H1 Assessment to Support a Bespoke Installation Permit Application: Pattemore's Dairy, Mosterton Road, Misterton, Crewkerne, Somerset, TA18 8NT

Prepared on behalf of:

Pattemore's Transport (Crewkerne) Ltd

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Abbreviations

AEL	Associated Emissions Level
AQIA	Air Quality Impact Assessment
BAT	Best Available Techniques
CH_4	Methane
CIP	Clean in Place
CO_2	Carbon dioxide
EA	Environment Agency
EAL	Environmental Assessment Level
ELV	Emission Limit Value
EPR	Environmental Permitting Regulations
ETL	Earthcare Technical Ltd
H1	Environment Agency Horizontal Guidance Note H1
kWe	Kilowatts electrical output
kWthi	Kilowatts thermal input
LWS	Local wildlife site
MCP	Medium Combustion Plant
MCPD	Medium Combustion Plant Directive
MWthi	Megawatts thermal input
n/a	Not applicable
NGR	National Grid Reference
NOx	Oxides of nitrogen
NO_2	Nitrogen dioxide
O_2	Oxygen
PC	Process Contribution
PEC	Predicted environmental concentration
SO_2	Sulphur dioxide
SAC	Special Area of Conservation
SG	Specified Generator
TVOC	Total gaseous and vaporous organic substances, expressed as total organic carbon
VOC	Volatile organic compounds

1 Introduction

This H1 Assessment (H1) has been prepared by Earthcare Technical Ltd (ETL) 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 1, the proposed installation includes emissions to air from 3 No. fixed boilers and 1. No mobile (standby) boiler on site, all of which are used to produce steam. An emergency back-up diesel generator is also available for on-site use.

Table 1 Combustion plant

Boiler number	Size (MWthi)	Approx. Date of Commissioning	Grid reference (X, Y)	Fuel
Boiler 1	3.34	Jun-01	346014, 107167	Kerosene
Boiler 2	3.33	Oct-22	346004, 107176	Kerosene
Boiler 3	0.72	Sep-95	345938, 107180	Kerosene
Boiler 4 *	3.27	Nov-02	345999, 107191	Kerosene
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 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 emissions to air risk assessment, that will also inform site-specific Best Available Techniques (BAT).

The emergency backup generator is used in abnormal operating circumstances; for the sole purpose of providing power at a 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.

The pollutants to be considered include oxides of nitrogen (NOx) and nitrogen dioxide (NO_2), carbon monoxide (CO), Total Volatile Organic Compounds (TVOC), and sulphur dioxide (SO_2). All sources on the Site which emit these pollutants under normal operation have been considered as part of this H1 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. Pollutants that do not screen out would need to be considered in an Air Quality Impact Assessment (AQIA) which would use detailed dispersion modelling.

1.1 Site location

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. Surrounding the Site, the area is used principally for farming and grassland. To the east of the Site there is a solar farm with an area of 2 hectares (5 acres) which is operated by Pattemore's Transport (Holdings) Ltd and from which energy is used on site and any excess exported to the National Grid.

There is one dwelling approximately 120m northwest of the Site boundary 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 that are also designated as SSSIs, the closest of which is Bracket's Coppice (SAC/ SSSI) 4.5km east of the Site. There are 14 No. Local Wildlife Sites within 2km of the Site, the closest of which is Newbridge Meadows (0.8km east), as listed within the EA Nature and Heritage Conservation Screening Reports provided in the accompanying Environmental Management System to the application.[2]

[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] Pattemore's Dairy Environmental Management System Manual (PAT-OD-01) V1.0 Issue 0 – Nov 2024.

1.2 About this report

This report describes: the assessment methodology and source data (section 2); the calculated impact (section 3); and concludes in section 4. Appendix K shows the H1 input and output tables.

2 Assessment methodology

2.1 H1 Emissions to Air Screening Assessment

The H1 screening evaluation has been undertaken following H1 methodology, set out in EA guidance[3],[4] and using the EA H1 Assessment Tool spreadsheet (v9.2). [1]

2.2 Assessment Criteria

2.2.1 Air Quality Standards and Critical Levels – Human Health

Table 2 sets out those Air quality strategy (AQS) objectives, Ambient Air Directive (AAD) Limit Values and Environmental Assessment Levels (EALs) for the protection of human health that are relevant to this assessment in determining receptor exposure. In the H1 Assessment Tool these are all referred to as EALs.

Table 2 Air Quality Standards for human health

Substance	Emission period	Limit (average)	Standard	Exceedances[1]
Benzene	24 hours	30 µg/m^3	EAL	None
Benzene	Annual	5 µg/m^3	AAD Limit Value and AQS Objective	None
Carbon monoxide	Maximum 8 hour running mean across a 24-hour period	10,000 µg/m^3	AAD Limit Value	None
Nitrogen dioxide	1 hour	200 µg/m^3	AAD Limit Value	Up to 18 1-hour periods
Nitrogen dioxide	Annual	40 µg/m^3	AAD Limit Value	None
Sulphur dioxide	15 minutes	266 µg/m^3	UK AQS Objective	Up to 35 15-minute periods
Sulphur dioxide	1 hour	350 µg/m^3	AAD Limit Value	Up to 24 1-hour periods
Sulphur dioxide	24 hours	125 µg/m^3	AAD Limit Value	Up to 3 24-hour periods

Notes: from https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit
[1]number of times a year that the limit may be exceeded
AQS: Air quality strategy; AAD: Ambient Air Directive; EAL: Environmental Assessment Level

[3] Environment Agency and Department for Environment, Food & Rural Affairs, Air emissions risk assessment for your environmental permit, Available at: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit [Accessed 11 November 2024]
[4] H1 Software Tool, Version 9.2, Available at: https://admlc.com/h1-tool/ [Accessed 11 November 2024]

2.2.2 Environmental standards for protected conservation areas

The AQS objectives and AAD Limit Values for the protection of vegetation and ecosystems applicable to this assessment are presented in Table 3.

Table 3 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 oxides (expressed as nitrogen dioxide)[2]	30 µg/m^3	Annual
Nitrogen oxides (expressed as nitrogen dioxide)	200 mg/m^3 75 µg/m^3 for detailed assessments where the ozone is below the AOT40[5] critical level and sulphur dioxide is below the lower critical level of 10 µg/m^3	Daily
Notes: 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		

2.3 Environment Agency Risk Assessment Guidance

The current evaluation is based on EA risk assessment guidance to determine the significance of the predicted impact. The guidance provides screening criteria for quantifying the environmental impacts of emissions to air, criteria include long and short-term EALs.

The guidance considers initial H1 screening and then detailed modelling. At the initial screening stage, **Test 1**, long-term and short-term concentrations due to the sources entered, referred to as the Process Contribution (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, **Test 2**, 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:

- for human receptors only, the short-term PC is less than 20% of the short-term environmental standards minus twice the long-term background concentration i.e., less than 20% of the 'Headroom', and
- the long-term PEC is less than 70% of the long-term environmental standards.

[5] 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]

In accordance with the guidance, it is not necessary to calculate PEC for short-term targets. For an ecological receptor, if the short-term PC exceeds 10% of the EAL, detailed modelling is required.

If the PC cannot be screened out on that basis, the guidance outlines further steps, including detailed modelling, which may lead to a requirement to carry out a cost-benefit analysis.

2.4 H1 Inputs – Process Emissions

Boiler 1 and Boiler 2 produce steam used for heating, cleaning equipment and pasteurisation. The new Clean in Place (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 (24 hours a day, 365 days a year).

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.

Boiler 4 is used for steam production for heating, cleaning equipment and pasteurisation. Boiler 4 is used 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 sources of emissions and assumed operating profiles are summarised in Table 4.

Table 4 Emission sources and operating profiles

Boiler number (Emission Point)	Series/ Type/ Serial Number	Plant Manufacturer	Assumed operating profile		
			Annual hours	Burner Status *	Assumed Load (%)
Boiler 1 (A1)	YSY5000-25	Dennis Baldwin & Sons	8,400 (96%)	Low fire/ High fire	100
Boiler 2 (A2)	YSY5000-79	Byworth	8,400 (96%)	Low fire/ High fire	100
Boiler 3 (A3)	SXA1000-184	Dennis Baldwin & Sons	8,400 (96%)	Low fire/ High fire	100
Boiler 4 (A4)	AX2500	ICI Caldaie	744 (8.5%)	Low fire/ High fire	100

Notes: All boilers are gas oil-fired (kerosene).

* 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'.

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)[6] by 1 January 2030. There are no BAT-AELs for SO_2, TVOC and CO, therefore monitored data has been used for these emissions where it exists:

- 200mg/Nm^3 for NOx (3% O_2), MCP ELV
- No limit set for SO_2; 4.0mg/m^3 (3% O_2), see Appendix C
- No limit set for TVOC; not monitored, emissions assumed to be negligible
- No limit set for CO; 88.0mg/m^3 (3% O_2), see Appendix C

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).[6] There are no BAT-AELs for SO_2, TVOC and CO; 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 Appendix E
- No limit set for TVOC; not monitored, emissions assumed to be negligible
- No limit set for CO; 85.2mg/m^3 (3% O_2), see Appendix E

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.[6] For assessment purposes, the MCPD ELV for NOx for existing plant fired by gas oil (Annex II, Part 1, Table 1)[6] 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 Appendix H
- No limit set for TVOC; not monitored, emissions assumed to be negligible
- No limit set for CO; 86.4mg/m^3 (3% O_2), see Appendix H

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)[6] 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 Appendix I
- 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 Appendix I
- No limit set for TVOC; not monitored, emissions assumed to be negligible
- No limit set for CO; 70.8mg/m^3 (3% O_2), see Appendix I

The effective stack height has been calculated for each point source in accordance with EA guidance.[7,8] All values of effective stack height are zero as the stacks are either less than 3m

[6] DIRECTIVE (EU) 2015/2193 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 25 November 2015 on the limitation of emissions of certain pollutants into the air from medium combustion plants
[7] Gov.uk Air emissions risk assessment for your environmental permit: Effective height of release: impact of nearby buildings (https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit)
[8] Environment Agency (2023) H1 Software Tool User Guide, Version 9.0, Accessed November 2024.

above the building on which the stack is located or are less than the height of the tallest building within the specified distance.[7]

Table 5 details the H1 input parameters for the point source emissions; the input data entered into the H1 Assessment Tool is shown in Appendix K, Table 6 and Table 7.

Table 5 Boiler emission parameters

Parameter	Units	Boiler 1 [1]	Boiler 2 [2]	Boiler 3 [3]	Boiler 4 [4]
Location	Easting, Northing	346014, 107167	346004, 107176	345938, 107180	345999, 107191
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	7.7	8.2	3.2	4.6
Eff. stack height	m	0	0	0	0
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 TVOC	mg/Nm^3	n/a	n/a	n/a	n/a
Exit concentration NOx	mg/Nm^3	200 (ELV, 3% O_2)	200 (ELV, 3% O_2)	263 (Monitored, 3% O_2)	200 (ELV, 3% O_2)
Exit concentration CO	mg/Nm^3	88 (Monitored, 3% O_2)	85.2 (Monitored, 3% O_2)	86.4 (Monitored, 3% O_2)	70.8 (Monitored, 3% O_2)
Emission rate SO_2	g/s	0.004	0.03	0.001	0.03
Emission rate TVOC	g/s	-	-	-	-
Emission rate NOx	g/s	0.18	0.22	0.04	0.23
Emission rate CO	g/s	0.08	0.09	0.02	0.07

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.

[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 C). 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 E). 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 H). 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 I). 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 the Boiler 1, Boiler 2 and Boiler 3 will operate 96% of the time, and Boiler 4 for 8.5% of the time.

3 Impact assessment

Output tables from the H1 Assessment Tool are shown in Appendix K, Table 8 to Table 11. Table 8 shows the long-term and short-term PCs and EALs for each pollutant.

3.1 Air Impact Screening, Test 1

In Table 9 the long-term and short-term PCs calculated by the H1 Assessment Tool are compared with the EAL. All pollutant-EAL combinations 'fail' Test 1 except for the short-term CO.

3.2 Air Impact Screening, Test 2

In Table 10 the long-term PECs are compared with the EALs, and the short-term PCs are compared with Headroom (EAL minus twice the long-term background concentration). Background data have been obtained from Defra's mapped background data provided for the UK at a 1km grid resolution.[9] All pollutant-EAL combinations 'fail' Test 2 with the exception of the two long-term SO_2 EALs for ecological receptors.

3.3 Summary

Table 11 is the output table summarising which pollutant-EALs require further assessment using detailed modelling. Those requiring detailed modelling are given as:

- 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)

[9] Defra, Background Maps, Available at: https://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html [Accessed 04 November 2024].

4 Conclusion

This H1 Assessment has been completed to assess whether the air quality impact of point source emissions to air at Pattemore's Dairy site, Mosterton Road, Misterton, Crewkerne, Somerset, can be screened from further assessment.

Emissions from the four gas oil-fired boilers have been considered. The EA's H1 Assessment Tool spreadsheet v9.2 has been used for quantitative assessment.

Test 1 of the assessment compared the long-term and short-term PCs calculated by the H1 Assessment Tool with the relevant EALs; all pollutant-EAL combinations were found to 'fail' Test 1 except for the short-term CO.

Test 2 compared the long-term PECs are compared with the EALs and the short-term PCs with Headroom (EAL minus twice the long-term background concentration); all pollutant-EAL combinations were found to 'fail' Test 2 with the exception of the two long-term SO_2 EALs for ecological receptors.

The pollutant-EALs which require further assessment using detailed modelling to be reported in an AQIA include EALs for human health and sensitive ecological receptors:

- 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)

An AQIA is in preparation to support this application.

Appendix A 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 B 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 C 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 D 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 E 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 F 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
Alastair Wolff | m: 07506 729 226
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10706

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atesta.com

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)

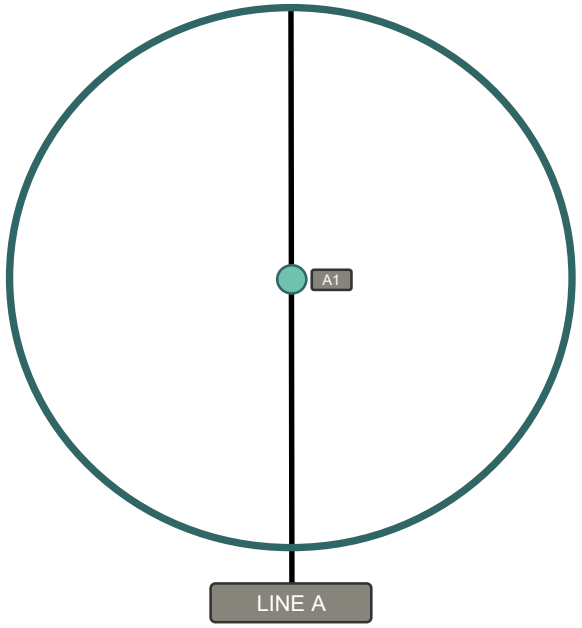
test parameter	run	details of monitoring deviation
All	1	There were no deviations associated with the monitoring employed.

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

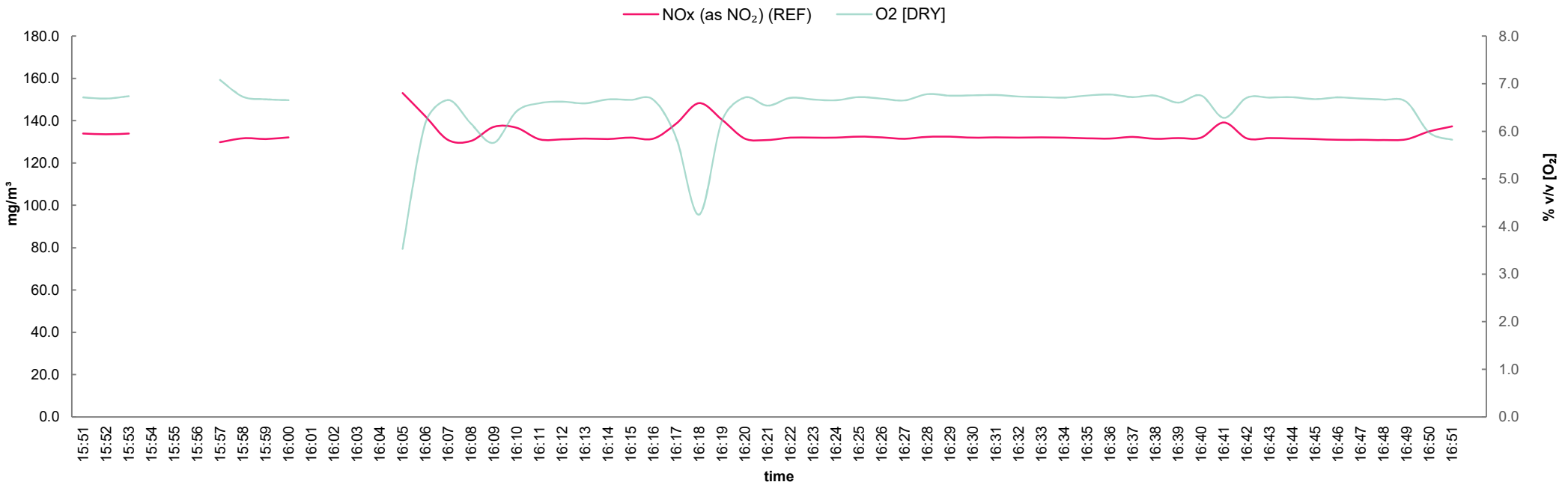
parameter	units	result ± MU (95% CI)	units	result ± MU (95% CI)
Oxides of Nitrogen (as NO_2)	mg/m³	133 ± 5.9	g/hr	

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

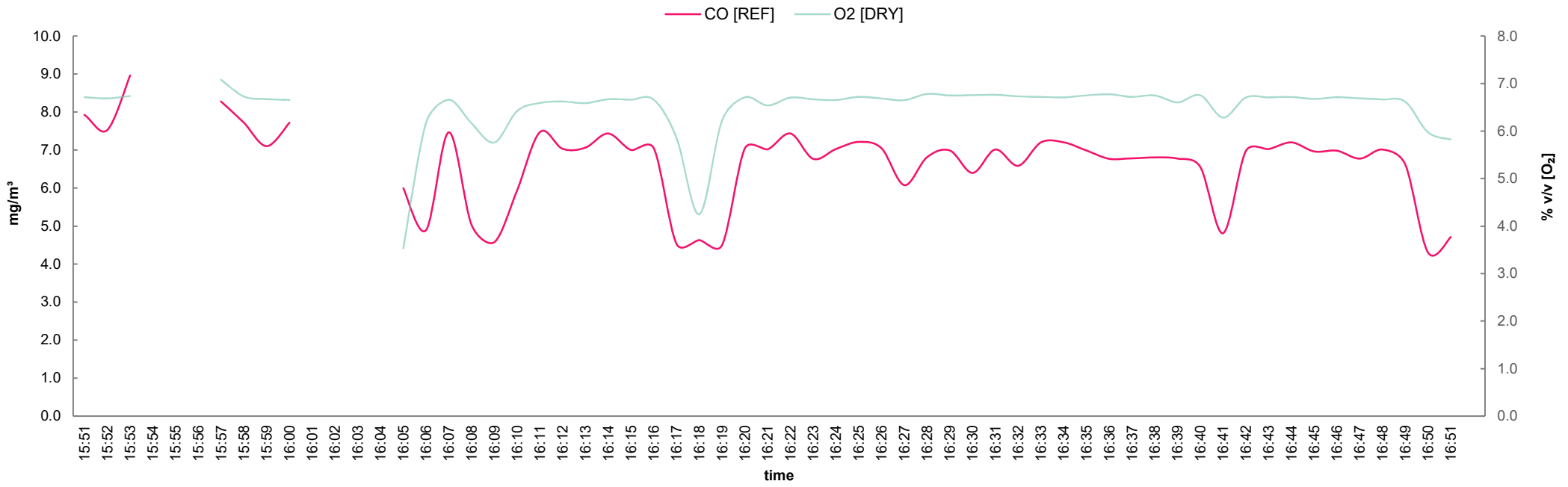
parameter	units	result ± MU (95% CI)	units	result ± MU (95% CI)
Carbon Monoxide	mg/m³	6.7 ± 0.3	g/hr	

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 G 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 H 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 I 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 J 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

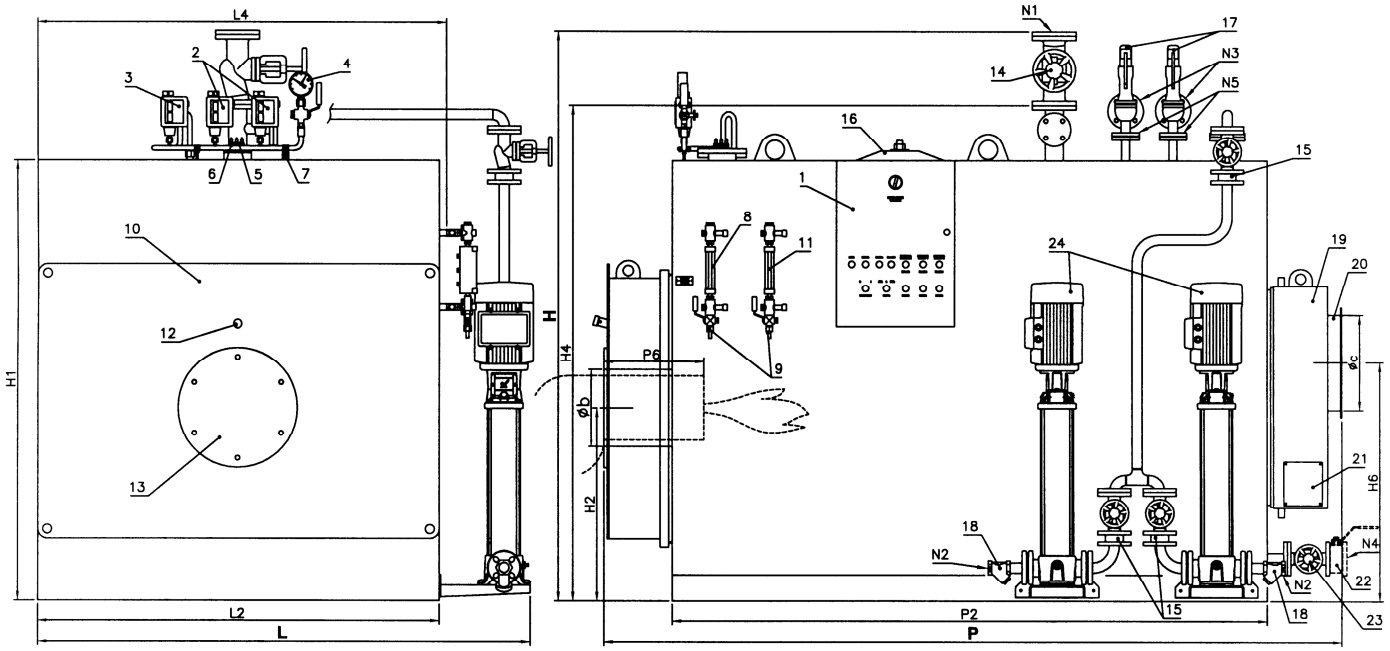


Fig. 1

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).

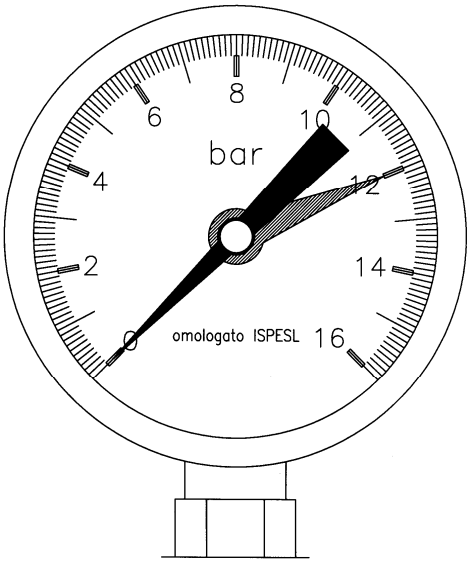


Fig. 2

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

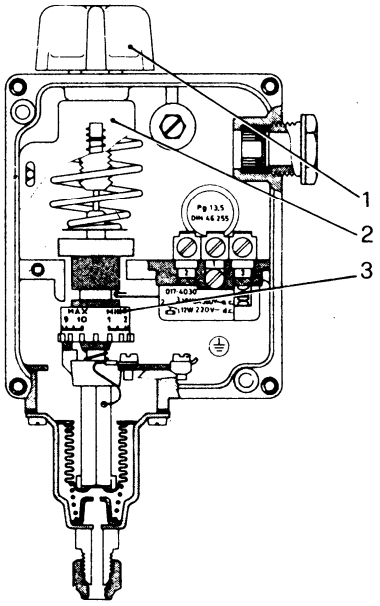


Fig. 3

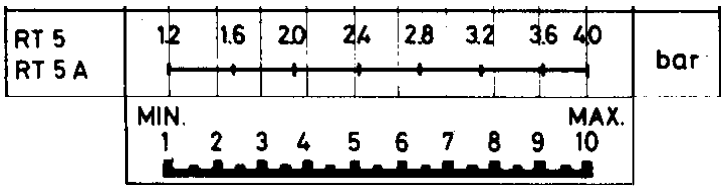


Fig. 4

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

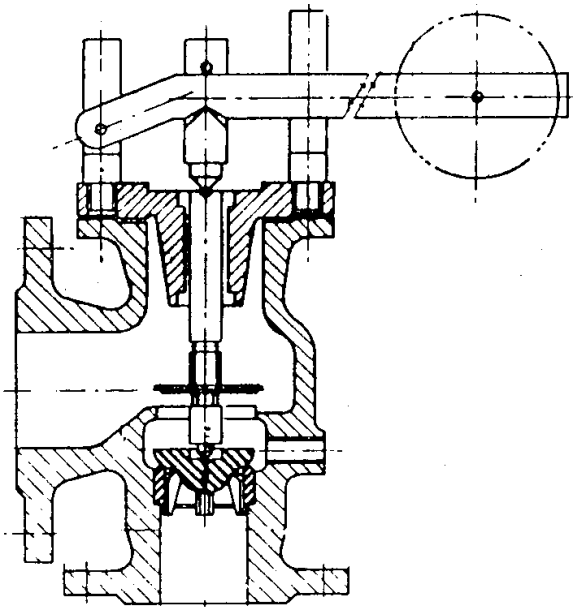


Fig. 5

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.

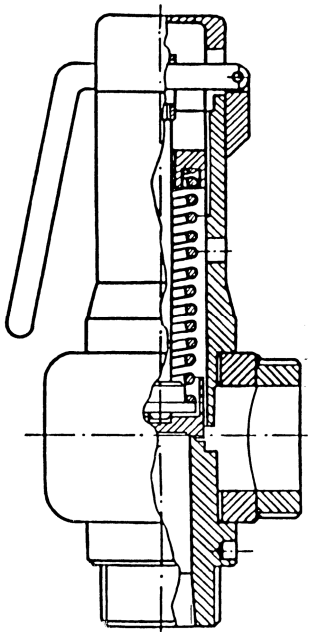


Fig. 6

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.

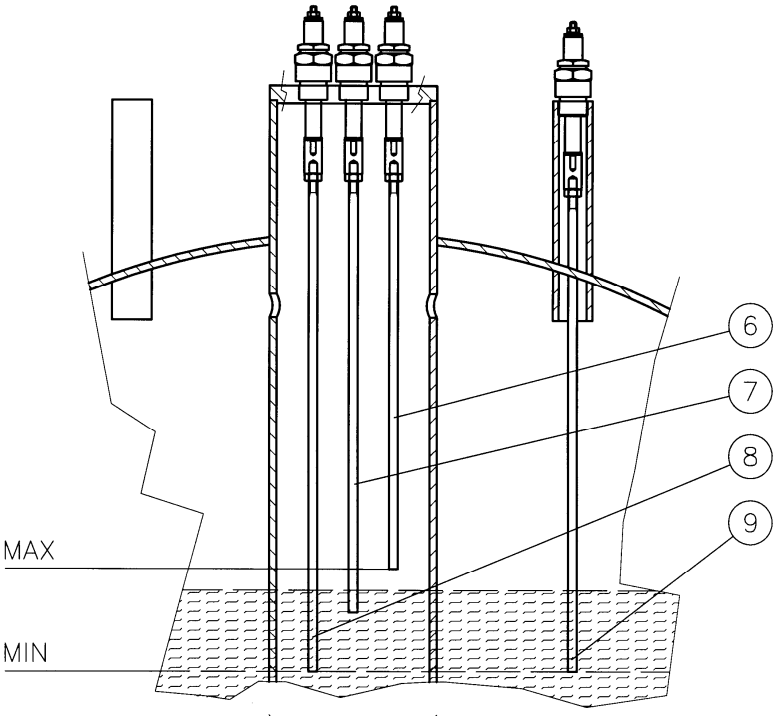


Fig. 7

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.

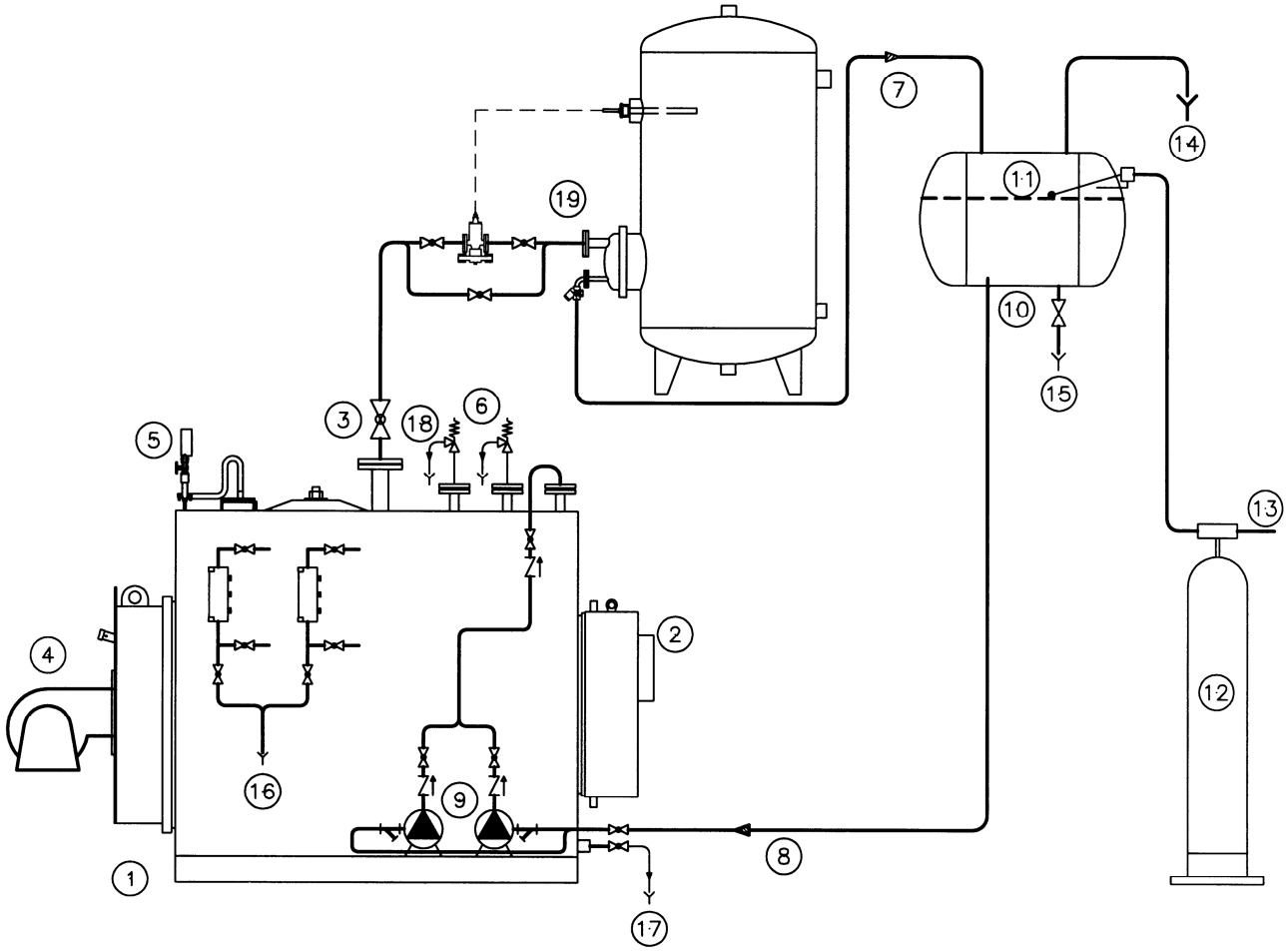


Fig. 9 ï System diagram

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.

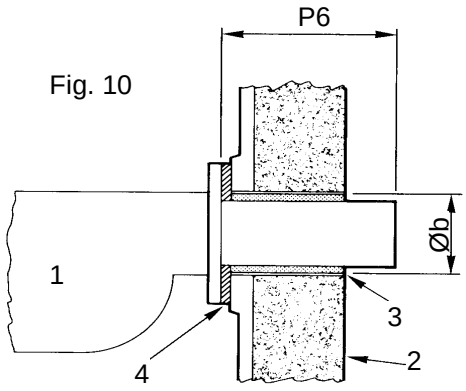
3.5 BURNER

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)

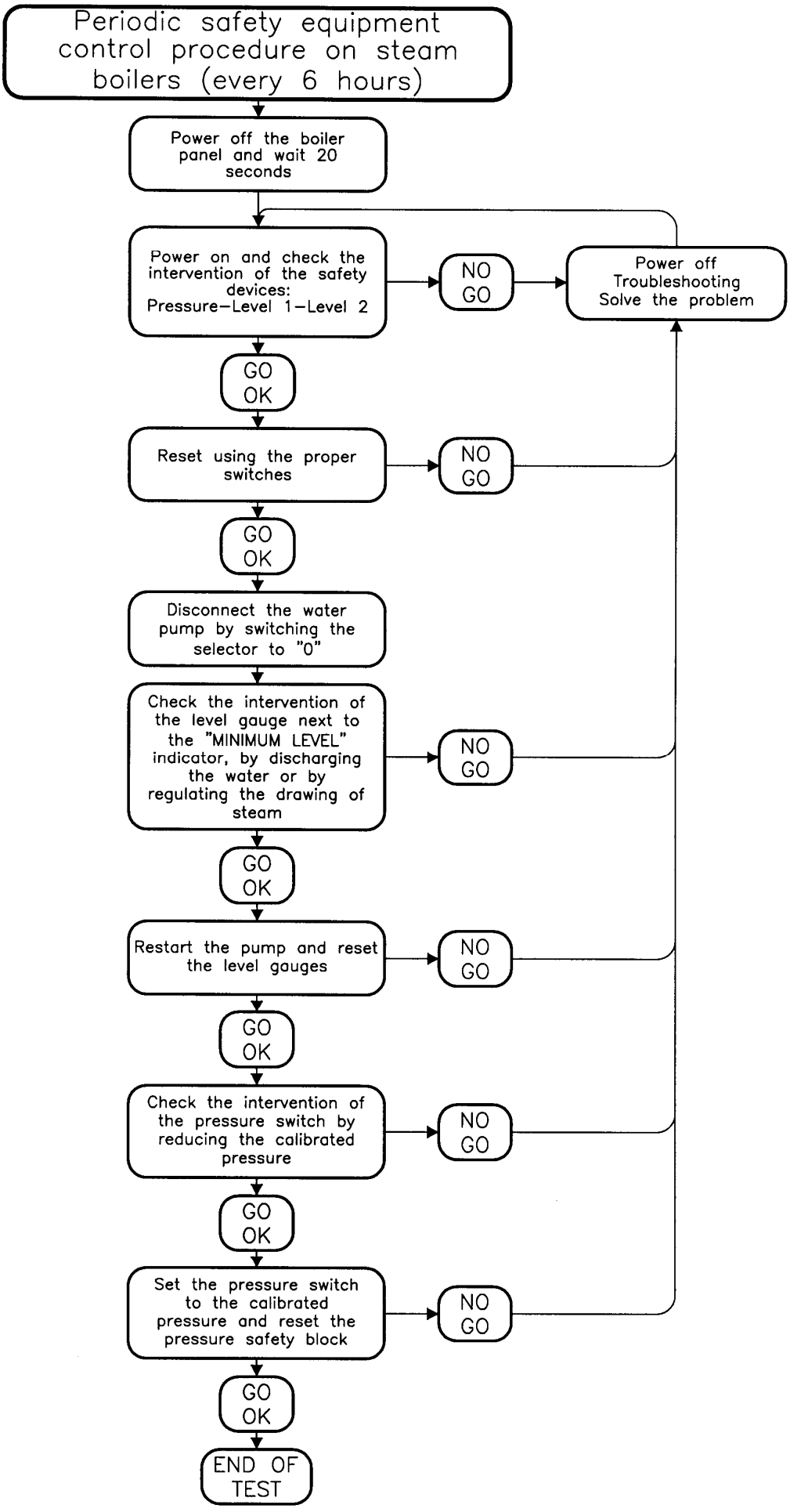
From time to time (every 6 hours of use) the thermal plant must be inspected by qualified personnel to check the efficiency of all safety accessories:

- 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

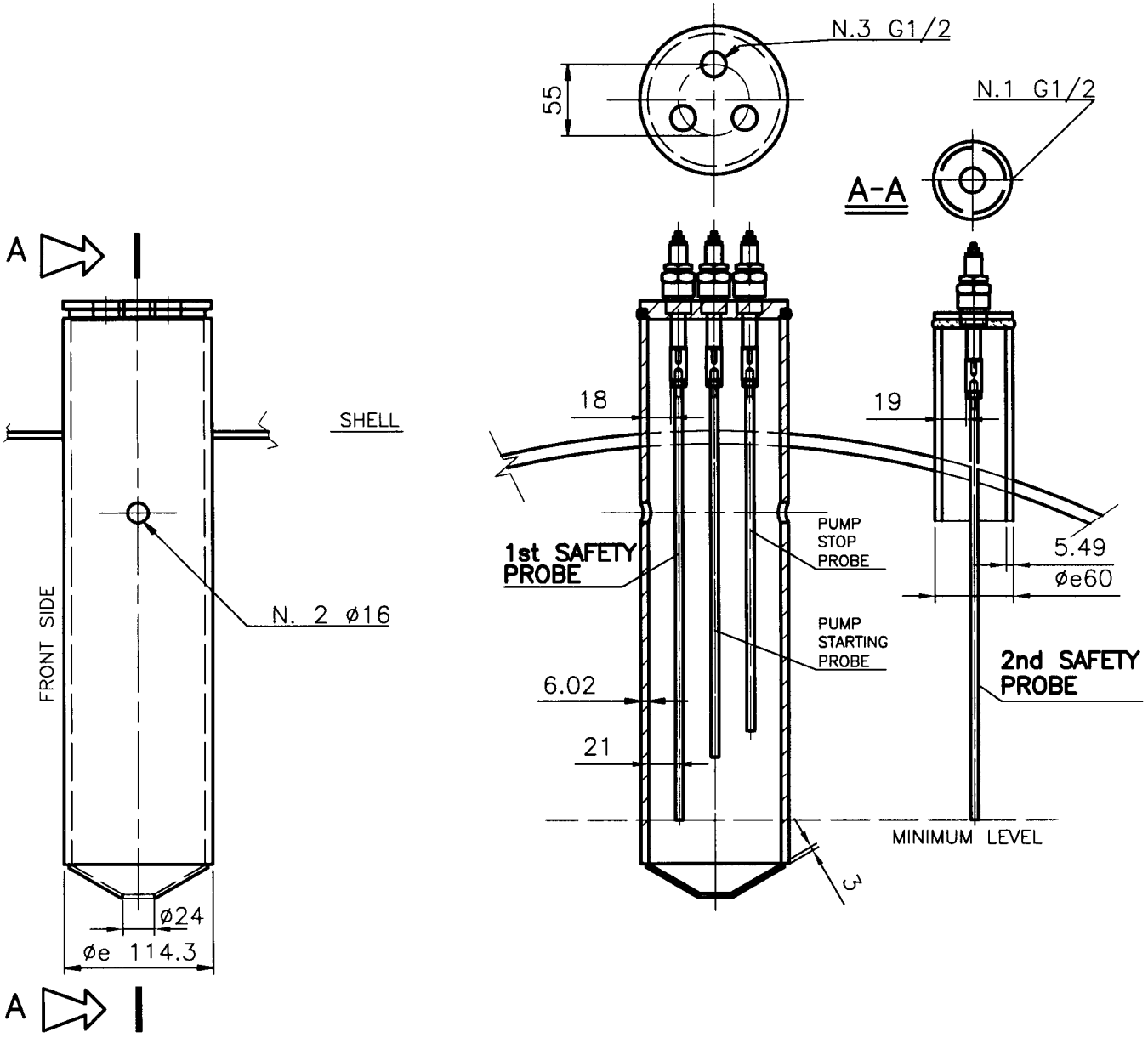
The water level limits consists in: n. 2 level rods, n. 2 probes, electrical cables, n. 2 electronic relays. The device prevents the lowering of the level of water in the steam generators and the consequent overheating of the membrature.

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).

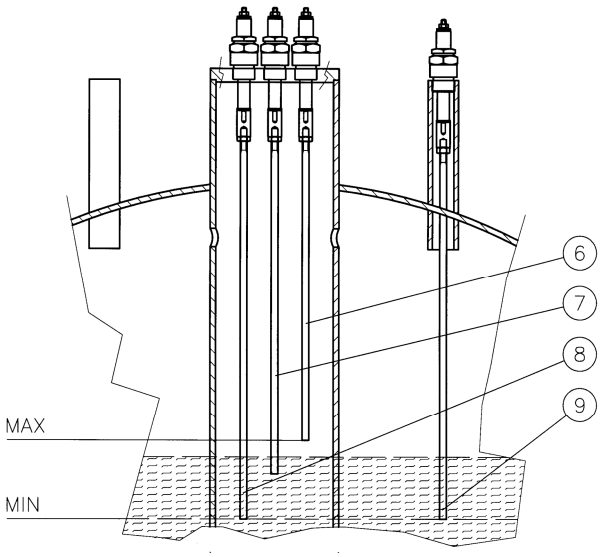
EXAMPLE: PROBES TANK FOR SAFETY AND REGULATION

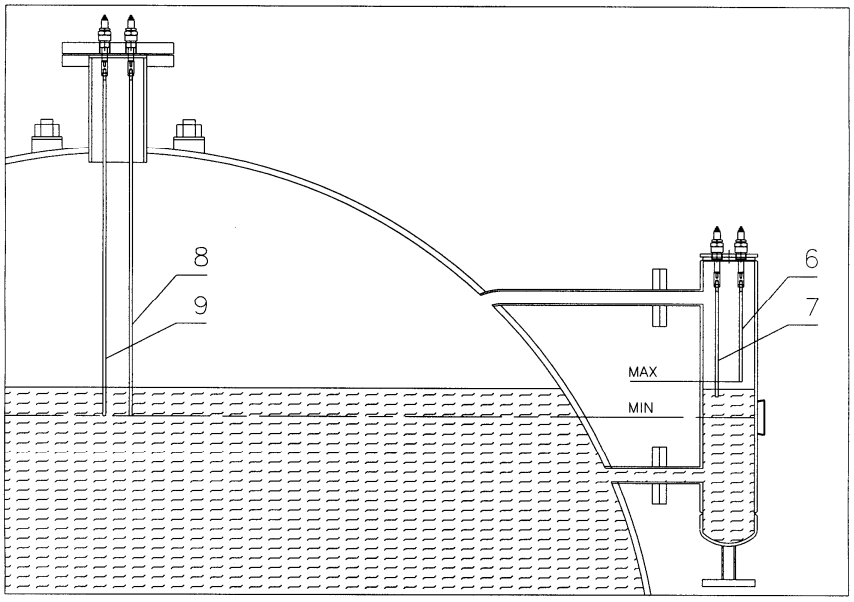


8.2 TYPICAL APPLICATIONS

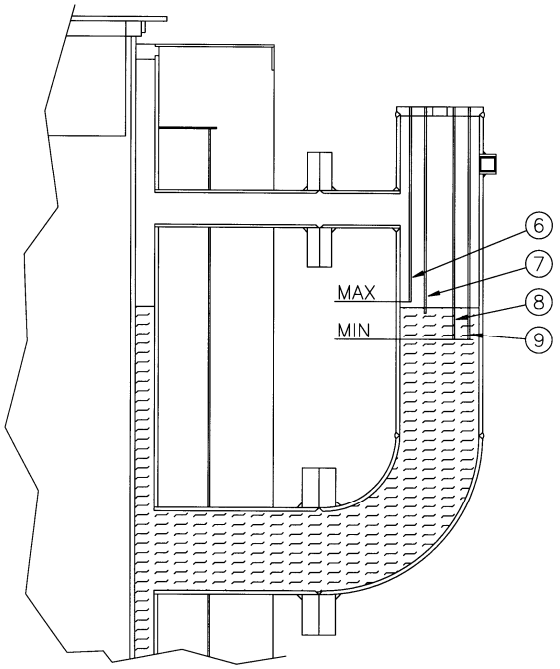
Boiler probes:

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

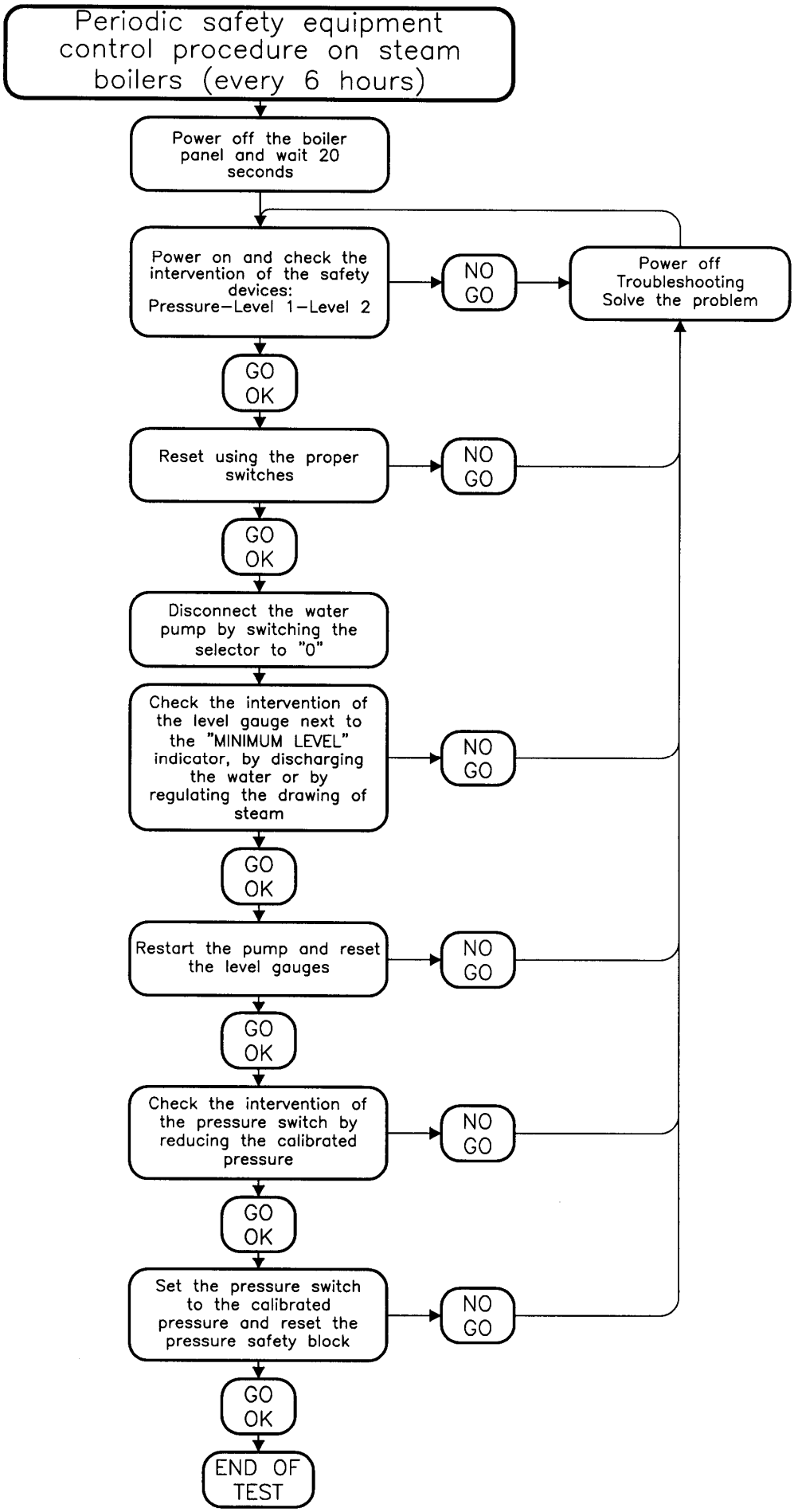
8.6.2 Periodic control (every 6 hours of use)

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

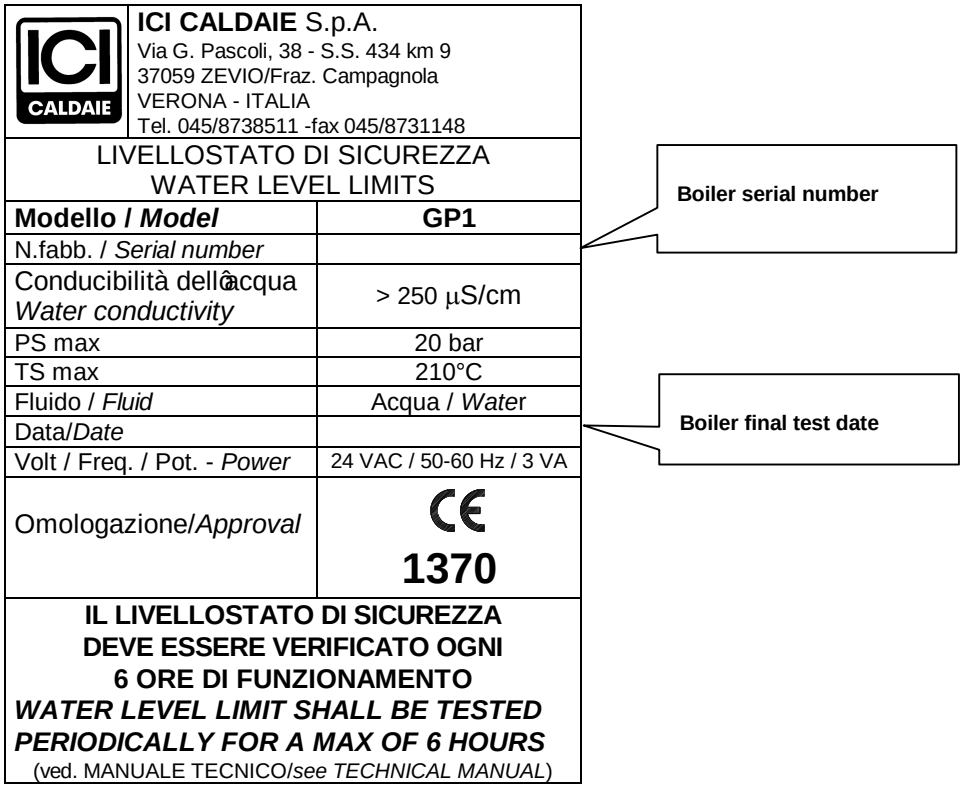
8.6.3 Extraordinary maintenance (water level limits substitution)

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
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The data reported are indicative only and are not binding. Our company reserves the right to introduce alterations at any time, as it deems fit and proper for the development of the product.

Appendix K H1 Assessment Tool Input and Output

Table 6 Input: Air release points

Release point code	Location or grid reference	Activity/Activities	Effective height (metres)	Dispersion factor (Long term)	Dispersion factor (short term)	Dispersion factor (monthly)	Efflux velocity (m/s)	Total flow (m3/h)
A1	346014, 107167	Heat	0	148	3900	529	12.4	3323
A2	346004, 107176	Heat	0	148	3900	529	7.67	3888
A3	345938, 107180	Heat	0	148	3900	529	27.5	720
A4	345999, 107191	Heat	0	148	3900	529	10.8	3499

Table 7 Input: Emissions inventory

Substance	Measurement method	Operating mode(%)	Long term conc (mg/m3)	Release rate g/s (long term)	Measurement basis (Long term)	Short term conc (mg/m3)	Release rate g/s (short term)	Measurement basis (short term)	Annual rate (t/yr)	Long term PC (ug/m3)	Short term PC (ug/m3)	Total Flow (m3/h)
Nitrogen dioxide	Estimated	96%	200	0.18	MPC ELV	200	0.18	MPC ELV	5.59	26.2	360	3323
Nitrogen oxides (as NO2) (ecological)	Estimated	96%	200	0.18	MPC ELV	200	0.18	MPC ELV	5.59	26.2	425	3323
Carbon monoxide	Spot	96%	88	0.08	Spot	88	0.08	Spot	2.46	11.5	222	3323
Sulphur dioxide (15 min mean)	Spot	96%	4	0.00	Spot	4	0.00	Spot	0.11	0.52	19.3	3323
Sulphur dioxide (24 hr mean)	Spot	96%	4	0.00	Spot	4	0.00	Spot	0.11	0.52	8.50	3323
Sulphur dioxide (ecological-lichens and bryophytes)	Spot	96%	4	0.00	Spot	4	0.00	Spot	0.11	0.52	14.4	3323
Sulphur dioxide (ecological-other vegetation)	Spot	96%	4	0.00	Spot	4	0.00	Spot	0.11	0.52	14.4	3323
Nitrogen dioxide	Estimated	96%	200	0.22	MPC ELV	200	0.22	MPC ELV	6.54	30.7	421	3888
Nitrogen oxides (as NO2) (ecological)	Estimated	96%	200	0.22	MPC ELV	200	0.22	MPC ELV	6.54	30.7	497	3888
Carbon monoxide	Spot	96%	85.2	0.09	Spot	85.2	0.09	Spot	2.79	13.1	251	3888

Substance	Measurement method	Operating mode(%)	Long term conc (mg/m3)	Release rate g/s (long term)	Measurement basis (Long term)	Short term conc (mg/m3)	Release rate g/s (short term)	Measurement basis (short term)	Annual rate (t/yr)	Long term PC (ug/m3)	Short term PC (ug/m3)	Total Flow (m3/h)
Sulphur dioxide (15 min mean)	Spot	96%	29.3	0.03	Spot	29.3	0.03	Spot	0.96	4.50	165	3888
Sulphur dioxide (24 hr mean)	Spot	96%	29.3	0.03	Spot	29.3	0.03	Spot	0.96	4.50	72.8	3888
Sulphur dioxide (ecological-lichens and bryophytes)	Spot	96%	29.3	0.03	Spot	29.3	0.03	Spot	0.96	4.50	123	3888
Sulphur dioxide (ecological-other vegetation)	Spot	96%	29.3	0.03	Spot	29.3	0.03	Spot	0.96	4.50	123	3888
Nitrogen dioxide	Estimated	96%	200	0.04	MPC ELV	200	0.04	MPC ELV	1.21	5.69	78.0	720
Nitrogen oxides (as NO2) (ecological)	Estimated	96%	200	0.04	MPC ELV	200	0.04	MPC ELV	1.21	5.69	92.1	720
Carbon monoxide	Spot	96%	86.4	0.02	Spot	86.4	0.02	Spot	0.52	2.46	47.2	720
Sulphur dioxide (15 min mean)	Spot	96%	6.08	0.00	Spot	6.08	0.00	Spot	0.04	0.17	6.36	720
Sulphur dioxide (24 hr mean)	Spot	96%	6.08	0.00	Spot	6.08	0.00	Spot	0.04	0.17	2.80	720
Sulphur dioxide (ecological-lichens and bryophytes)	Spot	96%	6.08	0.00	Spot	6.08	0.00	Spot	0.04	0.17	4.75	720
Sulphur dioxide (ecological-other vegetation)	Spot	96%	6.08	0.00	Spot	6.08	0.00	Spot	0.04	0.17	4.75	720
Nitrogen dioxide	Estimated	9%	236	0.23	Spot	236	0.23	Spot	0.61	2.89	447	3499
Nitrogen oxides (as NO2) (ecological)	Estimated	9%	236	0.23	Spot	236	0.23	Spot	0.61	2.89	528	3499
Carbon monoxide	Spot	9%	70.8	0.07	Spot	70.8	0.07	Spot	0.18	0.87	188	3499
Sulphur dioxide (15 min mean)	Spot	9%	33.6	0.03	Spot A2	33.6	0.03	Spot	0.09	0.41	171	3499
Sulphur dioxide (24 hr mean)	Spot	9%	33.6	0.03	Spot A2	33.6	0.03	Spot	0.09	0.41	75.1	3499
Sulphur dioxide (ecological-lichens and bryophytes)	Spot	9%	33.6	0.03	Spot A2	33.6	0.03	Spot	0.09	0.41	127	3499
Sulphur dioxide (ecological-other vegetation)	Spot	9%	33.6	0.03	Spot A2	33.6	0.03	Spot	0.09	0.41	127	3499

Table 8 Output: Air impacts – pollutants

Number	Substance	Long term EAL (ug/m3)	Long term PC (ug/m3)	Long term modelled PC	Short term EAL (ug/m3)	Short term PC (ug/m3)	Short term modelled PC
1	Nitrogen dioxide	40	65.48876689		200	1306.48949	
2	Nitrogen oxides (as NO2) (ecological)	30	65.48876689		75	1541.657599	
3	Carbon monoxide	0	27.94		10000	708.00	
4	Sulphur dioxide (15 min mean)	0	5.60		266	361.69	
5	Sulphur dioxide (24 hr mean)	0	5.60		125	159.25	
6	Sulphur dioxide (ecological-lichens and bryophyt	10	5.60		0	269.92	
7	Sulphur dioxide (ecological-other vegetation)	20	5.60		0	269.92	

Table 9 Output: Air impacts – Test 1

Number	Substance	Long term EAL (ug/m3)	Long term PC (ug/m3)	%PC of EAL (long term)	>1% of EAL? (long term)	Short term EAL (ug/m3)	Short term PC (ug/m3)	%PC of EAL (short term)	>10% of EAL? (short term)
1	Nitrogen dioxide	40	65.48876689	163.72%	fail	200	1306.48949	653.24%	fail
2	Nitrogen oxides (as NO2) (ecological)	30	65.48876689	218.30%	fail	75	1541.657599	2055.54%	fail
3	Carbon monoxide	0	27.93594076			10000	708.0007702	7.08%	pass
4	Sulphur dioxide (15 min mean)	0	5.604219727			266	361.6883918	135.97%	fail
5	Sulphur dioxide (24 hr mean)	0	5.604219727			125	159.2508591	127.40%	fail
6	Sulphur dioxide (ecological-lichens and bryophytes)	10	5.604219727	56.04%	fail	0	269.9167103		
7	Sulphur dioxide (ecological-other vegetation)	20	5.604219727	28.02%	fail	0	269.9167103		

Table 10 Output: Air impacts – Test 2

Number	Substance	Long term EAL (ug/m3)	Long term PC (ug/m3)	Air Background conc (ug/m3)	%PC of headroom (long term)	PEC Long term (µg/m3)	%PEC of EAL% (Long term)	%PEC of EAL>70%? (long	Short term EAL (ug/m3)	Short term PC (ug/m3)	%PC of the EAL-2*background	%PC of headroom >=20%? (short term)
1	Nitrogen dioxide	40	65.48876689	3.7	100%	69.19	172.97%	fail	200	1306.48949	678.34%	fail
2	Nitrogen oxides (as NO2) (ecological)	30	65.48876689	6.08	100%	71.57	238.56%	fail	75	1541.657599	2453.31%	fail
4	Sulphur dioxide (15 min mean)	0	5.604219727	1.88	100%	7.48			266	361.6883918	137.92%	fail
5	Sulphur dioxide (24 hr mean)	0	5.604219727	1.88	100%	7.48			125	159.2508591	131.35%	fail
6	Sulphur dioxide (ecological-lichens and br	10	5.604219727	0.73	60%	6.33	63.34%	pass	0	269.9167103		
7	Sulphur dioxide (ecological-other vegetati	20	5.604219727	0.73	29%	6.33	31.67%	pass	0	269.9167103		

Table 11 Output: Results - Air Assessment

Option	Substance	Test 1	Test 2
1	**Nitrogen dioxide**	**Fail**	**Fail**
1	**Nitrogen oxides (as NO2) (ecological)**	**Fail**	**Fail**
1	Carbon monoxide	Pass	
1	**Sulphur dioxide (15 min mean)**	**Fail**	**Fail**
1	**Sulphur dioxide (24 hr mean)**	**Fail**	**Fail**
1	Sulphur dioxide (ecological-lichens and bryophytes)	Fail	Pass
1	Sulphur dioxide (ecological-other vegetation)	Fail	Pass