with the burner	See the specific burner Manual
	Burner fuses interrupted	Replace the fuses
	No consent to the burner from the control pressure switch	Replace the control pressure switch
	No consent to the burner from the safety level relay	See ñIntervention safety level 1 or 2ò
	Erroneous connection to the control panel	Consult the wiring diagram

8 WATER LEVEL LIMITS

8.1 GENERAL

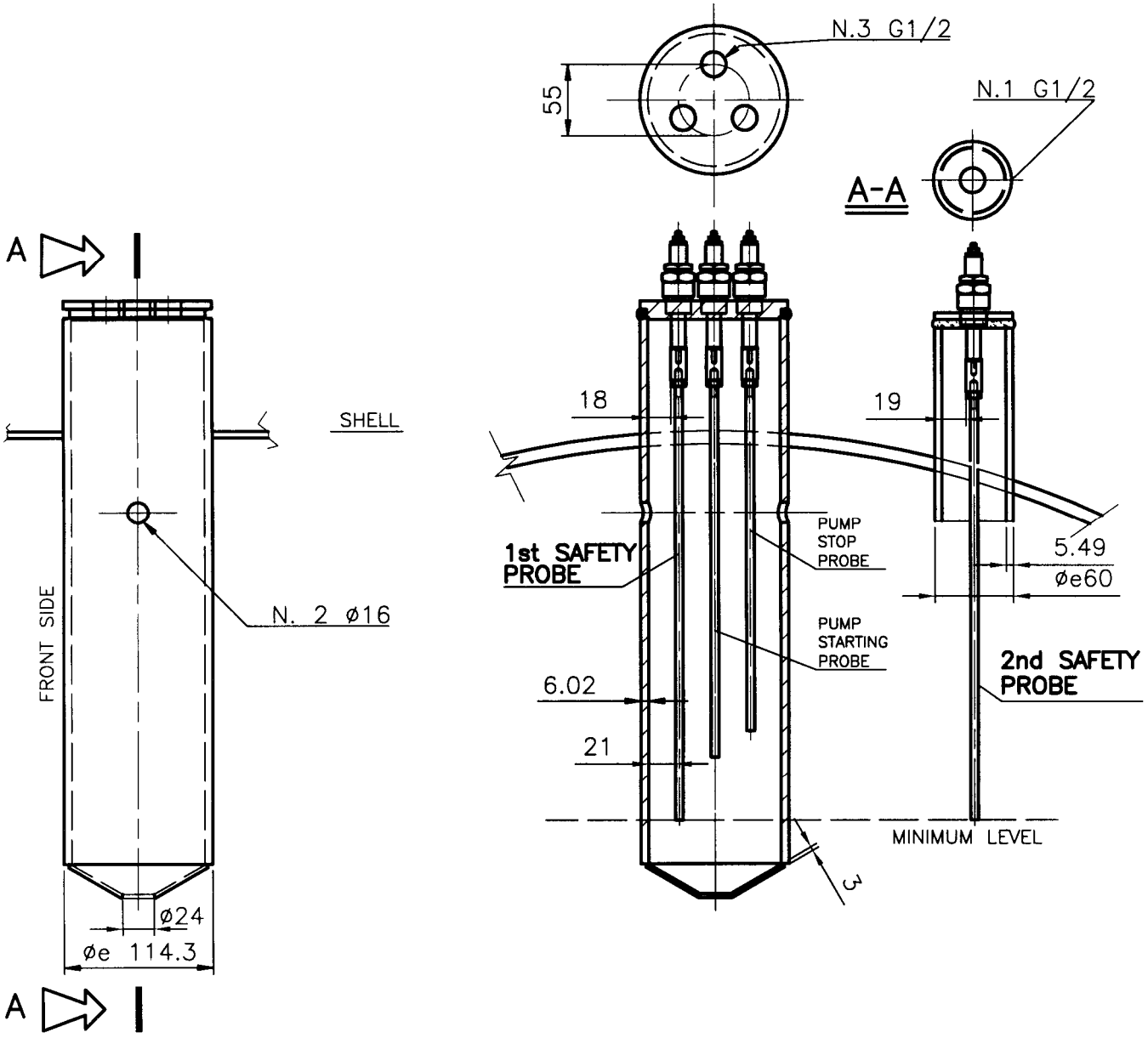
The water level limits consists in: n. 2 level rods, n. 2 probes, electrical cables, n. 2 electronic relays. The device prevents the lowering of the level of water in the steam generators and the consequent overheating of the membrature.

The principle of survey and control of the level is based on water conductivity. In order to guarantee the correct operation of the device, following conditions must be fulfilled:

- **Water conductivity > 250 μS/cm**
- **Water temperature < 210°C**
- **Pressure < 20 bar**

(See. " Operating water " - Tab. 2).

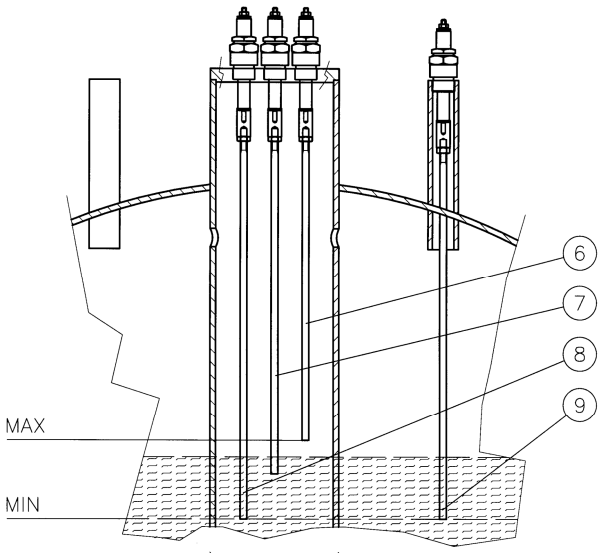
EXAMPLE: PROBES TANK FOR SAFETY AND REGULATION

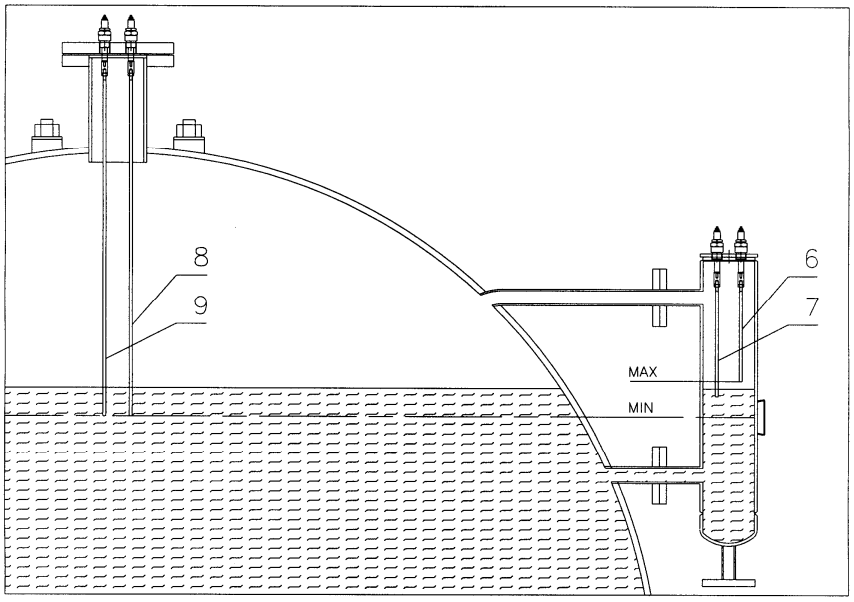


8.2 TYPICAL APPLICATIONS

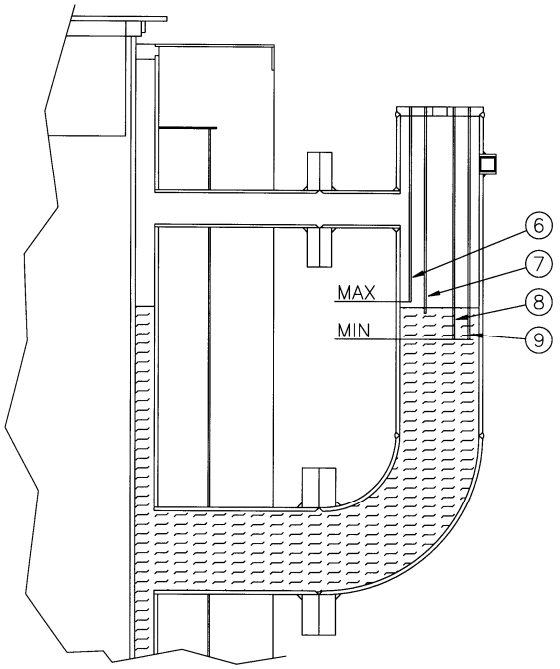
Boiler probes:

6 Pump stop
7 Pump starting
8 1st burner cut-out safety device and alarm ON.
9 2nd burner cut-out safety device and alarm ON





NOTE: it is recommended that an alarm bell is installed in the boiler room as well as a sound or visual alarm in highly visited rooms.



8.3 ELECTRICAL CONNECTIONS

Refer to the diagram supplied with the specific switchboard.

8.4 STEAM GENERATOR OPERATION
(Water level limits)

8.5 FIRST START-UP

Å Start the boiler, as follows:

1 Power up the boiler control panel
2 Make sure that the motor-driven pump drive shaft is free to rotate and that rotation direction is correct.
3 Set the pump selector switch on AUT and verify that burner cannot start before the attainment of the minimum level;
4 Make sure that the pump stops when the maximum level is reached, observing level indicators and checking the position of their cocks;
5 Maintain safety level reset pressed for 10 sec because it is employed an electronic delayed relay
6 Open the boiler discharge and check on the level indicator the intervention point of probe pump start
7 Set the pump selector switch on "0", leaving the discharge open, and check the intervention level of safety probes, referring to the minimum level information plate;
8 Close the discharge, place pump selector switch to AUT;

8.6 MAINTENANCE

8.6.1 Ordinary

- Bleed periodically (level indicators, probe-holder barrel if any, boiler) to avoid mud deposits.
- Check the efficiency of the regulation and control instruments by inspecting carefully the electrical (also connections); it is also recommended that the probe-holder ceramic plugs are replaced every year

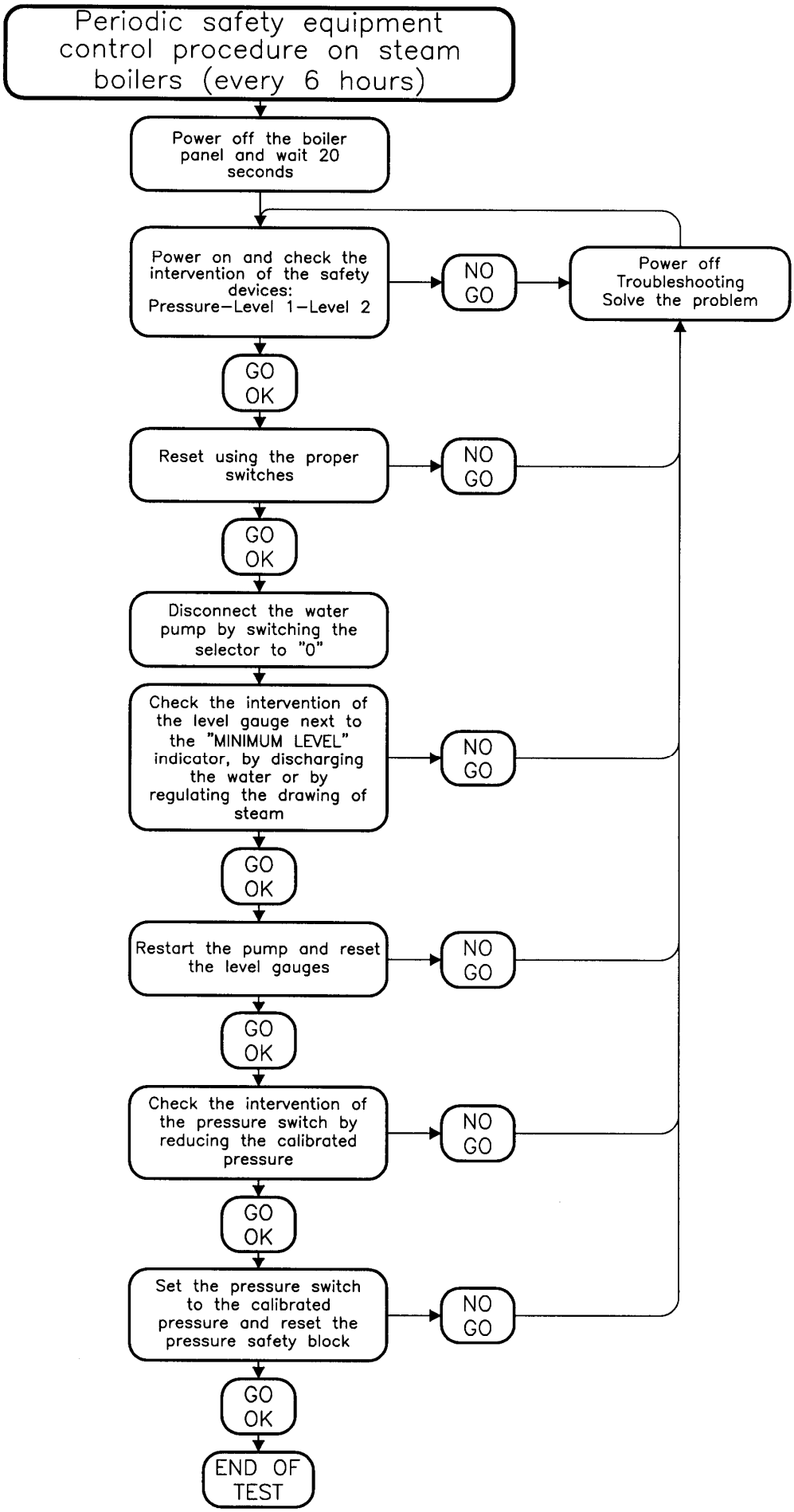
8.6.2 Periodic control (every 6 hours of use)

From time to time (every 6 hours of use) the thermal plant must be inspected by qualified personnel to check the efficiency of all safety accessories:

- Water level limits
- Safety valve

The system can be reset if no anomalies have been encountered: power off the panel for approx. 20 seconds, power on the main switch and press the reset buttons.

For further details follow the flow chart below:


Periodic safety equipment control procedure on steam boilers (every 6 hours)
Power off the boiler panel and wait 20 seconds
Power on and check the intervention of the safety devices: Pressure–Level 1–Level 2
NO GO
Power off Troubleshooting Solve the problem
GO OK
Reset using the proper switches
NO GO
GO OK
Disconnect the water pump by switching the selector to "0"
Check the intervention of the level gauge next to the "MINIMUM LEVEL" indicator, by discharging the water or by regulating the drawing of steam
NO GO
GO OK
Restart the pump and reset the level gauges
NO GO
GO OK
Check the intervention of the pressure switch by reducing the calibrated pressure
NO GO
GO OK
Set the pressure switch to the calibrated pressure and reset the pressure safety block
NO GO
GO OK
END OF TEST

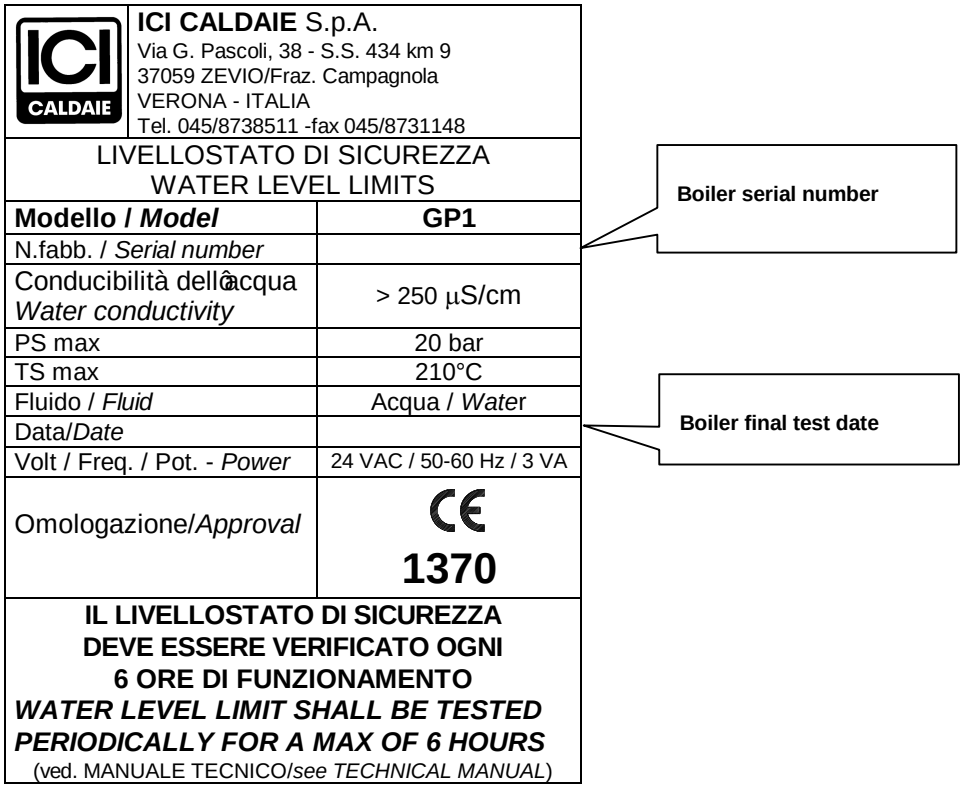
8.6.3 Extraordinary maintenance (water level limits substitution)

To replace the water level limits or parts of it, follow strictly the instructions below:
1. Ensure that the new ceramic plug is intact
2. Check the length of the rod
3. Ensure that the rod is coaxial to the plug axis
4. Inspect the electrical system and, in particular, ensure that the resistance of the electric circuit linking the ceramic plug to the electrical panel is intact (resistance must be over 10 MOhm)
5. Ensure that the automatic level control consisting of the two ceramic plugs and their conductivity-relays, work well

8.7 TROUBLESHOOTING

FAULT	POSSIBLE CAUSE	RECOMMENDED REMEDY
Safety intervention level 1 or 2	Interrupted water level monitoring	Scaled stainless steel bar Broken connection cable
	Faulty safety level relay	Temporary replace the safety electronic relay with one of the two relays in the panel. If this is the problem, replace definitively the faulty relay.
	Water does not load	See ñLoadingò inconv.
Insufficient water load	Blocked pump	See. ñBlocked pumpò inconv.
	Dirty pump sucking filter	Clean the filter
	Level regulation anomaly	Temporary replace the safety electronic relay with one of the two relays in the panel. If this is the problem, replace definitively the faulty relay.
	Level regulation probes short circuit	Dismantle the adjustment probes to inspect visually the ceramic insulation
	Pump cavitatation	Insufficient head (=different height between the collecting vessel and the pump levels) in comparison with water temperature
		Clean the pump sucking filter
		Decrease the pipe resistance between the collecting vessel and the pump by increasing the passage section
	Pump sense of rotation	Invert one of the two phases (three-phase pump)
Burner always on	Incorrect electrical panel connection	Consult the electric diagram
	Faulty level safety relays	See ñSafety intervention level 1 or 2ò
	Regulation pressure and/or safety switches OFF	Check the pressure switches regulation
		Check the pressure switches connection to the electrical panel
Burner always off	Burner problems	See burner manual
	Interrupted burner fuses	Replace fuses
	Lack of burner consent from the regulation pressure switch	Replace regulation pressure switch
	Lack of burner consent from the level safety relays	See ñSafety intervention level 1 or 2ò
	Incorrect electrical panel connection	Consult the electric diagram

8.8 DATA LABEL



ICI CALDAIE S.p.A. Via G. Pascoli, 38 - S.S. 434 km 9 37059 ZEVIO/Fraz. Campagnola VERONA - ITALIA Tel. 045/8738511 -fax 045/8731148	
LIVELLOSTATO DI SICUREZZA WATER LEVEL LIMITS	
Modello / *Model*	**GP1**
N.fabb. / *Serial number*	
Conducibilità dell'acqua *Water conductivity*	> 250 µS/cm
PS max	20 bar
TS max	210°C
Fluido / *Fluid*	Acqua / *Water*
Data/*Date*	
Volt / Freq. / Pot. - *Power*	24 VAC / 50-60 Hz / 3 VA
Omologazione/*Approval*	CE **1370**
IL LIVELLOSTATO DI SICUREZZA DEVE ESSERE VERIFICATO OGNI 6 ORE DI FUNZIONAMENTO ***WATER LEVEL LIMIT SHALL BE TESTED PERIODICALLY FOR A MAX OF 6 HOURS*** (ved. MANUALE TECNICO/*see TECHNICAL MANUAL*)	

Boiler serial number

Boiler final test date

Appartenente al Gruppo Finluc, iscritto R.I. VR n. 02245640236
Via G. Pascoli, 38 - 37059 Zevio - fraz. Campagnola - VERONA - ITALIA
Tel. 045/8738511 - Fax 045/8731148
info@icicaldaie.com - www.icicaldaie.com

Appendix M EA Nature and Heritage Conservation Screening Reports

Nature and Heritage Conservation

Screening Report: Bespoke installation

Reference	**EPR/NP3127SX/P001**
NGR	**ST 46028 07159**
Buffer (m)	**90**
Date report produced	**03/07/2024**
Number of maps enclosed	**1**

This nature and heritage conservation report

The nature and heritage conservation sites, protected species and habitats, and other features identified in the table below **must be considered in your application**.

In the further information column, there are links which give more information about the site or feature type and indicate where you are able to self-serve to get the most accurate site boundaries or feature locations.

Most designated site boundaries are available on Magic map. Using Magic map allows you to zoom in and see the site boundary or feature location in detail, Magic map also allows you to measure the distance from these sites and features to your proposed boundary. Help videos are available on Magic map to guide you through.

Where information is not publicly available, or is only available to those with GIS access, we have provided a map at the end of this report.

Sites and Features within screening distance	Screening distance (km)	Further Information
Special Areas of Conservation (cSAC or SAC)	10	Joint Nature Conservation Committee and Magic map
Bracket's Coppice		
West Dorset Alder Woods		

Local Wildlife Sites (LWS) (see map below)	2	Appropriate Local Record Centre (LRC)

New Bridge Meadows

Ten Acre Copse

Langmoor Lane

Hawkhems Copse Meadow

Picket Farm Cops

Ten Acre Field

Misterton Plantation

Picket Plantation

Crondle Hill Plantation

Kithill

Cathole Bridge Meadow

Crondle Hill Coppice

River Parrett

Crondle Hill Field

Where protected species are present, a licence may be required from Natural England to handle the species or undertake the proposed works.

The relevant Local Records Centre must be contacted for information on the features within local wildlife sites. A small administration charge may also be incurred for this service.

The following nature and heritage conservation sites, protected species and habitats, and other features have been checked for, where they are relevant for the permit type requested, but have not been found within screening distance of your site unless included in the list above.

Special Areas of Conservation (cSAC or SAC), Special Protection Area (pSPA or SPA), Marine Conservation Zone (MCZ), Ramsar, Sites of Special Scientific Interest (SSSI), National Nature Reserve (NNR), Local Nature Reserve (LNR), Local Wildlife Sites (LWS), Ancient Woodland, relevant species and habitats.

Please note we have screened this application for features for which we have information. It is however your responsibility to comply with all environmental and planning legislation, this information does not imply that no other checks or permissions will be required.

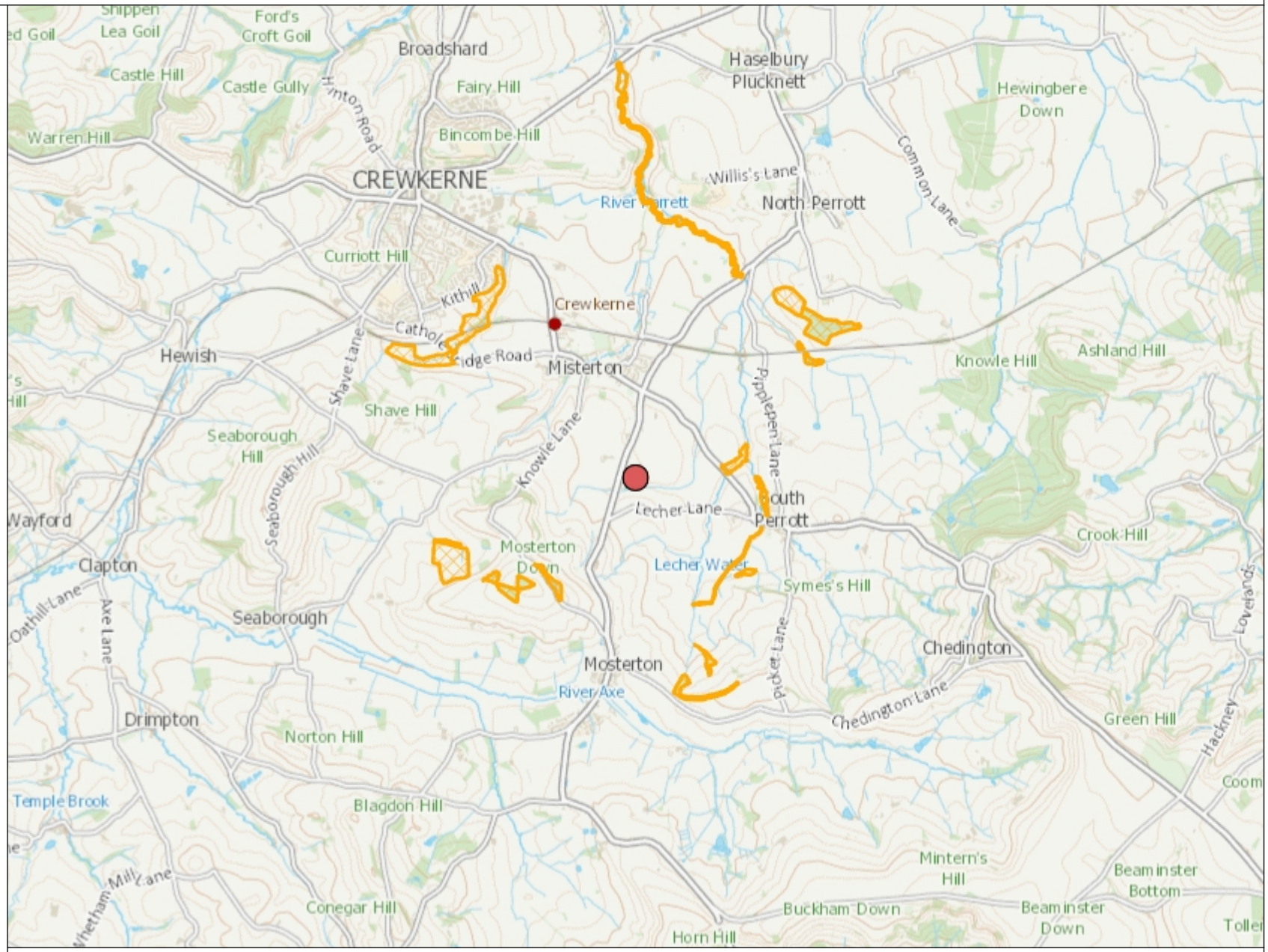
The nature and heritage screening we have conducted as part of this report is subject to change as it is based on data we hold at the time it is generated. We cannot guarantee there will be no changes to our screening data between the date of this report and the submission of the permit application, which could result in the return of an application or requesting further information

Local Wildlife Sites

Environment Agency

Legend

Local Wildlife Sites



1: 50,000

0 1,250

Metres

N W E S

Appendix N Human receptor results

Table 26 Long-term and short-term results NO_2

ID	Receptors	Comparison with annual mean AQS: 40µg/m³				Comparison with 99.79th percentile 1-hour threshold 200µg/m³			
		PC (µg/m³)	PC/AQS (%)	PEC (µg/m³)	PEC/AQS (%)	PC (µg/m³)	PC/AQS (%)	Headroom (µg/m³)	PC/Headroom (%)
R1	Owls Barton	0.66	1.7%	4.8	12%	11	5.7%	192	6.0%
R2	Knowle Farm & NS Used Car Dealer	0.58	1.4%	4.7	12%	7.5	3.7%	192	3.9%
R3	Houses off A3066 south of Misterton	0.60	1.5%	4.7	12%	5.8	2.9%	192	3.0%
R4	R V S Accident Repair	0.34	n/a	n/a	n/a	5.1	2.5%	192	2.6%
R5	Bluntsmoor Farm	0.20	0.5%	3.9	10%	4.6	2.3%	193	2.4%
R6	Chapel Court Farm including plant hire company	0.16	0.4%	3.8	10%	3.7	1.9%	193	1.9%
R7	Misterton village	0.17	0.4%	4.3	11%	3.3	1.6%	192	1.7%
R8	Misterton Church of England First School	0.12	0.3%	4.6	12%	3.1	1.5%	191	1.6%
R9	Badgers Glory	0.08	0.2%	4.2	11%	3.3	1.6%	192	1.7%
R10	Tumberlands, Lecher Lane	0.15	0.4%	3.8	10%	3.3	1.6%	193	1.7%
R11	Downbarn Farm – Dairy Farm	0.09	0.2%	4.0	10%	2.6	1.3%	192	1.3%
Notes: n/a = long-term AQS are not applicable at workplaces									

Table 27 Short-term results, 15-minute and 1-hour, SO_2

ID	Receptors	Comparison with 99.9th percentile 15-min threshold: 266µg/m³				Comparison with 99.73rd percentile 1-hour threshold: 350µg/m³			
		PC (µg/m³)	PC/AQS (%)	Headroom (µg/m³)	PC/Headroom (%)	PC (µg/m³)	PC/AQS (%)	Headroom (µg/m³)	PC/Headroom (%)
R1	Owls Barton	4.5	1.7%	262	1.7%	3.6	1.0%	346	1.0%
R2	Knowle Farm & NS Used Car Dealer	3.1	1.2%	262	1.2%	2.3	0.7%	346	0.7%
R3	Houses off A3066 south of Misterton	2.5	0.9%	262	1.0%	1.8	0.5%	346	0.5%
R4	R V S Accident Repair	2.4	0.9%	262	0.9%	1.5	0.4%	346	0.4%
R5	Bluntsmoor Farm	2.3	0.9%	262	0.9%	1.3	0.4%	346	0.4%
R6	Chapel Court Farm including plant hire company	2.0	0.8%	262	0.8%	1.0	0.3%	346	0.3%
R7	Misterton village	1.6	0.6%	262	0.6%	0.9	0.3%	346	0.3%
R8	Misterton Church of England First School	1.6	0.6%	262	0.6%	0.9	0.3%	346	0.3%
R9	Badgers Glory	1.9	0.7%	262	0.7%	0.9	0.3%	346	0.3%
R10	Tumberlands, Lecher Lane	1.8	0.7%	262	0.7%	0.9	0.3%	346	0.3%
R11	Downbarn Farm – Dairy Farm	1.5	0.6%	263	0.6%	0.8	0.2%	347	0.2%

Table 28 Short-term results, 24-hour, SO_2

ID	Receptors	Comparison with maximum 24h average AQS: 125µg/m³			
		PC (µg/m³)	PC/AQS (%)	Headroom (µg/m³)	PC/Headroom (%)
R1	Owls Barton	1.9	1.5%	121	1.6%
R2	Knowle Farm & NS Used Car Dealer	1.3	1.0%	121	1.1%
R3	Houses off A3066 south of Misterton	1.1	0.8%	121	0.9%
R4	R V S Accident Repair	0.8	0.6%	121	0.7%
R5	Bluntsmoor Farm	0.5	0.4%	121	0.4%
R6	Chapel Court Farm including plant hire company	0.4	0.4%	121	0.4%
R7	Misterton village	0.5	0.4%	121	0.4%
R8	Misterton Church of England First School	0.3	0.3%	121	0.3%
R9	Badgers Glory	0.3	0.3%	121	0.3%
R10	Tumberlands, Lecher Lane	0.3	0.3%	121	0.3%
R11	Downbarn Farm – Dairy Farm	0.3	0.2%	122	0.3%

Appendix O Ecological receptor results

Table 29 Results: Ecological receptors, long-term AQS for NOx

ID	Receptors	Comparison with annual mean AQS: 30µg/m^3			
		PC (µg/m^3)	PC/AQS (%)	PEC (µg/m^3)	PEC/AQS (%)
E1(a)	Bracket's Coppice	0.03	0.1%	5.6	19%
E1(b)	Bracket's Coppice	0.03	0.1%	5.6	19%
E2(a)	West Dorset Alder Woods	0.02	0.1%	5.2	17%
E2(b)	West Dorset Alder Woods	0.01	0.04%	5.3	18%
E3	New Bridge Meadows	0.36	1.2%	6.4	21%
E4(a)	Ten Acre Copse (a)	0.14	0.5%	6.1	20%
E4(b)	Ten Acre Copse (b)	0.09	0.3%	6.0	20%
E5(a)	Langmoor Lane (a)	0.17	0.6%	6.0	20%
E5(b)	Langmoor Lane (b)	0.14	0.5%	6.0	20%
E5(c)	Langmoor Lane (c)	0.13	0.4%	6.0	20%
E6	Hawkhems Copse Meadow	0.14	0.5%	6.0	20%
E7	Picket Farm Copse	0.09	0.3%	5.8	19%
E8	Ten Acre Field	0.08	0.3%	6.0	20%
E9	Misterton Plantation	0.06	0.2%	6.0	20%
E10	Picket Plantation	0.08	0.3%	5.8	19%
E11	Crondle Hill Plantation	0.12	0.4%	6.1	20%
E12(a)	Kithill (a)	0.04	0.1%	6.7	22%
E12(b)	Kithill (b)	0.04	0.1%	6.7	22%
E13	Cathole Bridge Meadow	0.05	0.2%	6.7	22%
E14	Crondle Hill Coppice	0.12	0.4%	6.1	20%
E15	River Parrett	0.09	0.3%	6.3	21%
E16	Crondle Hill Field	0.11	0.4%	6.1	20%
Notes: No further analysis required for LWS/ SNCIs if PC/AQS < 100%					

Table 30 Results: Ecological receptors, long-term and short-term AQS for NOx

ID	Receptors	Comparison with maximum daily AQS: 75µg/m^3	
		PC (µg/m^3)	PC/AQS (%)
E1(a)	Bracket's Coppice	0.61	0.81%
E1(b)	Bracket's Coppice	0.52	0.69%
E2(a)	West Dorset Alder Woods	0.41	0.55%
E2(b)	West Dorset Alder Woods	0.48	0.64%
E3	New Bridge Meadows	6.39	8.52%
E4(a)	Ten Acre Copse (a)	2.59	3.45%
E4(b)	Ten Acre Copse (b)	2.71	3.61%
E5(a)	Langmoor Lane (a)	3.15	4.20%
E5(b)	Langmoor Lane (b)	3.23	4.31%
E5(c)	Langmoor Lane (c)	3.08	4.11%
E6	Hawkhems Copse Meadow	2.65	3.53%
E7	Picket Farm Copse	2.64	3.52%
E8	Ten Acre Field	3.55	4.74%
E9	Misterton Plantation	2.91	3.87%
E10	Picket Plantation	2.11	2.82%
E11	Crondle Hill Plantation	1.72	2.29%
E12(a)	Kithill (a)	1.33	1.77%
E12(b)	Kithill (b)	1.19	1.59%
E13	Cathole Bridge Meadow	1.63	2.17%
E14	Crondle Hill Coppice	1.66	2.22%
E15	River Parrett	2.12	2.83%
E16	Crondle Hill Field	1.36	1.81%
Notes: No further analysis required for LWS/ SNCIs if PC/AQS < 100%			

Table 31 Results: Ecological receptors, long-term AQS for SO_2

ID	Receptors	Comparison with annual mean AQS: 20µg/m³				Comparison with annual mean AQS: 10µg/m³			
		PC (µg/m³)	PC/AQS (%)	PEC (µg/m³)	PEC/AQS (%)	PC (µg/m³)	PC/AQS (%)	PEC (µg/m³)	PEC/AQS (%)
E1(a)	Bracket's Coppice	0.003	0.01%	0.60	3.0%	0.003	0.03%	0.60	6.0%
E1(b)	Bracket's Coppice	0.002	0.01%	0.60	3.0%	0.002	0.02%	0.60	6.0%
E2(a)	West Dorset Alder Woods	0.001	0.01%	0.50	2.5%	0.001	0.01%	0.50	5.0%
E2(b)	West Dorset Alder Woods	0.001	0.01%	0.50	2.5%	0.001	0.01%	0.50	5.0%
E3	New Bridge Meadows	0.030	0.15%	0.76	3.8%	0.030	0.30%	0.76	7.6%
E4(a)	Ten Acre Copse (a)	0.012	0.06%	0.73	3.7%	0.012	0.12%	0.73	7.3%
E4(b)	Ten Acre Copse (b)	0.008	0.04%	0.83	4.1%	0.008	0.08%	0.83	8.3%
E5(a)	Langmoor Lane (a)	0.014	0.07%	0.70	3.5%	0.014	0.14%	0.70	7.0%
E5(b)	Langmoor Lane (b)	0.012	0.06%	0.73	3.7%	0.012	0.12%	0.73	7.3%
E5(c)	Langmoor Lane (c)	0.011	0.05%	0.70	3.5%	0.011	0.11%	0.70	7.0%
E6	Hawkhems Copse Meadow	0.012	0.06%	0.73	3.7%	0.012	0.12%	0.73	7.3%
E7	Picket Farm Copse	0.008	0.04%	0.69	3.4%	0.008	0.08%	0.69	6.9%
E8	Ten Acre Field	0.006	0.03%	0.83	4.1%	0.006	0.06%	0.83	8.3%
E9	Misterton Plantation	0.005	0.03%	0.83	4.1%	0.005	0.05%	0.83	8.3%
E10	Picket Plantation	0.006	0.03%	0.69	3.4%	0.006	0.06%	0.69	6.9%
E11	Crondle Hill Plantation	0.010	0.05%	0.73	3.7%	0.010	0.10%	0.73	7.3%
E12(a)	Kithill (a)	0.003	0.02%	1.27	6.4%	0.003	0.03%	1.27	13%
E12(b)	Kithill (b)	0.003	0.02%	1.27	6.4%	0.003	0.03%	1.27	13%
E13	Cathole Bridge Meadow	0.004	0.02%	1.27	6.4%	0.004	0.04%	1.27	13%
E14	Crondle Hill Coppice	0.010	0.05%	0.73	3.6%	0.010	0.10%	0.73	7.3%
E15	River Parrett	0.008	0.04%	0.84	4.2%	0.008	0.08%	0.84	8.4%
E16	Crondle Hill Field	0.009	0.05%	0.73	3.6%	0.009	0.09%	0.73	7.3%
Notes: No further analysis required for LWS/ SNCIs if PC/AQS < 100%									

Table 32 Results: Ecological receptors, nutrient nitrogen deposition

Receptors	Type	Comparison with nutrient nitrogen critical loads								
		Deposition velocity type	PC (kgN/ha/yr)	CLmin (kgN/ha/yr)	CLmax (kgN/ha/yr)	PC/CLmin (%)	PC/CLmax (%)	Background (kgN/ha/yr)	PEDR/CLmin (%)	PEDR/CLmax (%)
E1(a)	SAC	Forest	0.006	10	15	0.06%	0.04%	30.80	308%	205%
E1(a)	SAC	Grass	0.003	15	25	0.02%	0.01%	17.30	115%	69%
E1(a)	SSSI	Forest	0.006	15	20	0.04%	0.03%	30.80	205%	154%
E1(a)	SSSI	Grass	0.003	6	10	0.05%	0.03%	17.30	288%	173%
E1(b)	SAC	Forest	0.005	10	15	0.05%	0.03%	30.20	302%	201%
E1(b)	SAC	Grass	0.003	15	25	0.02%	0.01%	16.90	113%	68%
E1(b)	SSSI	Forest	0.005	15	20	0.03%	0.03%	30.20	201%	151%
E1(b)	SSSI	Grass	0.003	6	10	0.04%	0.03%	16.90	282%	169%
E2(a)	SAC	Forest	0.003	10	15	0.03%	0.02%	28.60	286%	191%
E2(a)	SAC	Grass	0.002	6	10	0.03%	0.02%	16.00	267%	160%
E2(b)	SAC	Forest	0.003	10	15	0.03%	0.02%	30.40	304%	203%
E2 (b)	SAC	Grass	0.001	6	10	0.02%	0.01%	17.50	292%	175%
E3	SNCI	Grass	0.036	5	10	0.72%	0.36%	18.03	361%	181%
E4(a)	SNCI	Forest	0.029	10	15	0.29%	0.19%	32.15	322%	215%
E4(b)	SNCI	Forest	0.019	10	15	0.19%	0.13%	32.21	322%	215%
E5(a)	SNCI	Grass	0.017	10	20	0.17%	0.08%	17.96	180%	89.9%
E5(b)	SNCI	Grass	0.014	10	20	0.14%	0.07%	17.90	179%	89.6%
E5(c)	SNCI	Grass	0.013	10	20	0.13%	0.07%	17.96	180%	89.9%
E6	SNCI	Forest	0.029	10	15	0.29%	0.19%	32.04	321%	214%
E7	SNCI	Forest	0.019	10	15	0.19%	0.12%	31.91	319%	213%
E8	LWS	Grass	0.008	10	20	0.08%	0.04%	18.09	181%	90.5%
E9	LWS	Forest	0.012	10	15	0.12%	0.08%	32.21	322%	215%
E10	SNCI	Forest	0.015	10	15	0.15%	0.10%	31.91	319%	213%
E11	LWS	Forest	0.025	10	15	0.25%	0.17%	32.71	327%	218%
E12(a)	LWS	Forest	0.008	10	15	0.08%	0.05%	32.39	324%	216%
E12(b)	LWS	Forest	0.007	10	15	0.07%	0.05%	32.39	324%	216%
E13	LWS	Grass	0.005	5	10	0.09%	0.05%	18.06	361%	181%

Receptors	Type	Comparison with nutrient nitrogen critical loads								
		Deposition velocity type	PC (kgN/ha/yr)	CLmin (kgN/ha/yr)	CLmax (kgN/ha/yr)	PC/CLmin (%)	PC/CLmax (%)	Background (kgN/ha/yr)	PEDR/CLmin (%)	PEDR/CLmax (%)
E14	LWS	Forest	0.023	10	15	0.23%	0.15%	32.71	327%	218%
E15	LWS	Grass	0.009	10	20	0.09%	0.05%	18.13	181%	90.7%
E16	LWS	Grass	0.011	10	20	0.11%	0.06%	18.17	182%	90.9%

Notes: No further analysis required for LWS/ SNCIs if PC/AQS < 100%

n/a = Critical Load Range not available

Table 33 Results: Ecological receptors, acid deposition

Receptors	Type	Deposition velocity type	PC (keqS/ha/yr)	PC (keqN/ha/yr)	Background (keqS/ha/yr)	Background (keqN/ha/yr)	Minimum critical loads [1]		
							PC (%)	Background (%)	PEC (%)
E1(a)	SAC	Forest	0.0006	0.0005	0.16	2.20	0.0	81.6	81.6
E1(a)	SAC	Grass	0.0003	0.0002	/	/	No sensitive features		
E1(a)	SSSI	Forest	0.0006	0.0005	0.16	2.20	0.0	81.6	81.6
E1(a)	SSSI	Grass	0.0003	0.0002	0.12	1.21	0.0	26.6	26.6
E1(b)	SAC	Forest	0.0005	0.0004	0.16	2.16	0.0	80.2	80.3
E1(b)	SAC	Grass	0.0002	0.0002	/	/	No sensitive features		
E1(b)	SSSI	Forest	0.0005	0.0004	0.16	2.16	0.0	80.2	80.3
E1(b)	SSSI	Grass	0.0002	0.0002	0.12	1.21	0.0	26.2	26.2
E2(a)	SAC	Forest	0.0003	0.0002	0.15	2.04	0.0	189	189
E2(a)	SAC	Grass	0.0002	0.0001	0.11	1.14	0.0	25.7	25.8
E2(b)	SAC	Forest	0.0003	0.0002	0.18	2.17	0.0	202	202
E2 (b)	SAC	Grass	0.0001	0.0001	0.11	1.15	0.0	25.7	25.8
E3	SNCI	Grass	0.0036	0.0026	0.12	1.29	0.2	29.0	29.2
E4(a)	SNCI	Forest	0.0028	0.0020	0.17	2.30	0.0	78.7	78.7
E4(b)	SNCI	Forest	0.0019	0.0013	0.17	2.30	0.0	181	181
E5(a)	SNCI	Grass	0.0016	0.0012	0.12	1.28	0.0	27.6	27.6
E5(b)	SNCI	Grass	0.0014	0.0010	0.12	1.28	0.0	27.6	27.6
E5(c)	SNCI	Grass	0.0013	0.0009	0.12	1.28	0.0	27.6	27.6
E6	SNCI	Forest	0.0029	0.0021	0.16	2.29	0.3	78.0	78.3
E7	SNCI	Forest	0.0018	0.0013	0.16	2.28	0.0	176	176
E8	LWS	Grass	0.0007	0.0005	0.12	1.29	0.0	198	198
E9	LWS	Forest	0.0012	0.0009	0.17	2.30	0.0	181	181
E10	SNCI	Forest	0.0015	0.0011	0.16	2.28	0.0	176	176
E11	LWS	Forest	0.0025	0.0018	0.16	2.34	0.0	80.2	80.2
E12(a)	LWS	Forest	0.0007	0.0005	0.17	2.31	0.0	86.0	86.0
E12(b)	LWS	Forest	0.0007	0.0005	0.17	2.31	0.0	86.0	86.0
E13	LWS	Grass	0.0005	0.0003	0.13	1.29	0.0	29.2	29.2

E14	LWS	Forest	0.0023	0.0017	0.16	2.34	0.0	80.2	80.2
E15	LWS	Grass	0.0009	0.0007	0.12	1.30	0.0	28.0	28.0
E16	LWS	Grass	0.0011	0.0008	0.12	1.30	0.0	28.0	28.0

Note: [1] %PC of minimum critical load determined using the Critical Load Function tool, available at www.apis.co.uk.
n/a = not available: this habitat is not sensitive to acidity