

ABBEEY POWER GENERATION

PROPOSED ENERGY BACKUP ELECTRICITY GENERATORS AT LAND OFF WHALEY ROAD, BARNSELEY, SOUTH YORKSHIRE

AIR POLLUTION DISPERSION MODELLING REPORT

MARCH 2012

	Name	Date
Written By	Danielle Tinker	28 March 2012
Checked By	Paul Beckett	28 March 2012
Authorised By	Paul Beckett	28 March 2012

This report has been prepared for the exclusive use of the commissioning party and may not be reproduced without prior written permission from Phlorum Limited.

All work has been carried out within the terms of the brief using all reasonable skill, care and diligence.

No liability is accepted by Phlorum for the accuracy of data or opinions provided by others in the preparation of this report, or for any use of this report other than for the purpose for which it was produced.



SOUTHERN OFFICE Sussex Innovation Centre, Science Park Square, Falmer, East Sussex BN1 9SB **T** 01273 7044 49 **F** 01273 7044 89

WESTERN OFFICE One Caspian Point, Pierhead Street, Cardiff Bay, Cardiff CF10 4DQ **T** 02920 920820

Registered in England and Wales. Registered office: Sussex Innovation Centre, Science Park Square, Falmer, East Sussex BN1 9SB. Reg No. 4967266



This paper comes from sustainable forest stocks approved by the FSC



CONTENTS

PAGE NO

1.	Introduction	1
2.	Assessment Methodology	2
3.	Results	14
4.	Discussion	16
5.	Conclusions	17

Figures

Appendix A – Diesel Backup Generator Emissions Monitoring

Appendix B – Wind rose for Church Fenton for 2011

1. INTRODUCTION

- 1.1 Phlorum Limited has been commissioned by Abbey Power Generation to produce an air quality assessment to support a planning application for the proposed development of emergency backup electricity generators at a site off Whaley Road in Barnsley, South Yorkshire. The site is located at Ordnance Survey grid reference: 431961,408504.
- 1.2 Figure 1 shows a map of the area and the application site boundary.
- 1.3 The site is currently an area of hard standing located on the north eastern edge of an industrial estate. The site is bounded to the north east by a railway, beyond which is green space. The wider landscape to the north east is predominantly agricultural and industrial to the south west.
- 1.4 The nearest residential areas are located approximately 360m west of the site boundary, in Burley Green. Other residential properties located nearby stretch along the B6428, which is approximately 390m to the north and larger residential areas are located to the south in Barnsley and to the north in Darton.
- 1.5 The proposed development comprises eight diesel-powered reciprocating engines. The engines will be brand-new units and will be compliant with all relevant EU emissions standards. They will be housed in purpose-built, weatherproof enclosures and will be located along the north and south boundaries of the site.
- 1.6 The purpose of the proposed development is to provide emergency backup electricity for the National Grid. This is becoming increasingly important as greater reliance is being placed on wind generation, which is susceptible to weather conditions and other issues that prevent wind turbines' operation. This can lead to unexpected changes in energy supply, which will consequently require a larger reserve capacity. Standing reserve plant, such as is proposed at Whaley Road, is a key solution to the growing reserve problem.
- 1.7 Although the proposed generators will run on fossil fuel, they are supporting the national planning shift towards more sustainable energy supply from wind and other renewable sources. As an emergency backup source, the generators will be used intermittently, usually once in any given day for less than an hour and are likely to be required for a total of approximately 75 hours per year; although up to 300 hours might be required. Therefore, by supporting national policy they can be considered an integral part of the UK's developing sustainable energy supply infrastructure.

2. BASELINE ASSESSMENT

- 2.1 The following air quality legislation and planning policies aimed at reducing adverse air quality effects have been considered in the assessment for the proposed emergency backup generators.

The UK Air Quality Strategy

- 2.2 The UK Air Quality Strategy (UKAQS)¹ sets a number of "standard" (Air Quality Standards (AQs)) concentrations that are to be achieved at sensitive receptor locations across the UK by various "objective" dates. The sensitive locations at which the standards and objectives apply are places where the population is expected to be exposed to the various pollutants over the particular averaging period. Thus for those objectives to which an annual mean standard applies, the most common sensitive receptor locations used to measure concentrations against the set standards are areas of residential housing, since it is reasonable to expect that people living in their homes could be exposed to pollutants over such a period of time. For shorter averaging periods of between 15 minutes, 1 hour or 1 day, the sensitive receptor location can be anywhere where the public could be exposed to the pollutant over these shorter periods of time.
- 2.3 The objectives adopted in the UK are based on the Air Quality Standard Regulations 2007² for the purpose of Local Air Quality Management (LAQM). These Air Quality Regulations have adopted into UK law the limit values required by European Union Daughter Directives on air quality. The latest strategy, which was published in 2007¹, replaces the provisional 2010 PM₁₀ objectives in England, Wales and Northern Ireland with an exposure reduction approach. This seeks to provide a more efficient way of achieving further reductions in the health effects of air pollution.

¹ **DEFRA**, 2007, The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, HMSO.

² **DEFRA**, 2007, The Air Quality Standards Regulations 2007 - Statutory Instrument 2007 No.64, HMSO.

- 2.4 At sensitive receptor locations where an objective concentration has been predicted to be exceeded, a local planning authority should declare an Air Quality Management Area (AQMA). In setting an AQMA, the local planning authority must then formulate an Air Quality Action Plan (AQAP) to seek to reduce pollution concentrations to values below the objective levels. In determining whether or not an AQMA needs to be declared, a local planning authority produces an on-going series of air quality review and assessment reports. These seek to audit, measure and predict pollution concentrations at sensitive receptor locations where the UKAQS objectives might be exceeded.
- 2.5 At present Barnsley Metropolitan Borough Council (BMBC) have declared 6 AQMAs due to elevated concentrations of NO₂. The nearest AQMA to the application site is located approximately 1.5km to the west, which follows the M1 through the borough.

Local Planning Policy

Barnsley Local Development Framework; Core Strategy³

- 2.6 The Core Strategy considers development in AQMAs in policy 41 noting that:

"development[s] in air quality management areas will be expected to demonstrate that it will not have a harmful effect on the health or living conditions of any future users of the development in terms of air quality (including residents, employees, visitors and customers), or that any such harmful effects can be mitigated against."

- 2.7 The council also notes that they will only permit:

"development[s] in air quality management areas which could cause more air pollution, where the developer provides an assessment that shows there will not be a significantly harmful effect on air quality."

- 2.8 Air quality is also noted in policy 28 Reducing the Impact of Road Travel. This policy aims to reduce the impact of road travel by:

³**Barnsley Metropolitan Borough Council**, 2011, Local Development Framework; Core Strategy, Adopted September 2011.

“developing and implementing robust, evidence based air quality action plans to improve air quality.”

Local Air Quality Management

- 2.9 Following obligations under the Environment Act 1995⁴, BMBC has published a series of Local Air Quality Management (LAQM) review and assessment reports. The latest report was an ‘Air Quality Progress report’⁵, published in 2011, which concluded that the AQs are currently being exceeded at a number of locations in the borough. As a result two AQMAs are being proposed. The first is for the Sheffield Road/Park Road/Cemetery Road junction in Barnsley town centre and the second is in the village of Langsett. However, the council has proposed that the Dodworth Road by-pass AQMA should be revoked, due to air quality improvements in recent years. Finally, the report notes that all diffusion tubes within the AQMA along the M1 met the AQS for NO₂ in 2010 for the first year since it was declared in 2001.

Baseline Concentrations

- 2.10 DEFRA provides estimated background concentrations of the UKAQS pollutants on the World Wide Web at the UK Air Information Resource (UK-AIR) website (www.uk-air.defra.gov.uk). These estimates are produced using detailed modelling tools and are presented as concentrations at central 1km² National Grid Square locations across the UK.
- 2.11 Being background concentrations, the UK-AIR data are intended to represent a homogenous mixture of all emission sources in the general area of a particular grid square location. Concentrations of pollutants at various sensitive receptor locations can, therefore, be calculated by modelling the emissions from a nearby pollution source, such as a busy road, and then adding this to the appropriate UK-AIR background datum.

⁴ **DEFRA**, 1995, Environment Act 1995, HMSO.

⁵ **Barnsley Metropolitan Borough Council**, 2011, LAQM Air Quality Management; Progress Report 2011. May 2011.

2.12 For the application site the predicted background pollution concentrations for the UKAQS pollutants for the baseline year of 2012 are presented in Table 2.1. These data were taken from the central grid square location closest to the application site (i.e. grid reference: 431500, 408500).

Table 2.1: Background concentrations of pollutants at the Application Site from UK-AIR

Pollutant	Prediction year	Predicted background concentration ($\mu\text{g.m}^{-3}$)	Averaging period	Air quality standard concentration ($\mu\text{g.m}^{-3}$)	Objective: to achieve the standard by
NO ₂	2012	12.84	annual mean	40.00	End of 2005
PM ₁₀	2012	14.36	(gravimetric) annual mean	40.00	End of 2004

2.13 Table 2.1 shows that the predicted background concentrations of the pollutants of major concern at the application site are well below their respective AQs.

Local Sources of Monitoring Data

Automatic Monitoring

2.14 BMBC currently run five automatic monitoring stations monitoring concentrations of SO₂, PM₁₀, NO₂ and O₃. Table 2.2 and Table 2.3 list the concentrations of NO₂ and PM₁₀, respectively, at these locations. The nearest monitoring location to the application site is the urban background station at Barnsley Gawber. This is approximately 1 km south of the application site.

Table 2.2: NO₂ annual mean concentrations (µg.m⁻³) and number of hours exceeding the short term AQS (shown in parentheses) at the automated monitoring stations in Barnsley

Site Name	Site Type	Distance from the kerb of the nearest road	Annual mean concentration µg.m ⁻³ AQS = 40µg.m ⁻³ (number of hours exceeding short term AQS*)		
			2008	2009	2010
Barnsley A628	Roadside	3.5m	46 (13)	42 (5)	42 (19)
Barnsley Gawbar	Urban Background	n/a	19(2)	19(0)	25(0)
Barnsley A635	Roadside	8m	-	-	40(3)

*Short term, average hourly AQS = 200µg.m⁻³ not to be exceeded more than 18 times per year

2.15 Table 2.2 shows that NO₂ concentrations exceeding the annual mean standard of 40µg.m⁻³ were only recorded at roadside monitoring stations. Additionally, the short term standard has been exceeded by 5% above the 18 hour allowance of exceeding 200µg.m⁻³ at the monitoring station located along the A628, which is within an AQMA.

Table 2.3: PM₁₀ annual mean concentrations (µg.m⁻³) and the number of days exceeding the short term standard at the automated monitoring stations in Barnsley

Site Name	Site Type	Distance from the kerb of the nearest road	Annual mean concentration µg.m ⁻³ AQS = 40µg.m ⁻³ (number of days exceeding short term AQS*)		
			2008	2009	2010
Barnsley Royston	Urban Industrial	n/a	22 (20)	21 (8)	20(11)

*Short term, 24-hourly average AQS = 50µg.m⁻³ not to be exceeded more than 35 times per year

2.16 Table 2.3 shows that the PM_{10} concentrations recorded at the urban industrial monitoring station are below the annual mean and the number of days exceeding the daily mean standard by 50% and 31% of their respective standards.

Non-automatic Monitoring

2.17 BMBC also runs a network of 103 NO_2 diffusion tubes throughout the borough. Monitoring locations that are within 3km of the application site are listed in Table 2.4.

Table 2.4: NO₂ annual mean concentrations (µg.m⁻³) reported from diffusion tube monitoring in the borough of Barnsley

ID	Site Location	Site Type	Distance from the Kerb (m)	Annual mean concentration, µg.m ⁻³ AQS = 40µg.m ⁻³		
				2008	2009	2010
22	Summer Lane	Kerbside	0.3	50.4	49.0	49.1
23	23 Dodworth Road	Roadside	1.5	52.6	50.5	46.2
25	53 Dodworth Road	Roadside	1.5	55.1	50.0	54.5
26	75 Dodworth Road	Roadside	N/A	41.9	31.9	35.1
27	Traffic Lights Dodworth Road	Roadside	2.5	56.6	54.8	54.6
28	Lancaster Street	Roadside	N/A	37.6	31.1	34.8
29	144 Dodworth Road, Adj Shaw Lane	Roadside	1.5	44.7	40.1	39.4
30	202 Dodworth Road East Xrds	Roadside	3.5	59.2	50.4	48.8
31	188 Dodworth Road SR Gent	Roadside	3.5	42.6	40.1	43.9
32	Wakefield Road/Wensley Road	Roadside	N.A	31.0	27.7	29.1
33	Wakefield Road/Brunswick Close	Kerbside	N/A	33.5	33.4	31.9
34	Wakefield Road/Carlton Road	Roadside	2	42.5	39.5	38.7
40	Huddersfield Road/Hopwood Street	Kerbside	N/A	39.8	38.2	41.2
41	Victoria Road/Huddersfield Road	Kerbside	0.3	43.6	38.4	44.0
42	Victoria Road/Huddersfield Road	Roadside	3	42.3	37.6	37.3
73	Pogmoor Crossroads	Roadside	N/A	44.9	41.2	41.4
76	Pogmoor Crossroads	Roadside	N/A	55.4	49.5	52.6
77	Post Office, Crown Hill Rd	Roadside	N/A	345.1	35.5	34.6
78	305 Dodworth Road	Roadside	3	67.4	61.8	59.9

ID	Site Location	Site Type	Distance from the Kerb (m)	Annual mean concentration, $\mu\text{g.m}^{-3}$ AQS = $40\mu\text{g.m}^{-3}$		
				2008	2009	2010
79	315 Dodworth Rd, Pogmoor	Kerbside	2.5	69.8	62.4	57.7
80	329 Dodworth Road	Roadside	2	61.8	56.4	54.5
81	M1 Junction 37	Roadside	N/A	35.1	32.2	33.7
83	23 Barnsley Road	Roadside	-	32.7	31.0	31.9
84	Barugh Grn Rd/Higham Com'n Rd	Roadside	2	-	-	35.7
85	Woodbine Cottages, Barnsley Road	Roadside	-	37.0	31.6	33.9
88	Royd Hill, Higham	Urban Background	N/A	42.3	38.3	34.8
89	Lansdowne Crescent, Darton	Urban Background	N/A	36.4	33.5	34.7
93	Junc.A637/B6428 (roundabout)	Roadside	1.5	-	-	39.5

2.18 Table 2.4 shows that annual mean NO_2 concentrations from 46% of the diffusion tube locations exceeded the AQS of $40\mu\text{g.m}^{-3}$ in 2010. Monitoring locations that recorded an exceedence were all located at roadside or kerbside locations and therefore do not represent sensitive receptors locations where the annual mean AQS would apply. Additionally, all diffusion tubes that exceeded the AQS, with the exception of tubes 40 and 41, are located within a declared AQMA. The urban background diffusion tubes, which are located in a location of relevant exposure, demonstrate that concentrations are more than 13% below the AQS.

2.19 The monitoring site located at the A637 and B6428 Roundabout is approximately 530m to the northwest of the application site. Concentrations at this monitoring location are recorded to be 1.25% below the annual mean NO_2 standard. However, this is a roadside location and therefore is not considered to be a location of relevant exposure for the annual mean AQS.

2.20 It is noted in the LAQM Technical Guidance 2009 (TG09)⁶ that if annual mean concentrations do not exceed $60\mu\text{g.m}^{-3}$ it is reasonable to assume that the short term hourly standard is likely to be achieved. Therefore, since the maximum monitored concentration in Table 4 is $59.9\mu\text{g.m}^{-3}$ this indicates that some monitoring locations approached the 18 hour standard. All of the 32% of the stations that can be considered to have approached the short term standard are more than 2.6km from the application site.

⁶ **DEFRA**, 2009, *Part IV of the Environment Act 1995, Local Air Quality Management, Technical Guidance LAQM. TG(09)*, DEFRA

3. ASSESSMENT METHODOLOGY

Emissions

- 3.1 Dispersion modelling was carried out using Breeze Aermod GIS Pro (Version 7.4.1). The model inputs are presented below in Table 2.1.
- 3.2 With the emergency backup generators likely to be used for up to one hour in any one day and for just 75 hours per year, it is highly unlikely that they will have any effect on annual average concentrations of air pollutants.
- 3.3 It is much more likely that their operation will affect the short term AQSs. Following discussions with the Technical Pollution Control Officer at BMBC, it was agreed that the focus of this assessment would be on the following pollutants and their respective short term AQSs:
 - 24-hour AQS for PM_{10} , which allows up to 35 daily exceedences of $50\mu g.m^{-3}$ per year;
 - hourly AQS for NO_2 , which allows up to 18 average hourly exceedences of $200\mu g.m^{-3}$ per year; and
 - AQSs for SO_2 , which allow up to 35 average 15 minute exceedences of $266\mu g.m^{-3}$ and 24 hourly exceedences of $350\mu g.m^{-3}$.
- 3.4 As a result of recent legislation that was brought in on January 1st 2011, the sulphur content of Standard Gasoil (red diesel), which the proposed generators will run on, has been reduced from 1,000ppm to 10ppm. This fuel is known as 'sulphur-free'. Therefore, emissions of SO_2 are deemed undetectable and have not been considered further within this assessment.
- 3.5 Table 3.1 lists the model inputs.

Table 3.1: Data inputs to Aermid (actual emission rates)

Model input	Statistic
Number of generators	8
Release height (m)	10
PM ₁₀ emission rate (g.s ⁻¹)	0.8181
NO _x emission rate (g.s ⁻¹)	0.0207*
Exhaust temperature (K)	664*
Exit velocity (m.s ⁻¹)	45
Exhaust diameter (m)	0.4
Stack area (m ²)	0.13
Emission Profile	1 hour a day at 18:00

*Derived from Monitoring data (see Appendix A)

- 3.6 Meteorological data from Church Fenton for 2011 were used. Although this was not the closest weather station it is considered the most representative of the application site. Emley Moor is located closer to the site but it is situated on higher ground and the last available data year is 2009. A wind rose of the meteorological data for Church Fenton for 2011 is shown in Appendix B. This shows that the wind is predominantly blowing from a south westerly direction, which is the prevailing situation in most inland areas of the UK.
- 3.7 The emissions from the proposed backup generators have been modelled as occurring for 1 hour a day at 18:00 hours. This can be considered a worst case as it is likely that the generators will only be required for a fraction of the year, mainly in the winter and autumn months. Emissions have also been modelled to emit vertically, although the exhausts emit horizontally. This is due to how the model calculates dispersion.
- 3.8 Building effects were taken into account using the EPA's Prime model. These effects considered all buildings and structures on the site that could affect building downwash. There are no significant hills or other obstructions in the area of Whaley Road. Therefore the model was run assuming flat terrain.
- 3.9 One receptor grid was used to calculate the pollution concentrations across the local area around the Whaley Road site. This grid was placed centrally to the site with its south west corner at grid reference 431000, 407000. It was made up of a network of 50 × 50 data point receptors spaced at 50m across a square area of 2,500m².

3.10 The hourly NO_2 AQS applies anywhere where the public could be exposed over this averaging period. This therefore includes any living areas, playing areas, footpaths, walkways, pavements, rights of way or other areas where the public have access close to the application site.

3.11 Such 'sensitive receptors' within 400m of the emergency backup generators are shown on Figure 1. Five sensitive receptors, with the addition of Receptor 1, which is a monitoring location, have been agreed with the local authority to be modelled. The nearest residential receptor is located approximately 360m to the west along Kelby Croft (Receptor 3). Further residential properties are located to the north along Dearne Hall Fold (Receptor 2). A public footpath is located approximately 80m east of the application site beyond the railway track (Receptor 6), and pavements follow Whaley Road (Receptor 4), which links to Claycliff Road to the west (Receptor 3).

3.12 The following equations were used to determine the concentrations relative to appropriate AQSs for each data point and receptor location above as suggested in TG09⁶. For the short term standards of PM_{10} :

- 90thile of the 24 hour mean process contribution plus once the annual mean background contribution.

3.13 For the short term standard of NO_2 :

- 99.8thile of the hourly process contribution of NO_x plus twice the annual mean background NO_2 concentration.

3.14 The background concentrations from the local background monitoring station Bansley Gawbar were used when considering the background concentration of NO_2 to determine the process contribution at each receptor point. This was selected as it constituted a worst case as concentrations predicted from DEFRA's Background Maps were lower. As a result of no urban background monitoring being performed for PM_{10} , the DEFRA background maps emission data were used for each gridded receptor point.

3.15 Contour plots have been produced from the pollution concentrations calculated from the equations listed above to show the pattern of dispersion.

4. RESULTS

Nitrogen Dioxide (NO₂)

- 4.1 A contour plot of NO₂ concentrations is shown in Figure 2. This shows that the locations of highest hourly NO₂ concentrations are to the north and south east of the application site. The highest 99.8thile concentration is predicted to occur to the north, at Grid Reference 432000, 408650, reaching 59.02µg.m⁻³. Table 4.1 lists the NO₂ concentrations predicted at each discrete receptor location.

Table 4.1: 99.8thile of hourly NO_x plus twice NO₂ background concentrations. (AQ5= 200µg.m⁻³ no more than 18 times a year)

Receptor location	Hourly NO ₂ concentration (µg.m ⁻³)	Proposed development/process contribution (µg.m ⁻³)
1	50.79	0.79
2	51.04	1.04
3	50.81	0.81
4	50.82	0.82
5	52.53	2.53
6	58.88	8.88

- 4.2 Table 4.1 shows that the highest concentration is predicted at Receptor 6 which is located to the east of the application site along the footpath. The proposed development contributes 8.88µg.m⁻³ to the 99.8thile of hourly mean concentration, which is 70% below the 200µg.m⁻³ AQ5.

PM₁₀

- 4.3 A contour plot of PM₁₀ concentrations is shown in Figure 3. This shows that the location of highest 90thile of daily mean PM₁₀ concentrations will occur to the east of the application site. The highest concentration is predicted to occur at Grid Reference 432100, 408550, with the 90thile of daily mean concentrations reaching 15.02µg.m⁻³. Table 4.2 lists the PM₁₀ concentrations at each discrete receptor location.

Table 4.2: 90thile of daily PM₁₀ plus background concentrations (AQS= 50 µg.m⁻³ no more than 35 times a year)

Receptor location	Daily mean PM ₁₀ Concentration (µg.m ⁻³)	Proposed development/process contribution (µg.m ⁻³)
1	14.39	0.03
2	14.38	0.02
3	14.36	<0.01
4	14.37	0.01
5	14.39	0.03
6	14.81	0.45

- 4.4 Table 4.2 shows that the highest concentration is predicted at Receptor 6 which is located to the east of the application site along the footpath. The proposed development contributes 0.45µg.m⁻³ to the 90thile of daily mean concentrations, which is 70% below the 50µg.m⁻³ AQS.

5. DISCUSSION

- 5.1 The data in Figure 2 and 3 show that the operation of the proposed backup generators would result in small increases in pollution concentrations in the local area.
- 5.2 The model has predicted that the highest increases in concentrations will occur to the north and east of the application site. Results show that the contribution to local air pollution concentrations from the operation of the generators would be up to $9.02\mu\text{g.m}^{-3}$ of the 99.8th %ile of hourly NO_2 concentrations and up to $0.6\mu\text{g.m}^{-3}$ of the 90th %ile of daily mean PM_{10} concentrations.
- 5.3 In terms of current pollution concentrations, the operation of the backup generators should not pose any significant obstacles to BMBC's planning policies. Moreover, as they support the shift towards more sustainable sources of energy, the proposed generators are in line with national and local planning objectives.
- 5.4 In consideration of the above, this assessment suggests that due to their highly infrequent use, the generators will not impact on existing air quality to an extent that might compromise the current achievement of the various UKAQS standards and objectives. This particularly relates to the short term AQSs for NO_2 and PM_{10} , which are of most relevance to the short term and intermittent use of the proposed generators.
- 5.5 It is therefore considered that the emergency backup generators should not cause a significantly adverse impact on local air quality and that the development is acceptable as proposed.

6. CONCLUSIONS

- 6.1 Overall, the predicted increases in pollution concentrations from the operation of the emergency backup generators are considered to be insignificant, and they are deemed to be acceptable as proposed in terms of their impact on local air quality.
- 6.2 The net benefit of the scheme will be to reduce total emissions of NO_x and carbon across the UK, which will be of benefit environment as a whole.
- 6.3 The development is considered, therefore, to be in keeping with the environmental, energy and sustainability aims of the local authority's planning policies and objectives. There is therefore no apparent reason, on air quality grounds, why its planning application should not be approved.



Figures

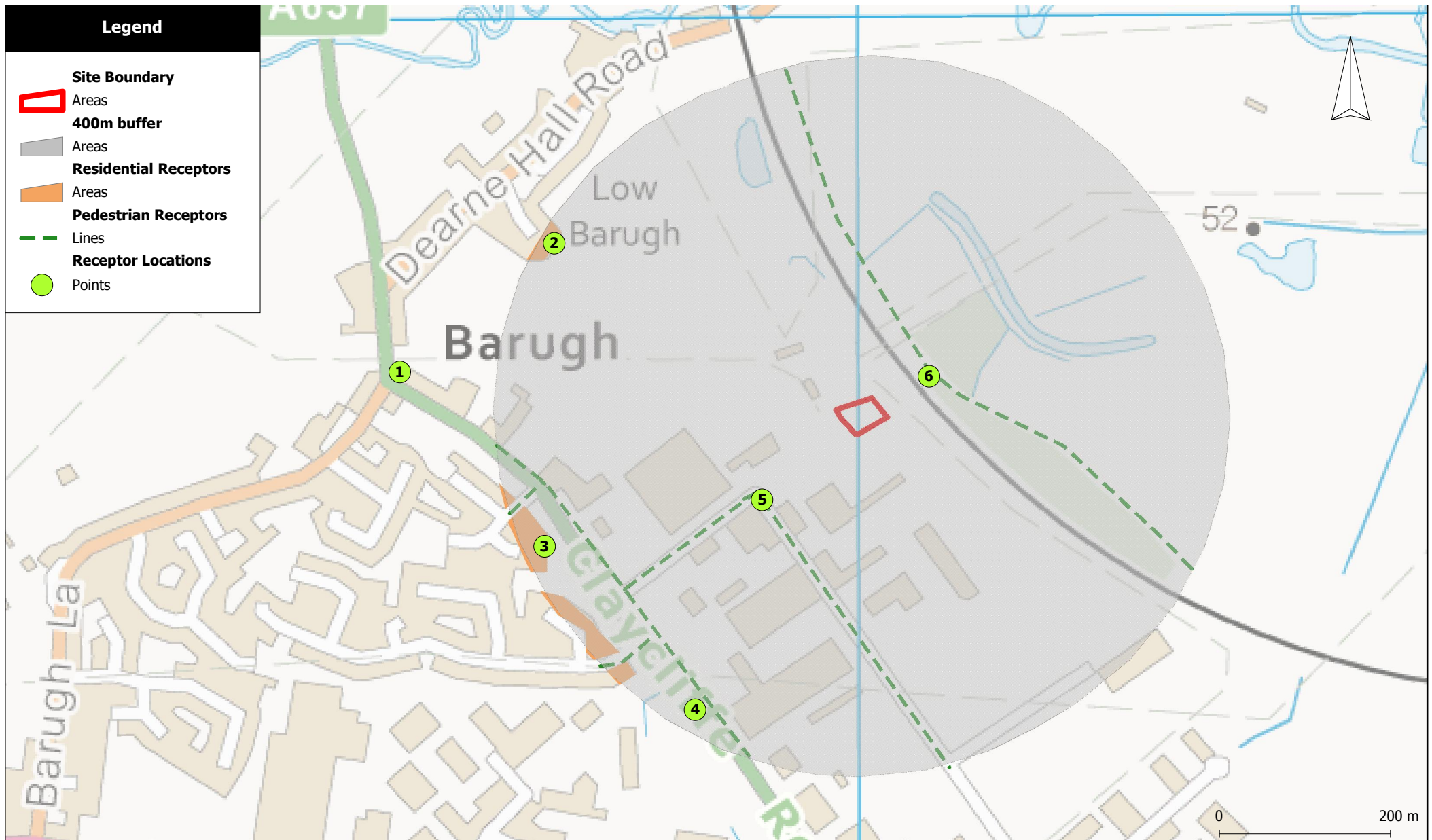


Figure 1: Whaley Road, Barnsley
Proposed Emergency Backup Electricity Generators

Drawn by: DT
On the: 26/03/2012
Scale: 1:6000 @A4
Ref:4683



Phlorum Limited, Carrington Business Park,
Carrington, Manchester, M31 4DD.

Tel: 0161 776 4328 / Fax: 0161 775 8995
Web: www.phlorum.com Email: info@phlorum.com

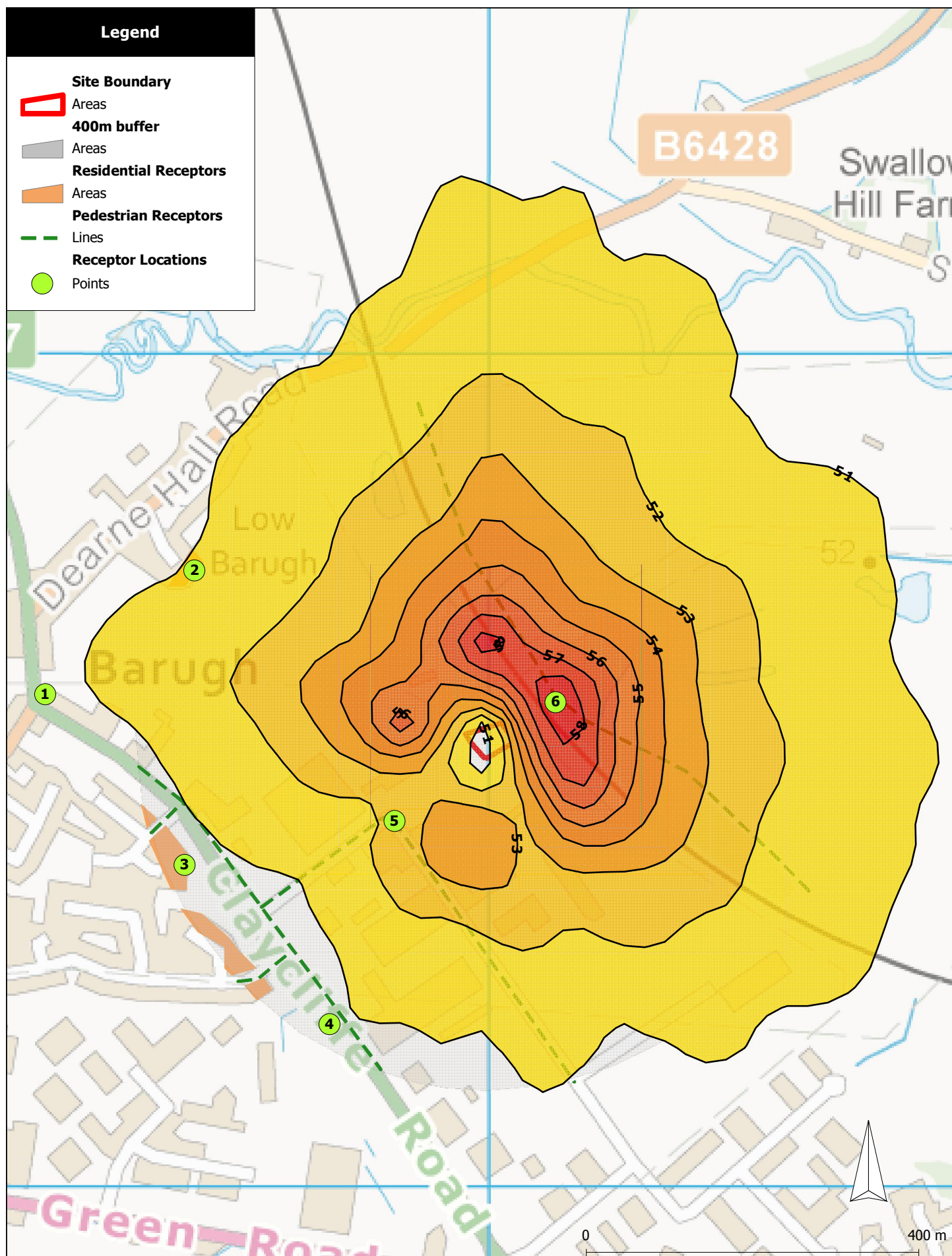


Figure 3: Whaley Road, Barnsley
90th%ile of daily mean PM10 concentrations
(ug.m-3)

Drawn by:DT
On the: 28/03/2012

Scale: 1:8000
Ref:4683

Appendix A
Diesel Backup Generator
Emissions Monitoring



NORTHERN OFFICE
Phlorum Limited
Carrington Business Park
Carrington
Manchester
M31 4DD
T 0161 776 4328
F 0161 775 8995
E info@phlorum.com
W www.phlorum.com

26 March 2012

By Email Only (roland@thurgartonpriory.co.uk)

Roland Duce
Abbey Power Generation
Devonshire House
1 Devonshire Street
London, W1W 5DR

Our ref: PB/4589_S/DT

Dear Roland:

Emergency Backup Electricity Generators: Emissions Monitoring at Station Road, Ecclesfield, S35 9XN

1. Introduction

- 1.1 Phlorum has been appointed by Abbey Power Generation to perform monitoring of flue gases arising from a Perkins 4012-46TAG 3A Diesel Engine at the Emergency Backup Electricity site in Ecclesfield. The data collected from this monitoring are to be used to determine the specification, if required, of abatement, at other proposed emergency backup electricity generator sites.
- 1.2 This letter report presents the results of this monitoring and the specification of the monitor is attached.

2. Assessment Methodology

Monitoring

- 2.1 Monitoring was carried out at the emergency backup generator site along Station Road in Ecclesfield, S35 9XN, on the 15th of March 2012. Monitoring was undertaken outside of the generators availability window which was after 13:30. During the availability window the generators must be available to provide electricity, when required, to the National Grid.
- 2.2 The monitoring recorded the emissions from both exhausts from a single generator. The exhausts exit from the top of the engine enclosure which houses the generator and the two exhausts connect to a single outlet flue where emissions are released to the atmosphere.



SOUTHERN OFFICE Sussex Innovation Centre, Science Park Square, Falmer, East Sussex BN1 9SB T 01273 7044 49 F 01273 7044 99

WESTERN OFFICE One Caspian Point, Pierhead Street, Cardiff Bay, Cardiff CF10 4DQ T 02920 920820

Registered in England and Wales. Registered office: Sussex Innovation Centre, Science Park Square, Falmer, East Sussex BN1 9SB. Reg No. 4967256



This paper comes from sustainable forest stocks approved by the FSC

- 2.3 Concentrations of NO, NO₂, NO_x and SO₂ were recorded after the generator had reached maximum capacity at 1.5MW. The readings were recorded using a Testo 350 XL and control unit air quality monitor. This device also measures oxygen content and temperature of flowing gas streams, which were also recorded during the monitoring visit. Total emissions from both engine exhausts were measured at the combined, single release point where the flue emits to atmosphere, as shown in Figure 1. This was monitored via a sampling port that was drilled into the flue.



Figure 1: Testo 350 XL probe in the exhaust of the Perkins 4012-46TAG 3A

- 2.4 The Testo 350 XL and Control Unit is designed for the intended purpose to 'emission check' flue gases and perform 'inspections in order to be able to supply information on process measurements'. The Testo 350 XL was set up to monitor continuously and spot measurements were taken every 5 minutes for a period of 15 minutes. The monitor was calibrated on the 12th of March 2012.

3. Results of the Monitoring

Testo 350 XL monitoring

- 3.1 Table 1 shows the mean results of the monitoring and the mean and maximum emission concentrations.

Table 1: Results from Testo 350 XL fuel monitoring at the Emergency Backup Electricity Generators site in Ecclesfield

Measure ment	Tempe rature (K)	O ₂ (%)	NO _x (µg.m ⁻³)	NO (µg.m ⁻³)	NO ₂ (µg.m ⁻³)	SO ₂ (µg.m ⁻³)
Total mean of monitoring period	664	12.5	3,547	3,323	178	undetected
Maximum recorded during monitoring period	669	17.1	3,589	3,459	297	undetected

3.2 The results listed in Table 1 show that at full capacity, the concentration being emitted is 3,547µg.m⁻³ of NO_x while concentrations of SO₂ were undetectable.

3.3 Table 2 lists the calculated emissions rate considering the flow rate is 350 m³.min⁻¹, as provided by Abbey Power.

Table 2: Emission rate at 664K and 5.8m.s⁻¹ from a Perkins 4012-46TAG 3A

Measure ment	Tempe rature (K)	air flow (m ³ .s ⁻¹)	NO _x (g.s ⁻¹)	NO (g.s ⁻¹)	NO ₂ (g.s ⁻¹)	SO ₂ (g.s ⁻¹)
Total mean of monitoring period	664	5.8*	0.021	0.019	0.001	undetected
Maximum recorded during monitoring period	669	5.8*	0.021	0.020	0.0001	undetected

* Calculated from 350m³.min⁻¹ as listed in the attached technical data sheet.



4. Conclusions

- 4.1 Monitoring was performed from the flue of a Perkins 4012-46TAG 3A Diesel Engine at the Emergency Backup Electricity Generators site in Ecclesfield. This was performed using a Testo 350 XL while the generator was running at maximum capacity.
- 4.2 The average concentration emitted and emission rates during the operation of the diesel engine are presented in Tables 1 and 2, along with the highest emissions recorded for each pollutant. The concentrations and emission rates presented in these tables should be used when undertaking assessments to determine the concentrations at other proposed emergency backup electricity generator sites.

Yours sincerely

A handwritten signature in black ink that reads "D. Tinker".

Danielle Tinker
Environmental Consultant

Encs.

cc. Alex Duce (alex.duce@abbeypowergeneration.com)

Technical Data

4000 Series

Diesel Engine - Electropak

4012-46TAG3A

Basic technical data

Number of cylinders 12
 Cylinder arrangement Vee, 60°
 Cycle 4 stroke
 Induction system Turbocharged
 Combustion system direct injection
 Compression ratio 13:1
 Bore 160 mm
 Stroke 190 mm
 Cubic capacity 45-842 litres
 Direction of rotation anti-clockwise when viewed from flywheel
 Firing order 1^A, 6^B, 5^A, 2^B, 3^A, 4^B, 6^A, 1^B, 2^A, 5^B, 4^A, 3^B
 Cylinder 1 furthest from flywheel
Note: Cylinders designated 'A' are on the right hand side of the engine when viewed from the flywheel end

Approximate weights

Description	unit	Tropical	Temperate
Engine (dry)	Kg	4400	4400
Electropak (wet) + fuel cooler	Kg	6450	6086
Electropak (wet) - fuel cooler	Kg	6425	6070

Overall dimensions of Electropak

	unit	Tropical	Temperate
Height	mm	2610	2259
Length	mm	3883	3915
Width	mm	2164	2198

Moment of inertia

Engine 9,73 kgm²
 Flywheel 9,57 kgm²

Cyclic irregularity for engine/flywheel maximum

4012-46TAG3A 1:638

Ratings

Steady state speed stability at constant load ± 0.25%
 Electrical rating are based on average alternator efficiency and are for guidance only (0.8 power factor being used).

Operating point

Engine speed 1500 rev/min
 Static injection timing see engine number plate
 Cooling water exit temperature < 98 °C
 Fuel data to conform to BS2869 class A2 or BS EN590

Performance

All data based on operation to ISO 3046/1, BS 5514 and DIN 6271 standard reference conditions.

Noise

For noise data, refer to page 16.
 For engines operating in ambient conditions other than the standard reference conditions stated below, a suitable de-rate must be applied.
 De-rate tables for increased ambient temperature and/or altitude are available, please contact Perkins Applications Department.

Test conditions

Air temperature 25 °C
 Barometric pressure 100 kPa
 Relative humidity 30%
 Air inlet restriction at maximum power (nominal) 2,5 kPa
 Exhaust back pressure at maximum pressure (nominal) 3,0 kPa
 Fuel temperature (inlet pump) 58 °C maximum
 For test conditions relevant to data on load acceptance, refer to page 16 of this document.

General installation

4012-46TAG3A - Temperate

Designation	Units	Type of operation and application		
		Baseload power	Prime power	Standby power
Gross engine power	kWm	1260	1500	1643
Fan and battery charging alternator power	kW	64		
Nett engine power	kWm	1196	1436	1579
Brake mean effective pressure (gross)	kPa	2192	2610	2859
Combustion air flow at ISO conditions	m³/min	115	125	135
Exhaust gas temperature (max) after turbo	°C	480		
Exhaust gas flow (max) at atmospheric pressure	m³/min	350		
Boost pressure ratio	-	3,0	3,4	3,7
Mechanical efficiency	%	89	91	92
Overall thermal efficiency (nett)	%	41,5	41,0	39,0
Friction power and pumping losses	kWm	120		
Mean piston speed	m/s	9,5		
Engine coolant flow	l/s	1020		
Typical Genset electrical output (0.8pf)	kVA	1420	1705	1875
	kWe	1136	1364	1500
Assumed alternator efficiency	%	95		

4012-46TAG3A - Tropical

Designation	Units	Type of operation and application		
		Baseload power	Prime power	Standby power
Gross engine power	kWm	1260	1500	1643
Fan and battery charging alternator power	kW	60		
Nett engine power	kWm	1200	1440	1583
Brake mean effective pressure (gross)	kPa	2192	2610	2859
Combustion air flow at ISO conditions	m³/min	115	125	135
Exhaust gas temperature (max) after turbo	°C	480		
Exhaust gas flow (max) at atmospheric pressure	m³/min	350		
Boost pressure ratio	-	3,0	3,4	3,7
Mechanical efficiency	%	89	91	92
Overall thermal efficiency (nett)	%	41,5	41,0	39,0
Friction power and pumping losses	kWm	120		
Mean piston speed	m/s	9,5		
Engine coolant flow	l/s	1020		
Typical Genset electrical output (0.8pf)	kVA	1425	1710	1880
	kWe	1140	1368	1504
Assumed alternator efficiency	%	95		

Note: Not to be used for combined heat and power (CHP) purposes (indicative figures only). If necessary, please consult the Applications Department, Perkins Engines Company Limited, Stafford.

Rating definitions

Baseload power

Unlimited hours usage with an average load factor of 100% of the published baseload power rating.

Prime power

Variable load. Unlimited hours usage with an average load factor of 80% of the published Prime Power over each 24 hour period. A 10% overload is available for 1 hour in every 12 hours.

Standby power

Limited to 500 hours annual usage with an average load factor of 80% of the published Standby Power rating over each 24 hour period. Up to 300 hours of annual usage may be run continuously. No overload is permitted on Standby Power.

Emissions capability

All 4012-46TAG ratings are optimised to the 'best fuel consumption' and do not comply to Harmonised International Regulation Emission Limits. More information on these statements can be obtained by contacting the Applications Department at Perkins Engines Company Limited.

Energy balance

4012-46TAG3A - Temperate

Designation	Units	Baseload power	Prime power	Standby power
Energy in fuel	kW	3137	3650	4100
Energy in power output (gross)	kW	1260	1500	1643
Energy to cooling fan	kW	64		
Energy in power output (nett)	kW	1196	1436	1579
Energy to exhaust	kW	1010	1102	1219
Energy to coolant and oil	kW	477	510	625
Energy to radiation	kW	90	110	123
Energy to charge coolers	kW	300	429	490

4012-46TAG3A - Tropical

Designation	Units	Baseload power	Prime power	Standby power
Energy in fuel	kW	3137	3650	4100
Energy in power output (gross)	kW	1260	1500	1643
Energy to cooling fan	kW	60		
Energy in power output (nett)	kW	1200	1440	1583
Energy to exhaust	kW	1010	1102	1219
Energy to coolant and oil	kW	477	510	625
Energy to radiation	kW	90	110	123
Energy to charge coolers	kW	300	428	490

Note: Not to be used for combined heat and power (CHP) purposes (indicative figures only). If necessary, please consult the Applications Department, Perkins Engines Company Limited, Stafford.

Cooling system

Recommended coolant: 50% inhibited ethylene glycol or 50% inhibited propylene glycol and 50% clean fresh water. For combined heat and power systems (CHP) and where there is no likelihood of ambient temperature below 10 °C, then clean 'soft' water may be used, treated with 1% by volume of Perkins inhibitor in the cooling system. The inhibitor is available in 1 litre bottles from Perkins under part number 21825 735.

Maximum pressure in crankcase water jacket ... 170 kPa

Maximum top tank temperature (standby) ... 98 °C

Maximum static pressure head on pump ... 7 m

Total coolant capacity

Electrounit (engine only) ... 73 litres

Electropak (engine and radiator):

-temperate... 207 litres

-tropical... 210 litres

Maximum permissible restriction to coolant pump flow... 20 kPa

Thermostat operating range... 71 - 85 °C

Ambient cooling clearance (standby power) based on air temperature at fan 6 °C above ambient.

Temperature rise across the engines (standby power) with inhibited coolant ... 8 °C

Coolant temperature shutdown switch setting ... 101 °C rising

Coolant immersion heater capacity (2 off) ... 4 kWe each

Radiator

Temperate

Radiator face area ... 3,46 m²

Material and number of rows:

-charge air and water jacket... copper, 4 rows

Fins per inch and material:

-charge air and water jacket... brass, 12 rows

Width of matrix ... 2,10 m

Height of matrix... 1,65 m

Weight of radiator... 1620 kg

Total coolant capacity including engine and pipes. ... 212 litres

Pressure cap setting (min) ... 70 kPa

Tropical

Radiator face area ... 4,08 m²

Material and number of rows:

-charge air and water jacket... copper, 4 rows

Fins per inch and material:

-charge air and water jacket... brass, 12 rows

Width of matrix ... 1,97 m

Height of matrix... 2,07 m

Weight of radiator... 1630 kg

Total coolant capacity including engine and pipes. ... 226 litres

Pressure cap setting (min) ... 70 kPa

Water jacket cooling data

Temperate and Tropical

-coolant flow ... 1020 litres/min

-coolant exit temperature (max) ... 98 °C

-coolant inlet temperature (min) ... thermostatic control

-coolant inlet temperature (max) ... 90 °C

Coolant pump

Speed ... 1.4 x e rev/min

Method of drive ... gear

Fan

Type ... axial flow

Diameter

-Temperate ... 1600 mm

-Tropical ... 1740 mm

Number of blades... 12

Material ... Aluminium

Drive ratio

-Temperate ... 0.93:1

-Tropical ... 0.80:1

4012-46TAG3A - Temperate, Standby power

Maximum additional restriction (duct allowance) to cooling airflow and resultant minimum airflow		
Ambient clearance: 50% Glycol	Duct allowance (Pa)	Min airflow (m ³ /sec)
40 °C	250	32

4012-46TAG3A - Tropical, Standby power

Maximum additional restriction (duct allowance) to cooling airflow and resultant minimum airflow		
Ambient clearance: 50% Glycol	Duct allowance (Pa)	Min airflow (m ³ /sec)
50 °C	125	37

Lubrication system

Recommended SAE viscosity: A multigrade oil conforming to the following must be used: API CH4 15W/40.

Note: For additional notes on lubricating oil specifications, please refer to the Operation and Maintenance Manual (OMM).

Lubricating oil capacity

-total system capacity... 177 litres

-sump maximum... 159 litres

-sump minimum... 136 litres

-oil temperature at normal operating conditions to bearings 105 °C

Lubrication oil pressure

-at rated speed ... 400 kPa

-minimum at 80 °C... 340 kPa

-oil relief values open ... 400 kPa

-oil filter spacing ... 20 microns

-sump drain plug tapping size ... G1

-oil pump speed... 2100 rev/min

-method of drive ... gear

-shutdown switch pressure setting (where fitted) .. 193 kPa falling

Oil pump flow ... 6,0 litres/sec

Normal operating angles

Front and rear... 5°

Side tilt ... 10°

Oil consumption

Prime power	Units	
After "running in" (typically after 250 hours)	g/kWhr	0,52
Oil flow rate from pump	litres/sec	6

Electrical system

Type ... insulated return

Alternator voltage ... 24 volts with integral regulator

Alternator output... 40 amps output, 28 volts at 20 °C ambient

Starter type... axial

Starter motor voltage... 24 volts

Starter motor power. ... 16,4 kW

Number of teeth on flywheel ... 156

Number of teeth on starter pinion ... 12

Minimum cranking speed ... 120 rev/min

Pull in current of starter motor

solenoid @ -25 °C max ⁽¹⁾ ... 30 amps at 24 volts

Hold in current of starter motor

solenoid @ -25 °C max ⁽¹⁾ ... 9 amps at 24 volts

Stop solenoid hold-in current... 1,1 amps at 24 volts

Engine stop solenoid ... 24 volts

1. All leads to rated at 10 amps minimum

Fuel system

Recommended fuel to conform to:

BS2869 1998 Class A2 or BS EN590

Injection system direct

Fuel injection pump and injector type combined unit injector

Injector pressure 140 MPa

Lift pump type Tuthill TCH 1-089

Delivery

-4012-46TAG3A. 1020 litres/hour

Heat retained in fuel to tank 8 kW

Fuel inlet temperature to be less than 58 °C

Delivery pressure 300 kPa

Maximum suction head at pump inlet 2,5 m

Maximum static pressure head 3 m

Fuel filter spacing 10 microns

Governor type electronic

Governing to ISO 8528-12 CLASS 3 and 4; ISO 8528-5 CLASS G2

Tolerance on fuel consumption 5%

Fuel consumption

Ratings	g/kW/hr	litres/hr
4012-46TAG3A, Temperate & Tropical		
Standby	211	405
Prime	208	370
Baseload	207	310
75% Prime	206	275
50% Prime	202	187

Note: Fuel consumption calculated on gross rated powers.

Induction system

Maximum air intake restriction of engine:

-clean filter 2 kPa

-dirty filter. 4 kPa

-air filter type paper element

Exhaust system

Exhaust outlet size (internal) 2 x 254 mm Table D flanges

Exhaust outlet flange size 2 x 254 mm Table D flanges

Back pressure for total system at standby power 5 kPa

For recommended pipe sizes, please refer to the Installation Manual.

Cold start recommendations

Temperature range	
5 °C down to -10 °C (41 °F to 14 °F)	Oil: 15W40 CH4 Starter: 2 x 24 volts Battery: 4 x 12V 286 Ah Max breakaway current: 1600 amps Cranking current: 810 amps Aids: block heaters Min mean cranking speed: 120 rev/min

Notes:

- The battery capacity is defined by the 20 hour rate
- The oil specification should be for the minimum ambient temperature as the oil will not be warmed by the immersion heater
- Breakaway current is dependant on battery capacity available. Cables should be capable of handling the transient current which may be up to double the steady cranking current.

Engine mounting

Maximum static bending moment at rear face of block 1356 Nm

Maximum additional load applied to flywheel

due to all rotating components 850 kg

Centre of gravity

Bare engine, dry

-forward of the rear face of the cylinder block 771 mm

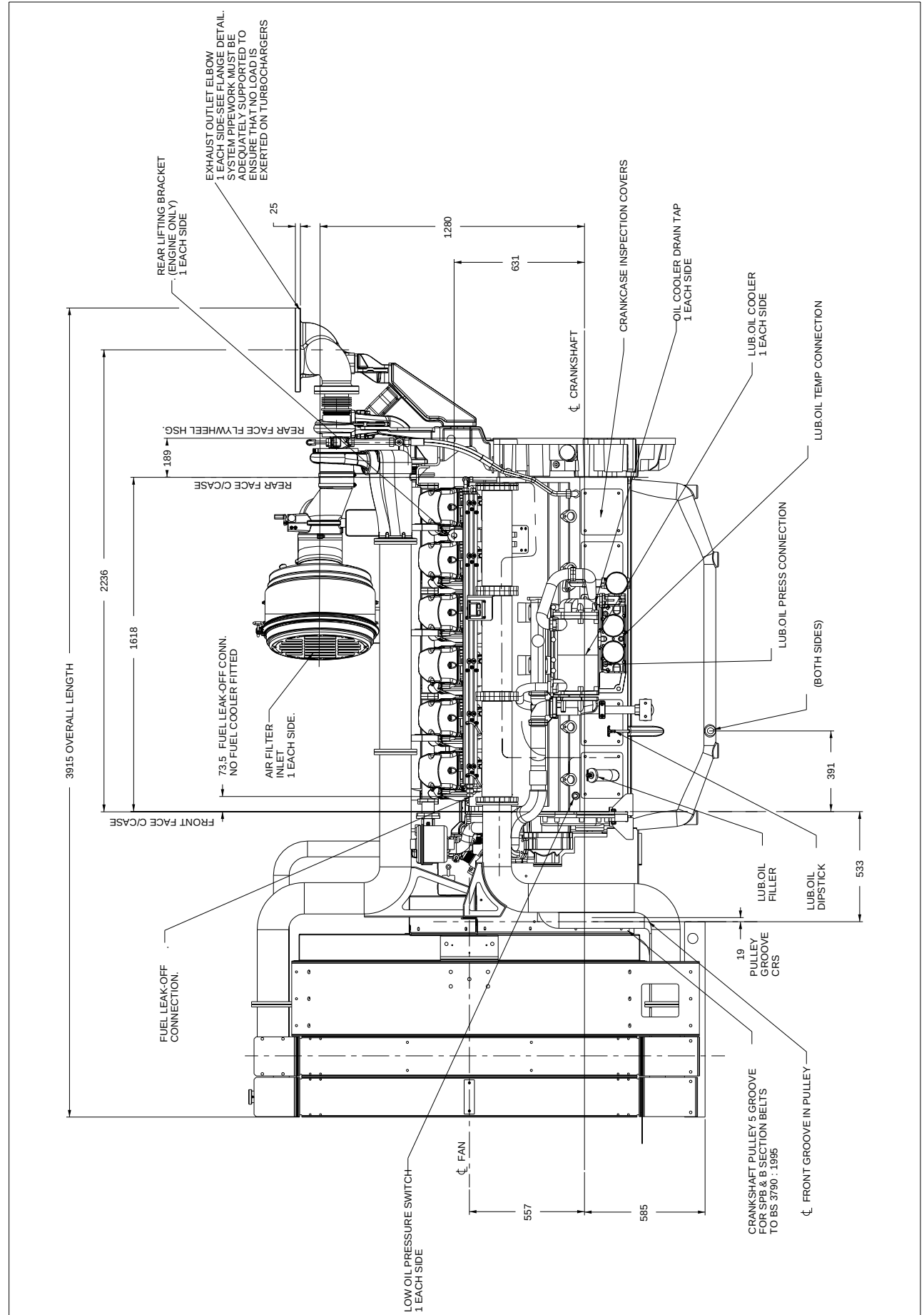
-above the crankshaft centre line 32 mm

ElectropaK, dry

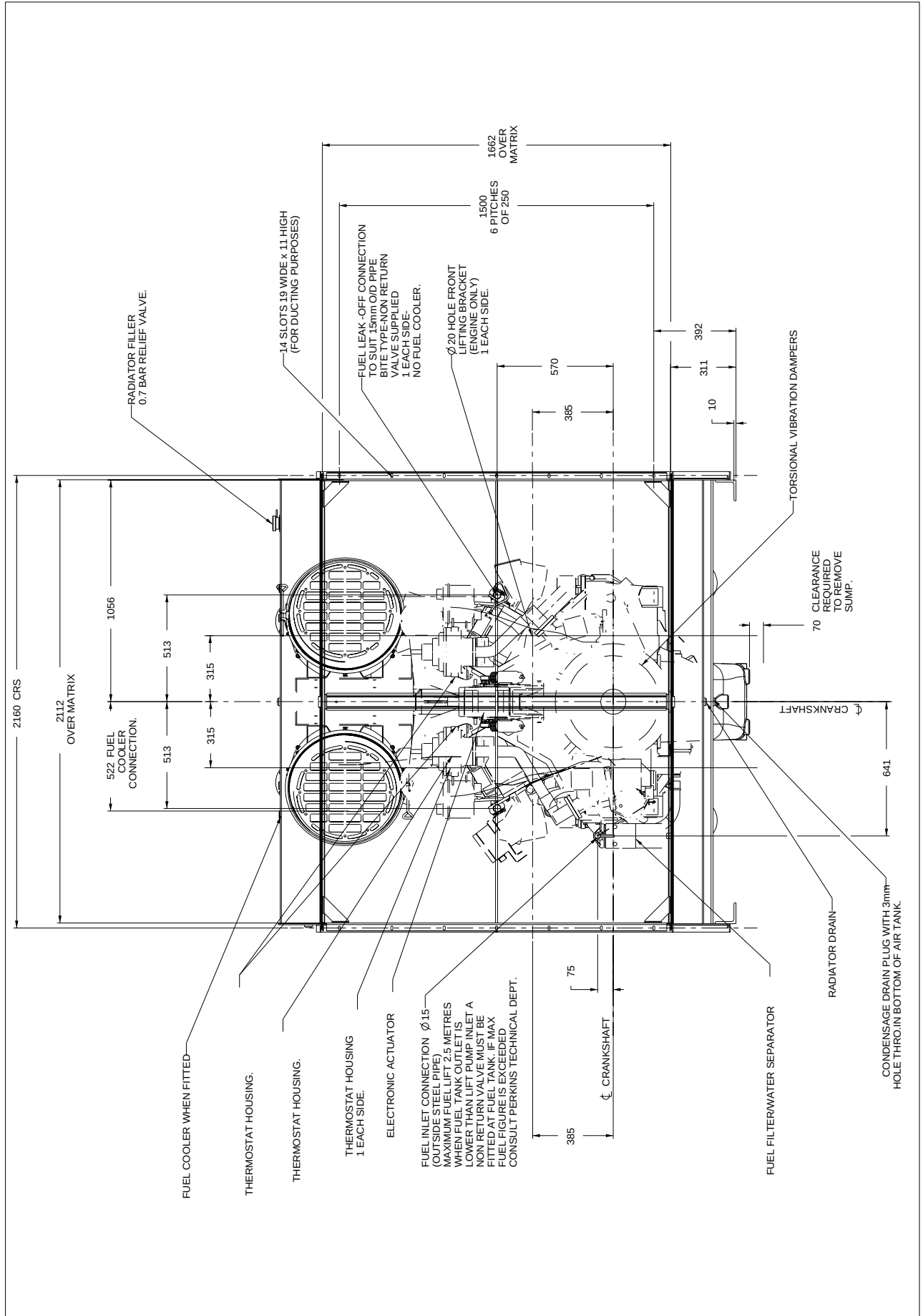
-forward of the rear face of the cylinder block 1176 mm

-above the crankshaft centre line 32 mm

4012-46TAG3A Temperate - Left hand side view

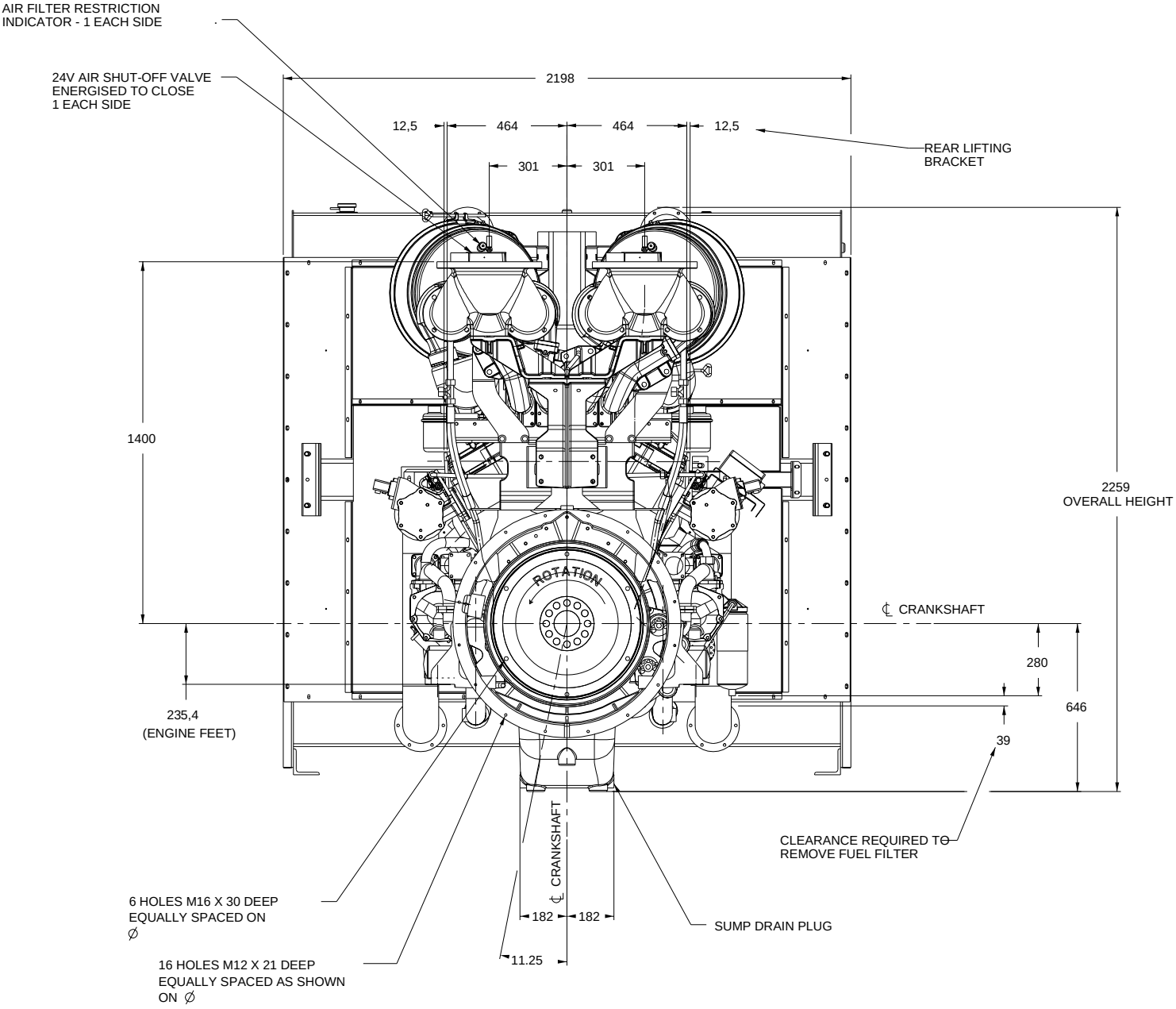


4012-46TAG3A Temperate - Front view

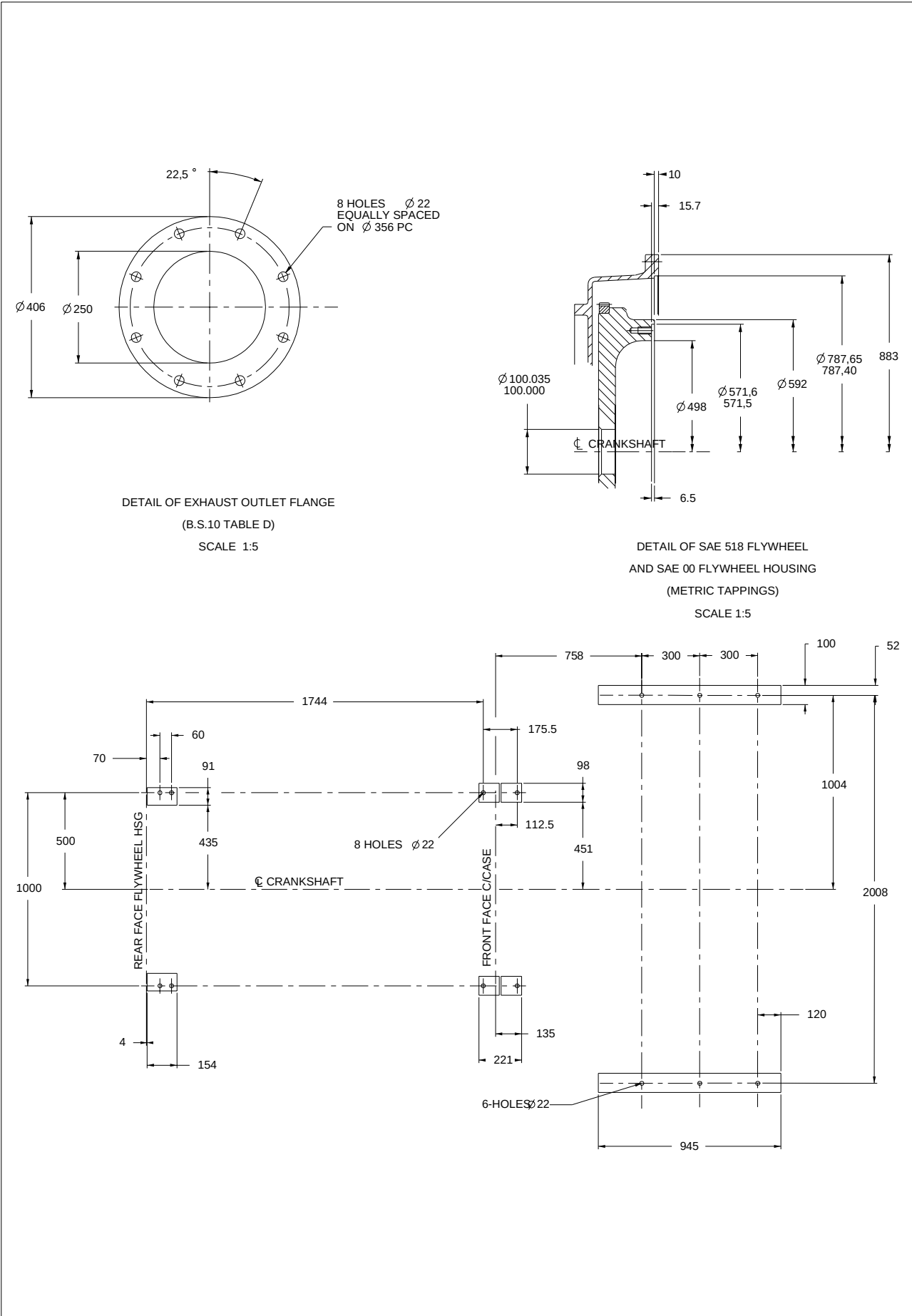


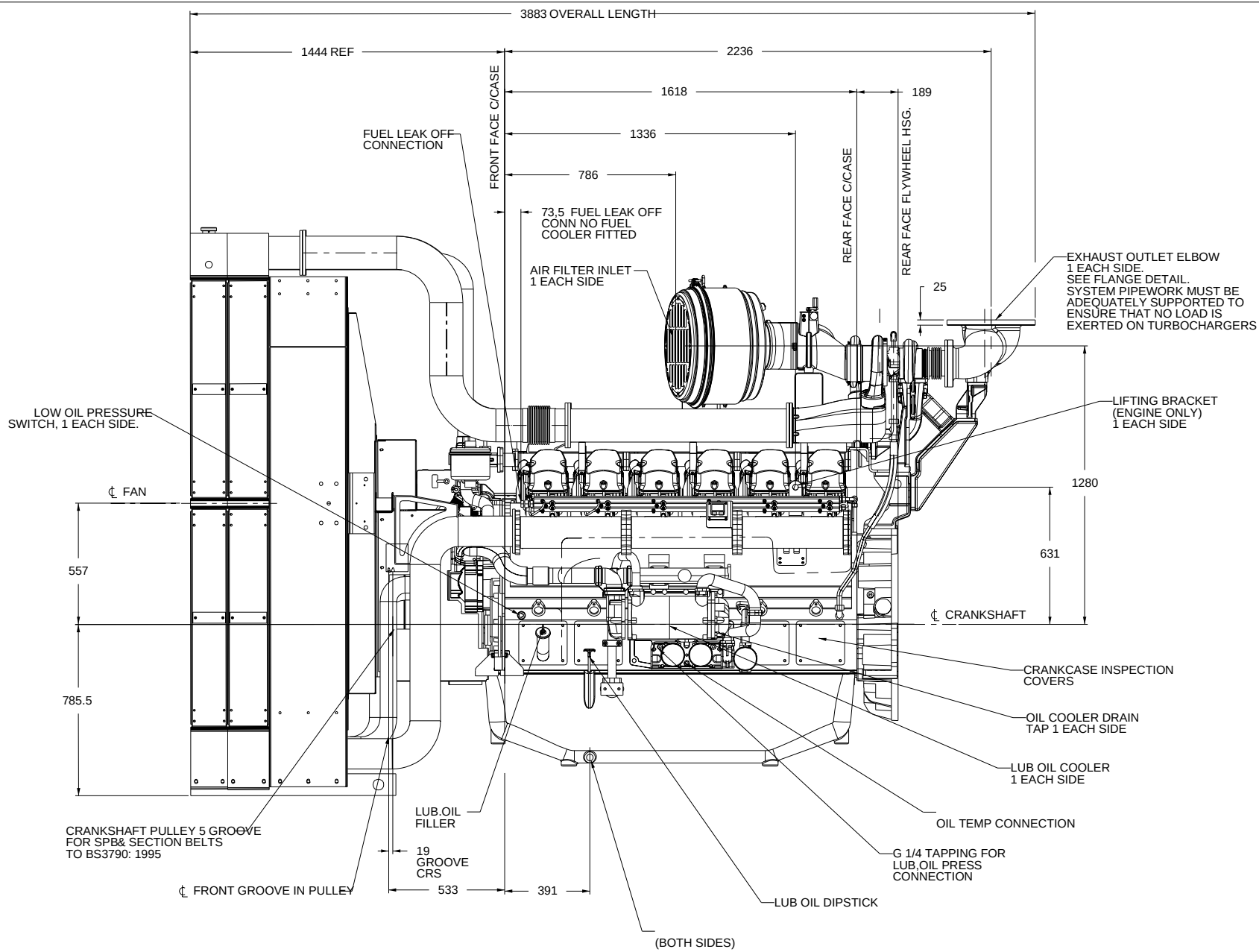
Technical drawing of a 24V diesel engine, showing various components and dimensions. The drawing is oriented horizontally, with the engine block on the left and the alternator on the right. The following components are labeled:

- 12 FRONT LIFTING BRACKET.
- 1310
- FRONT FACE C/CASE
- 614
- 571
- 97
- CRANKCASE BREATHER 1 EACH SIDE SUPPLIED WITH FLEXIBLE PIPE Ø 51 INSIDE x 865 LONG.
- G3/4 FUEL COOLER CONNECTIONS.
- RADIATOR WATER LEVEL SWITCH.
- AIR FLOW
- 245
- 1031
- 24V ALTERNATOR
- LUBE OIL PUMP
- FUEL LIFT PUMP
- 1854 CENTRE OF GRAVITY WET NO FUEL COOLER.
- 1851 CENTRE OF GRAVITY WET WITH FUEL COOLER.
- H.W.T PROTECTION SWITCH 1 EACH SIDE
- ELECTRONIC CONTROL UNIT FOR ACTUATOR
- AIR FILTER 1 EACH SIDE
- EXHAUST GAS HIGH TEMP PROTECTION MODULE 1 EACH SIDE
- DUAL 24V STARTERS
- CRANKSHAFT
- LUB OIL FILTERS 3 EACH SIDE
- STARTER RELAY
- G1/4 TAPPING FOR LUB OIL PRESSURE CONNECTION
- LUB OIL TEMPERATURE CONNECTION
- FUEL HAND PRIMING PUMP

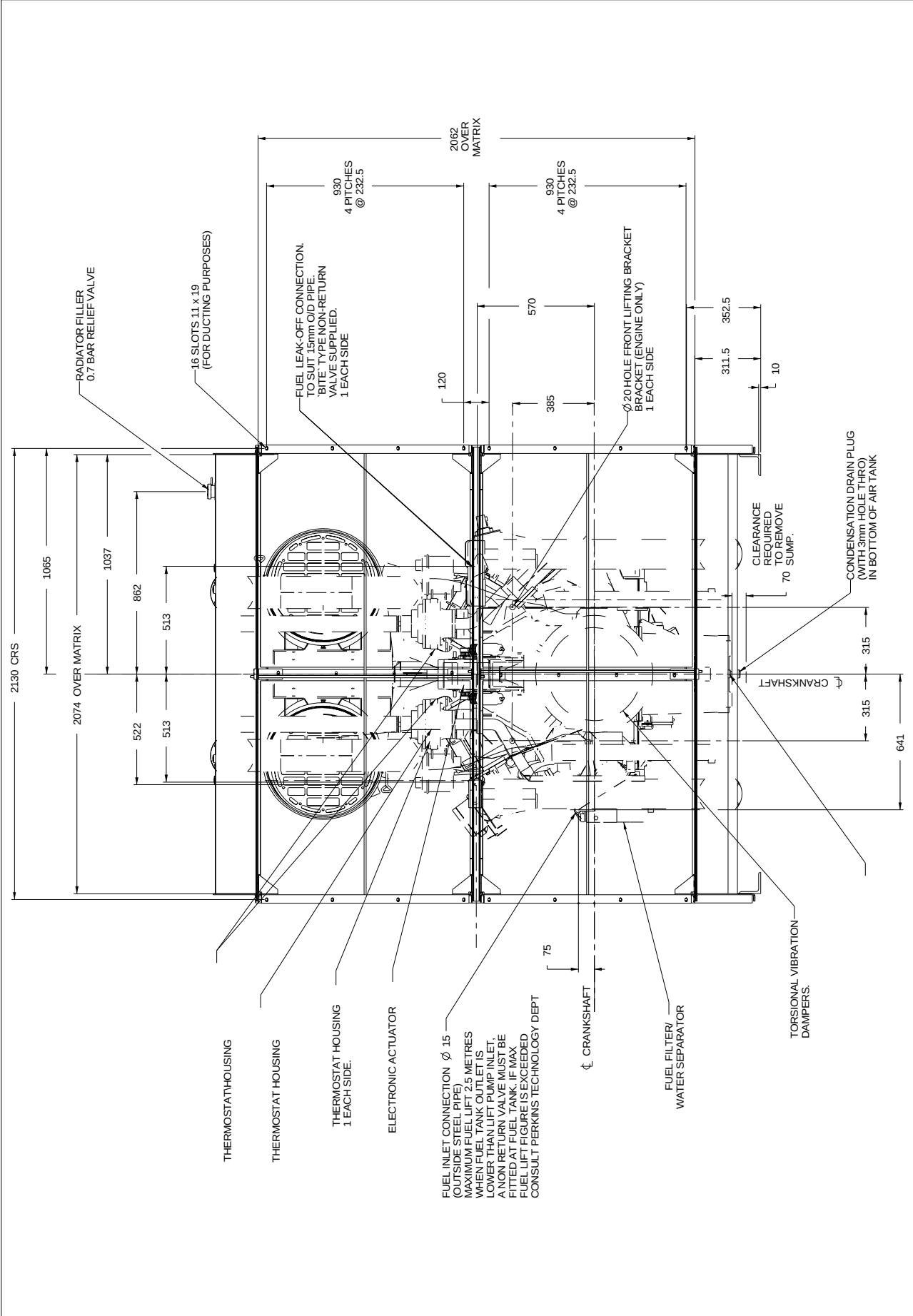


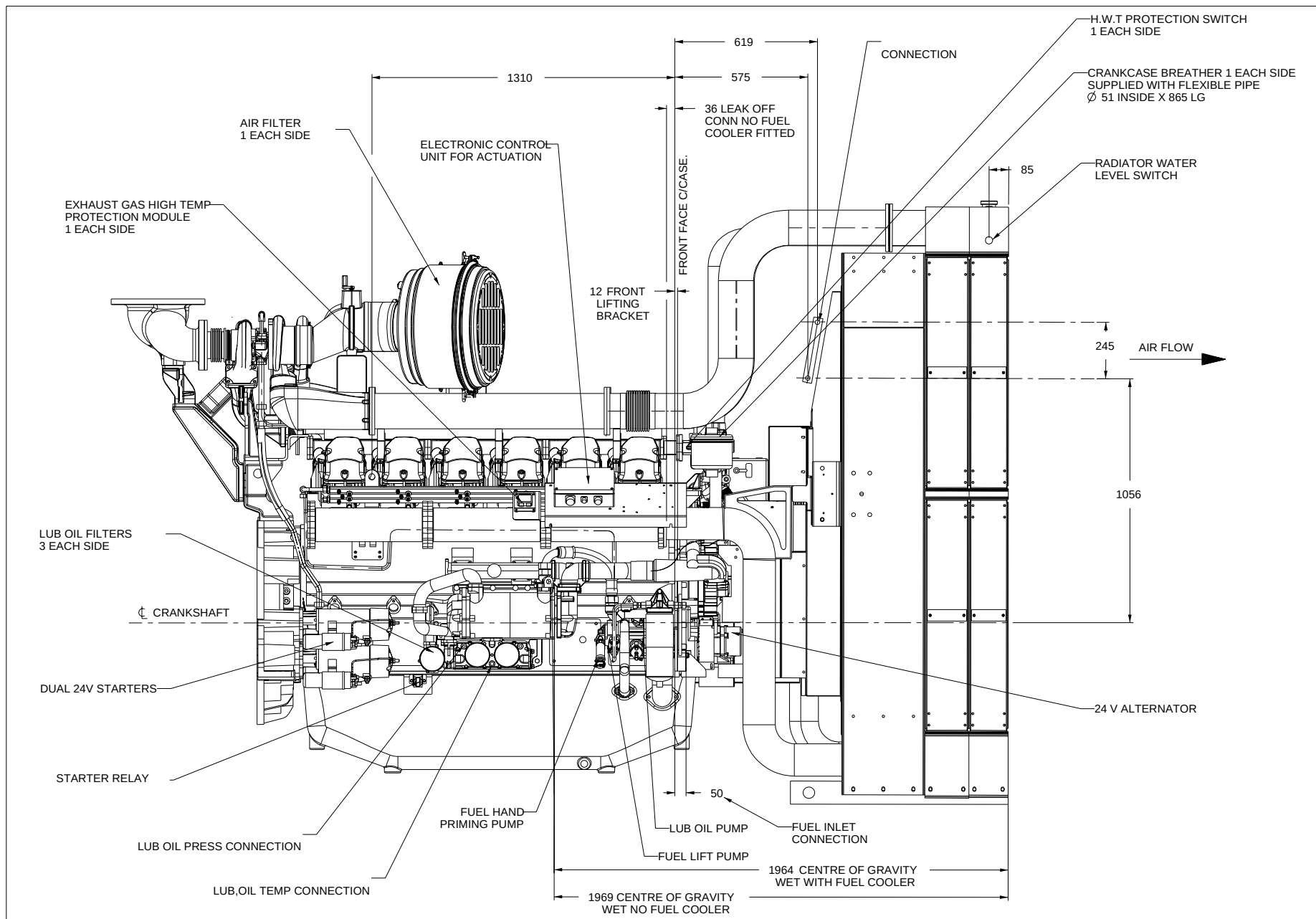
4012-46TAG3A Temperate - Plan view of support pads, exhaust outlet flange and flywheel



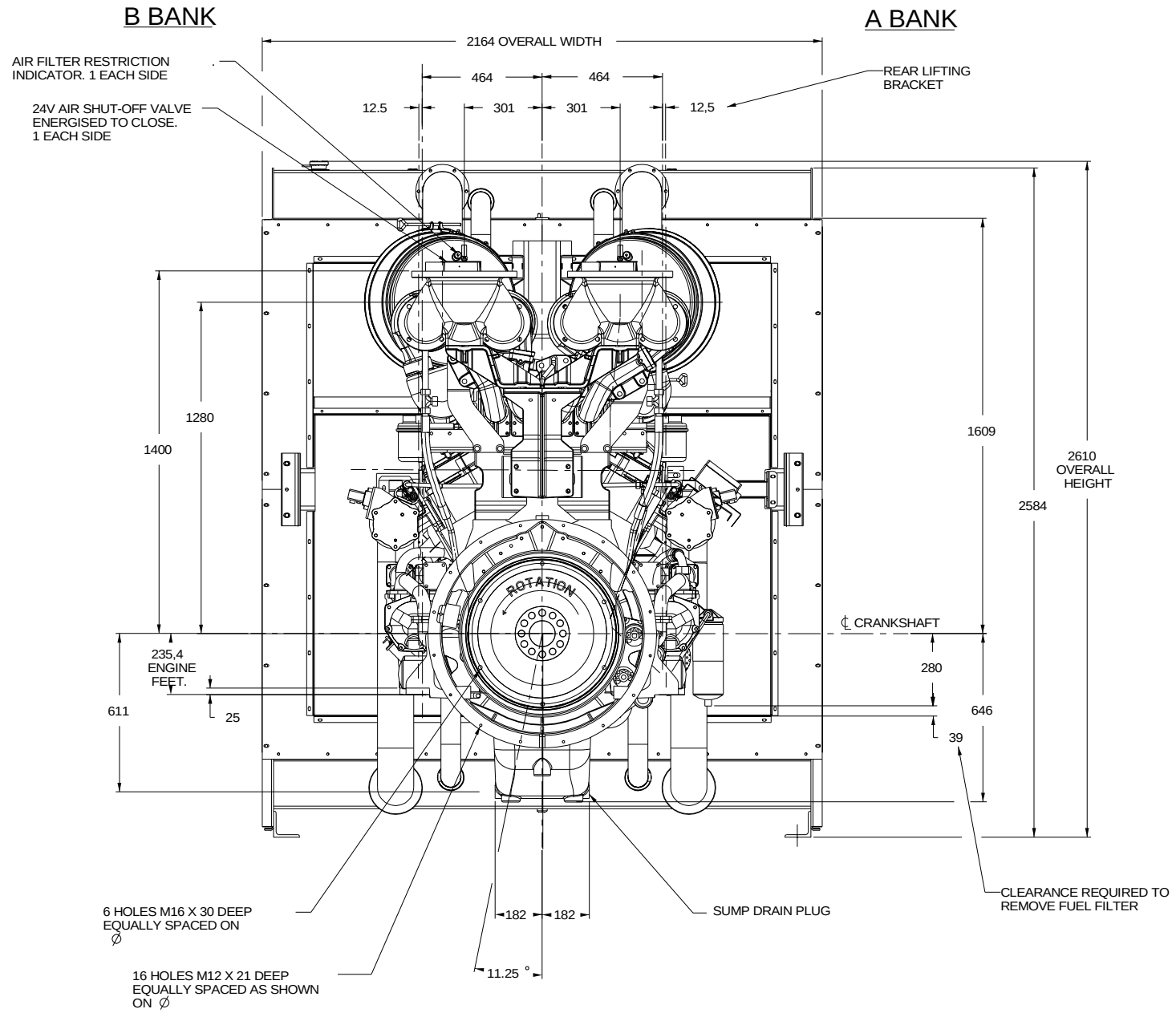


4012-46TAG3A Tropical - Front view

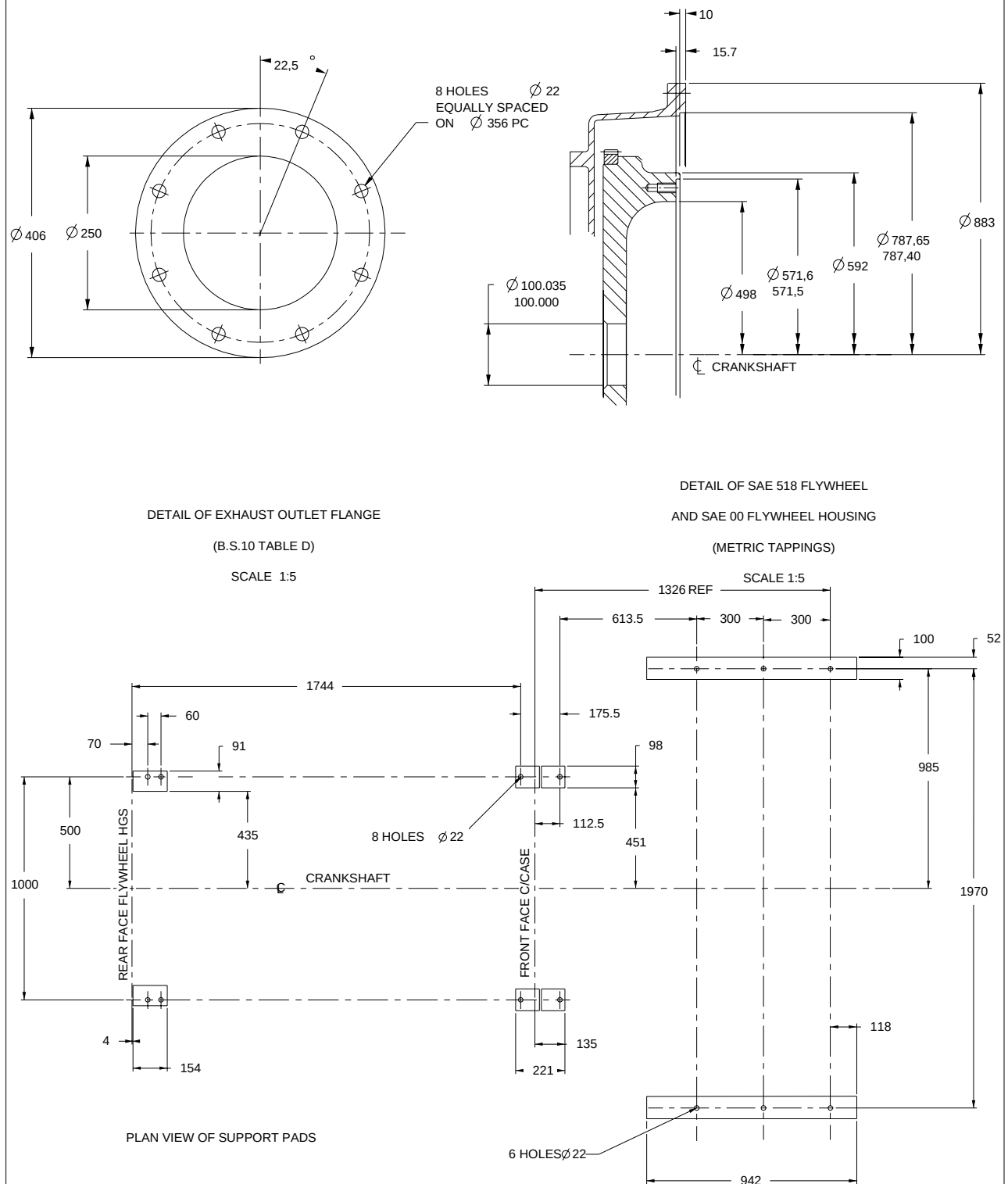


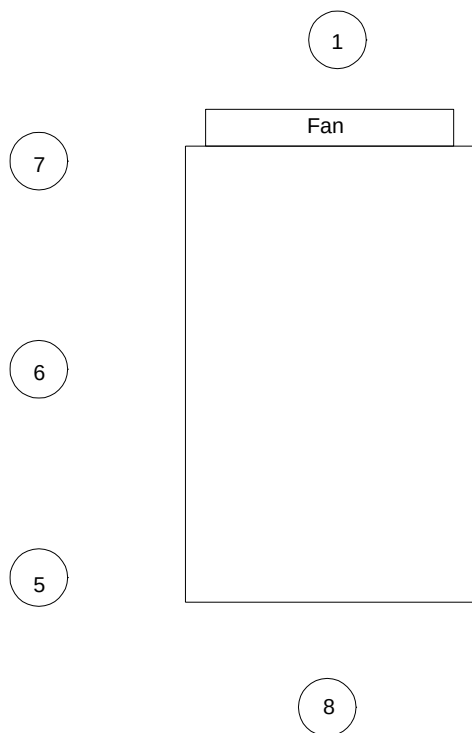


4012-46TAG3A Tropical - Right hand side view



4012-46TAG3A Tropical - Plan view of support pads, exhaust outlet flange and flywheel





Noise Levels

The figures for total noise levels are typical for an engine running at Standby Power rating in a semi-reverberant environment and measured at a distance of one metre from the periphery of the engine.

Total Noise Level

Sound pressure level re: -20x10 Pa
Ambient noise level 79 dBA

Octave analysis performed at the position of maximum noise.

ENGINE 1500 RPM POWER STANDBY
1/3 (1/1 bandwidth)OCTAVE ANALYSIS

SITE

POSN.	DBA	HZ	DB AT POSN ...6...
1	114	31.5	90.2
2	113	63	101
3	111	125	104
4	110	250	112
5	110.5	500	109
6	111	1k	107
7	110.5	2k	104
8	107	4k	101
		8k	100

		16k	98
POSN.	DBA	HZ	DB AT POSN ...6...
1	114	31.5	90.9
2	113	63	101
3	111	125	104
4	110	250	110
5	110	500	109
6	111	1k	106
7	110	2k	103
8	107	4k	100
		8k	99
		16k	98

POSN.	DBA	HZ	DB AT POSN ...6...
1	114	31.5	91
2	113	63	101
3	111	125	104
4	110	250	110
5	110	500	109
6	111	1k	106
7	110	2k	103
8	107	4k	100
		8k	99
		16k	98

AMBIENT NOISE...79.....DBA

Typical load acceptance (cold)

Engine type	Initial load acceptance when engine reaches rated speed (15 seconds maximum after engine starts to crank)				2nd load application immediately after engine has recovered to rated speed (5 seconds after initial load application)			
	Prime power%	Load kWe nett	Transient frequency deviation %	Frequency recovery time seconds	Prime power%	Load kWe nett	Transient frequency deviation %	Frequency recovery time seconds
4012-46TAG3A	63	860	≤ 10	5	37	505	≤ 10	5

The above figures were obtained under test conditions as follows:

Engine block temperature 40 °C

Ambient temperature 25 °C

Governing mode Isochronous

Alternator inertia. 50 kgm²

Under frequency roll off (UFRO) point set to 49,5

UFRO rate set to 16 v/hz

LAM on / off on

All tests were conducted using an engine installed and serviced to Perkins Engines Company Limited recommendations.

Applied load is a percentage of generator electrical output efficiency as published in the general installation section of this data sheet.

The information given on this Technical Data Sheet is for standard engines, and for guidance only. For ratings other than those shown contact Perkins Engines Company Limited, Stafford.



Perkins Engines Company Limited
Peterborough PE1 5NA United Kingdom
Telephone +44 (0) 1733 583000
Fax +44 (0) 1733 582240
www.perkins.com

All information in the document is substantially correct at the time of printing but may be subsequently altered by the company.

Distributed by

Appendix B

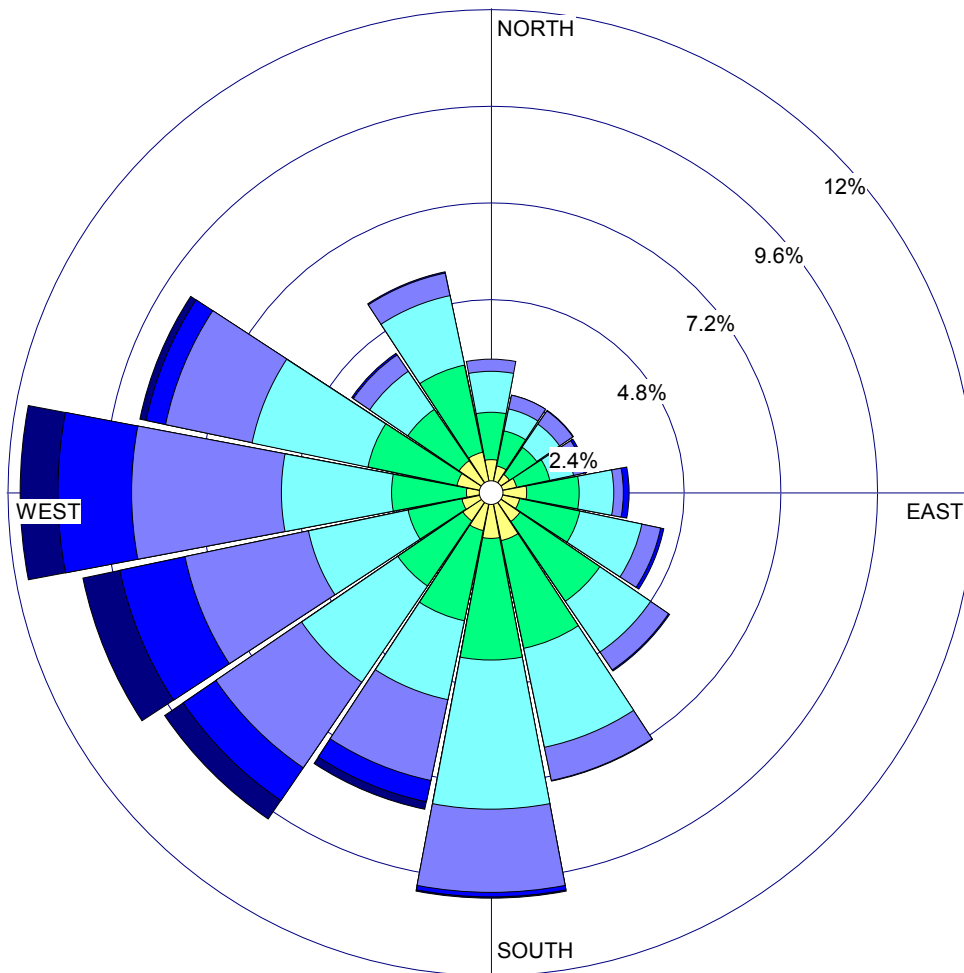
Wind rose for Church Fenton

for 2011

WIND ROSE PLOT:

Church Fenton

DISPLAY:

**Wind Speed
Direction (blowing from)**

COMMENTS:

DATA PERIOD:

**2011
Jan 1 - Dec 31
00:00 - 23:00**

COMPANY NAME:

Phlorum

MODELER:

DT

CALM WINDS:

0.31%

TOTAL COUNT:

8760 hrs.

AVG. WIND SPEED:

8.61 Knots

DATE:

28/03/2012

PROJECT NO.:

4683