



Land Quality Management Ltd

**Inter Laboratory Comparison  
of Landfill Gas Emissions**

**Final Report (Revision 2)**

**April 2003**



Land Quality Management Ltd

**Inter Laboratory Comparison  
of Landfill Gas Emissions**

**Final Report (Revision 2)  
April 2003**

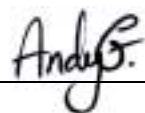
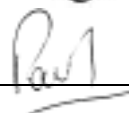
Land Quality Management Ltd  
SChEME  
The University of Nottingham  
University Park  
Nottingham NG7 2RD

Tel: 0115 951 4112  
Fax: 0116 951 4640

e-mail: [andy.gillett@lqm.co.uk](mailto:andy.gillett@lqm.co.uk)



<i>Managing Client</i>	<b>Natural Power</b>
<i>Funding Clients</i>	<b>Natural Power, Shanks Waste Solutions, Biffa Waste Services Ltd, Viridor Waste Management &amp; Finning (UK) Ltd</b>
<i>Project Title</i>	<b>Inter Laboratory Comparison of Landfill Gas Emissions</b>
<i>Report Title</i>	<b>Final Report (Revision 2)</b>
<i>Authors</i>	<b>A G Gillett &amp; R G Gregory</b>
<i>LQM Reference Number</i>	<b>496</b>
<i>Client Reference Number</i>	<b>2881 - 514/92</b>

<i>Document Version</i>	Final Report (Revision 2)	
<i>Main Author</i>	Dr A G Gillett	 signature
<i>Approved for issue by</i>	Dr C P Nathanail	 signature
<i>Position</i>	Director	
<i>Date</i>	07 April 2003	
<i>Status</i>	Public	

This document has been prepared by Land Quality Management Ltd within the terms of the Contract, scope of work, and resources agreed in writing with the client.

Land Quality Management Ltd has no responsibility to the client and/or others for any matters outside the scope of the above agreement.

This document is intended for the sole use of the client indicated above and Land Quality Management Ltd accepts no responsibility of whatever nature to third parties to whom this document or any part of this document is made known. Any such parties rely upon that information at their own risk.



## EXECUTIVE SUMMARY

This study is concerned with the reproducibility of supply gas and emissions data from landfill gas utilisation plant. Emissions have previously been monitored from the exhaust of one of the landfill gas spark ignition engines at the utilisation scheme at this landfill site by Lab C. Emissions of polychlorinated dibenzo-p-dioxins (dioxins) and polychlorinated dibenzofurans (furans), determined by Lab C as part of the Environment Agency's monitoring programme supporting the development of a sampling protocol for landfill gas engines, varied over nearly two orders of magnitude, from 0.0338 to 1.5043 ng TEQ/Nm<sup>3</sup> (dry gas, 5% O<sub>2</sub>) from the same sample location (pre-fitted exhaust ports). It is not clear as to why these large differences exist.

Therefore this project was commissioned to use three independent laboratories (Lab A, Lab B and Lab C) to:

- assess the practical variation / consistency in laboratory sampling and analytical practices when measuring dioxin and furan emissions at or near the limits of detection of the method; and
- investigate other bulk and trace analytes as part of a broader laboratory method comparison.

The practical difficulties of laboratories sampling the same exhaust system at the same time mean that the effect of potential temporal differences in emissions (potentially arising from differences in gas quality and engine performance) could not be excluded from this study.

Each of the laboratories sampled dioxins and furans in accordance with their own UKAS method based upon CEN 1948-1:1997, with a field blank per sampling campaign taken. Gas velocities and temperatures were determined during the course of the test to ensure sampling was carried out isokinetically. Sampling ports were located at 5D and 2D from the inlet and outlet, respectively, in accordance with BS 6069: 1992, using a specially designed sampling sleeve that had previously been shown to give consistent dioxin and furan emission results.

Two of the independent laboratories were generally consistent in the exhaust emissions they reported for the same engine, whilst one of the laboratories (Lab C) reported large differences (relative to Lab A and B) in the emissions of THC, dioxins and furans, HCl and particulates.

Step changes in the emissions log of some of the bulk exhaust gases observed in this study have a large effect on the average reported engine emission for this site (e.g. THC, Lab C). No obvious explanation for such differences is presently available, either by consideration of the logged operational parameters of the engine management system or by consulting the

monitoring laboratory. Such unexplained behaviour could potentially invalidate emissions measurements and require re-sampling.

Based on the results in this study the potential variation in the reported time averaged exhaust emissions, between individual laboratories, for the same landfill gas engine may be anticipated as follows:

- **CO** up to 300 mg/Nm<sup>3</sup>;
- **NO<sub>x</sub>** up to 80 mg/Nm<sup>3</sup>;
- **THC** up to 600 mg/Nm<sup>3</sup>;
- **Dioxins and furans** up to 0.6 ng/Nm<sup>3</sup>;
- **HCl** up to 14 mg/Nm<sup>3</sup>;
- **HF** up to 2 mg/Nm<sup>3</sup>; and
- **Particulates** up to 35 mg/Nm<sup>3</sup>.

Based on results in this study the percentage difference between the reported time averaged exhaust emission by an individual laboratory and the mean value determined by a number of laboratories, for the same landfill gas engine, may be anticipated as follows:

- **CO** up to ± 13% of the mean engine value;
- **NO<sub>x</sub>** up to ± 8% of the mean engine value;
- **THC** up to ± 32% of the mean engine value;
- **Dioxins and furans** up to ± 197% of the mean engine value;
- **HCl** up to ± 94% of the mean engine value;
- **HF** up to ± 51% of the mean engine value; and
- **Particulates** up to ± 141% of the mean engine value.

The inter-laboratory variation (and/or temporal variation in exhaust emissions) observed within this study suggests that variations in bulk emissions (CO, NO<sub>x</sub> and THC), which are expected, may be important in the assessment of compliance with proposed emissions standards. For example, using the measurements made in this study some of the currently proposed emission limits for landfill gas engines commissioned after 1 November 2004 (Environment Agency, 2002), may or may not have been exceeded, dependent upon which laboratory had been chosen to test and report emissions. Therefore, the acceptable variance from the emission standard and ability of independent laboratories to replicate exhaust emissions on the same engine may become a significant factor in the regulation of landfill gas engine emissions, and the setting of emission limits by the Environment Agency.

The large variation in reported dioxin and furan emissions (up to 150 – 200 times differences between laboratories), close to the limits of detection, may have a very significant effect upon the assessment of these secondary monitoring parameters. These are to be assessed on an individual site basis, based on a risk assessment and local environmental impact effects (Environment Agency, 2002). Previous work (e.g. Cains and Dyke, 1993) has suggested that the formation of the lower chlorinated congeners (i.e. tetrachloro and pentachloro congeners) are favoured by low temperature (within the 200 – 450 °C range) and poor combustion conditions. Such conditions were experienced during the dioxin monitoring program performed by Lab C, which report the relatively high dioxin emissions (dominated by the lower chlorinated tetra and pentachloro- furan congeners) for the engine in this study. Abnormal combustion conditions were also previously associated with a relatively high dioxin emission for the engine in this study.

The congener breakdown (% TEQ) of the emissions of dioxins and furans from the engine exhaust are very similar to those of the inlet air to the engine combustion chamber, suggesting that the dioxins emitted by the combustion plant are the main source of dioxins and furans in the ambient air surrounding the plant.

The reported concentration of dioxins and furans within the exhaust dust is 248 ng-TEQ/kg dust. This concentration level is not sufficient to fully explain the comparatively high dioxin and furan exhaust emission result reported by Lab C (0.6054 ng-TEQ/Nm<sup>3</sup>, dry gas, 5% O<sub>2</sub>) compared to Lab A or Lab B (0.004 and 0.003 ng-TEQ/Nm<sup>3</sup>, dry gas, 5% O<sub>2</sub>, respectively). It would take at least 200 – 1000 times the quantity of particulates routinely collected (1-5 mg particulates) to account for this discrepancy, by the inadvertent sampling of exhaust adhered particulates. Differences in the congener breakdown (% TEQ) of the engine exhaust emission and dust also suggests that the source of the discrepancy in dioxin and furan emission results could not be accounted for by the inadvertent sampling of exhaust adhered particulates.

A number of recommendations have been made based upon the findings of this study:

- The microburner technique used by Lab A in the determination of halide (and total sulphur) concentrations within the supply gas is preferred as a more reliable forecast of total Cl and F compared to the techniques employed by Lab B and Lab C in this trial.
- A concise log of any disruptions to the normal operation of the engine during any testing program should be provided by the monitoring laboratory, as well as the site/engine operator, and reported to the Environment Agency.
- A clear log of any variations in the stack conditions during testing should be clearly reported in order to inform the engine operator and Environment Agency of any possible changes of sampling conditions over the course of any emissions test. Plotting real time

data collected during the monitoring period allows a ready visual inspection of the relative changes in measured parameters over the test period. Unexpected changes in either the operating conditions of the gas engine or the measured emissions values will be potentially identifiable by this inspection process. Explanations for these changes should be identified. Deviations from the expected performance should be noted and collected data removed from the calculation of the reported average emission over the monitoring period if the deviation is due to external influences not representative of the intended normal operating conditions of the test (e.g. inadvertent air ingress into the gas field, and resulting unplanned changes to engine operating settings).

- Continued collation of data such as that collected and reported in this study should be maintained in order to build up a more significant database on engine emissions than already exists. Combined with the detailed environmental monitoring site reports, such as those obtained within this study, will allow a greater understanding of the likely variations to be expected between different monitoring laboratories.
- Supervision (and in some cases independent supervision) of monitoring teams is likely to improve quality and subsequent usability of the data collected (akin to independent landfill CQA). Supervisors are more likely to be aware of site and other external factors (such as gas field or engine performance) and their likely effect upon emissions data.
- A gas balance between the supply gas and exhaust gas parameters should be performed because it adds quality and credibility to the emissions measurements.
- Further research into the temporal response of monitoring equipment and emission test results in relation to changes in the engine operating parameters, engine maintenance cycle and variation within the supply gas is required.

The Environment Agency is currently developing technical guidance on controlling landfill surface emissions and establishing reference emission standards for gas utilisation and flaring plant. A draft '*Guidance for Monitoring Landfill Gas Engine Emissions*' (Environment Agency, 2002) has recently undergone a phase of public consultation. The findings of this project may provide a contribution to this consultation process.

## CONTENTS

### EXECUTIVE SUMMARY

<b>1</b>	<b>INTRODUCTION .....</b>	<b>7</b>
1.1	BACKGROUND AND OBJECTIVES .....	7
1.2	MONITORING PROGRAMME .....	8
1.2.1	<i>Engine supply gas inlet</i> .....	8
1.2.2	<i>Engine exhaust emissions</i> .....	9
1.2.3	<i>Additional Speciated dioxin and furan measurements</i> .....	9
<b>2</b>	<b>SAMPLING AND ANALYTICAL METHODS.....</b>	<b>11</b>
2.1	LANDFILL SUPPLY GAS (ENGINE INLET) .....	11
2.2	ENGINE EXHAUST EMISSIONS .....	13
2.2.1	<i>Dioxins and furans</i> .....	13
2.2.2	<i>Other analytes</i> .....	14
2.3	AMBIENT AIR AND EXHAUST DUST .....	16
<b>3</b>	<b>LANDFILL GAS ENGINE AND SITE PERFORMANCE.....</b>	<b>17</b>
3.1	SUMMARY OF ENGINE PERFORMANCE.....	17
3.1.1	<i>Background</i> .....	17
3.1.2	<i>Lab A monitoring period (9-10 September 2002)</i> .....	17
3.1.3	<i>Lab B monitoring period (12 September 2002)</i> .....	18
3.1.4	<i>Lab C monitoring period (17-18 September 2002)</i> .....	18
3.2	ENGINE OIL ANALYSIS .....	19
3.3	LANDFILL GAS QUALITY .....	22
<b>4</b>	<b>RESULTS.....</b>	<b>23</b>
4.1	LANDFILL GAS ENGINE INLET .....	23
4.1.1	<i>CH<sub>4</sub>, CO<sub>2</sub>, O<sub>2</sub> and CO</i> .....	23
4.1.2	<i>Total Cl, F and S</i> .....	23
4.1.3	<i>Gas flow rate, temperature and delivery pressure</i> .....	25
4.2	ENGINE EXHAUST EMISSIONS.....	25
4.2.1	<i>Bulk emissions (CO, NO<sub>x</sub>, THC and SO<sub>2</sub>)</i> .....	25
4.2.2	<i>Halide emissions (HCl and HF)</i> .....	27
4.2.3	<i>Dioxin and furan exhaust emissions</i> .....	35
4.3	MASS BALANCES (CL, F AND S) .....	36
4.4	AMBIENT AIR (DIOXINS AND FURANS) .....	37
4.5	EXHAUST DUST (DIOXINS AND FURANS) .....	37
4.6	SUMMARY AND DISCUSSION (DIOXINS AND FURANS).....	39

---

<b>5</b>	<b>COMPARISON OF DIOXINS AND FURANS EMISSIONS AND CONGENER BREAKDOWN OBTAINED IN THIS AND OTHER STUDIES .....</b>	<b>43</b>
5.1	DIOXINS AND FURANS EMISSIONS DATABASE .....	43
5.2	DIOXINS AND FURANS CONGENER DATA .....	46
<b>6</b>	<b>CONCLUSIONS AND RECOMMENDATIONS.....</b>	<b>53</b>
6.1	CONCLUSIONS .....	53
6.2	RECOMMENDATIONS .....	56
6.3	RECOMMENDATIONS FOR FUTURE RESEARCH.....	57
<b>7</b>	<b>REFERENCES .....</b>	<b>58</b>

## **ANNEXES**

**ANNEX 1 ENGINE LOG EXTRACTS (17/09/02 – 18/09/02)**

**ANNEX 2 ENGINE SUMMARY INLET AND EMISSIONS DATA SHEETS**

**ANNEX 3 ENGINE LOG EXTRACTS (04/12/01 – 07/12/01)**

# 1 INTRODUCTION

## 1.1 Background and objectives

This study is concerned with the reproducibility of laboratory analysis of supply gas to and emissions from landfill gas utilisation plant. Three laboratories took part in this inter-comparison exercise (Labs A-C). Emissions have been previously monitored from the exhaust of one of the landfill gas spark ignition engines at the utilisation scheme at this landfill site by Lab C. Emissions of polychlorinated dibenzo-p-dioxins (dioxins) and polychlorinated dibenzofurans (furans), determined by Lab C as part of the Environment Agency's monitoring programme supporting the development of a sampling protocol for landfill gas engines, varied over nearly two orders of magnitude, from 0.0338 to 2.3031 ng TEQ/Nm<sup>3</sup>. This depended on sample location (pre-fitted exhaust ports or end-of-pipe, respectively). On a separate sample date the emissions of dioxins and furans were re-sampled by Lab C at the pre-fitted ports. The emissions on this occasion were quantified at 1.5043 ng TEQ/Nm<sup>3</sup>, close to two orders of magnitude higher than on the previous sample date, though comparable to the initial end-of-pipe measurement. Emissions of other analytes tested by Lab C were generally consistent across the different sampling locations and dates, although emissions of total unburnt hydrocarbons on the second sample date were close to twice those initially measured. Land Quality Management Ltd (LQM) have previously found that emissions of dioxins and furans, from the exhausts of similar plant, varied between 0.0009 and 0.0046 ng TEQ/Nm<sup>3</sup> (Gillett et al, 2002).

Therefore this project was commissioned to use three independent laboratories to assess the practical variation and consistency in laboratory sampling and analytical practices when measuring dioxin emissions at or near the limits of detection of the method. Other analytes, such as chlorine and fluorine, have also been investigated as part of a broader laboratory method comparison. This provides more information in trying to understand the relationship between total measured chlorine in the inlet gas and PCDDs/PCDFs emissions.

The Environment Agency is currently developing technical guidance on controlling landfill surface emissions and establishing reference emission standards for gas utilisation and flaring plant. A draft '*Guidance for Monitoring Landfill Gas Engine Emissions*' (Environment Agency, 2002) is currently under consultation. It is anticipated that this research may provide a contribution to the consultation process by helping to clarify the acceptable variation from the emission standard that may be encountered in the measurement of emissions from landfill gas utilisation equipment that may arise during routine monitoring programs.

It should be noted that to more fully account for the inter-laboratory variation in reported dioxins and furans emissions in terms of the variation introduced by sampling and analytical differences, each laboratory would have been required to take three samples (plus field

blanks) one for each separate analytical house used in this study. Such an approach was not taken on the basis of the clients requirements. Any possible effect of variations in the temporal emission of dioxins and furans were beyond the scope of this study given the practical difficulties of each laboratory having to sample at different times.

## 1.2 Monitoring programme

Three experienced laboratories were selected for comparative purposes:

- Lab A;
- Lab B; and
- Lab C.

Lab C and Lab A were responsible for the analytical work supporting the Environment Agency's and the *shanks first fund* research, respectively. Lab B are a third laboratory who also have considerable experience in emission stack testing from landfill gas utilisation plant.

LQM managed and coordinated the laboratories on site to ensure as consistent approach as possible was achieved by each laboratory over the course of each monitoring program. An isokinetic sampling sleeve was used to standardise the sampling location so that laboratory sample collection and analysis can be compared. This also allows comparison of this technique with the end-of-pipe and stub exhaust port measurements performed by one of the laboratories in a previous monitoring campaign, under a different contract. The sampling sleeve design construction and application to emissions monitoring is described by Gillett et al. (2002) and Gregory et al. (2002).

### 1.2.1 Engine supply gas inlet

The following suite of analytes were determined by each laboratory (using their own in-house procedures) within the inlet supply gas supply to the engine:

- Methane (CH<sub>4</sub>);
- Carbon dioxide (CO<sub>2</sub>);
- Carbon monoxide (CO);
- Oxygen (O<sub>2</sub>);
- Nitrogen (N<sub>2</sub>);
- Total chlorine (as HCl); and
- Total fluorine (as HF).

The inlet temperature, pressure and volumetric gas flow rate were also determined. The following additional engine gas inlet data was provided to this project by Lab A:

- Total sulphur; and
- Comparison of analytical methods for the determination of CO.

### ***1.2.2 Engine exhaust emissions***

The three laboratories chosen worked as closely as was practicable within their own in-house operational procedures, to the same sampling reference methods for the following suite of analytes within the exhaust emissions from the same landfill gas engine:

- Speciated Dioxins/Furans (PCDDs/PCDFs);
- Total particulate matter (TPM);
- Hydrogen chloride (HCl);
- Hydrogen fluoride (HF);
- Oxides of nitrogen (NO<sub>x</sub>);
- Carbon Monoxide (CO);
- Total unburnt hydrocarbons (THC); and
- Oxygen (O<sub>2</sub>);

The exhaust velocity, temperature, pressure, moisture content and volumetric flow rate were also determined. The following additional engine exhaust emissions data was provided to this project:

- Oxides of sulphur (Lab C); and
- Carbon dioxide (Lab C and Lab A).

### ***1.2.3 Additional Speciated dioxin and furan measurements***

Lab A was also commissioned to carry out an additional assessment of the speciated PCDDs/PCDFs that:

- may be contained within the inlet supply gas;
- may be associated with dust adhering to the inner surface of the exhaust ('exhaust dust'); and
- may be contained within the ambient air within close proximity of the air inlet supply to the gas engine.

A matrix illustrating the above monitoring program for each of the three laboratories is provided within Table 1.1.

**Table 1.1 Sampling matrix of analytes and locations for each monitoring laboratory (monitoring period in brackets)**

Location	Determinand	Lab A	Lab B	Lab C	
		(09-10/09/02)	(12/09/02)	(17-18/09/02)	
<b>Engine</b>	CH <sub>4</sub>	✓	✓	✓	
<b>Gas Inlet</b>	CO <sub>2</sub>	✓		✓	
	CO	✓	✓	✓	
	O <sub>2</sub>	✓	✓	✓	
	N <sub>2</sub>	✓	✓	✓	
	Total Cl (as HCl)	✓	✓	✓	
	Total F (as HF)	✓	✓	✓	
	Total S	✓			
	Speciated PCDFs/PCDDs	✓			
	Temperature	✓	✓	✓	
	Pressure	✓	✓	✓	
	Flow rate	✓	✓	✓	
	<b>Sampling Sleeve</b>	Speciated PCDFs/PCDDs	✓	✓	✓
	<b>(Engine Exhaust Emissions)</b>	Total particulates	✓	✓	✓
HCl		✓	✓	✓	
HF		✓	✓	✓	
NO <sub>x</sub> (as NO <sub>2</sub> )		✓	✓	✓	
SO <sub>x</sub> (as SO <sub>2</sub> )				✓	
CO		✓	✓	✓	
THC		✓	✓	✓	
O <sub>2</sub>		✓	✓	✓	
CO <sub>2</sub>		✓		✓	
Velocity		✓	✓	✓	
Temperature		✓	✓	✓	
Pressure		✓	✓	✓	
Flow rate		✓	✓	✓	
<b>Ambient Air at Engine Inlet</b>	Speciated PCDFs/PCDDs	✓			
<b>Exhaust Dust</b>	Speciated PCDFs/PCDDs	✓			

## 2 SAMPLING AND ANALYTICAL METHODS

The following sampling and analytical methods were conducted and employed by each laboratory as outlined within the following sub-sections. The differences between the laboratories are indicated below.

### 2.1 Landfill supply gas (engine inlet)

The list of test methods and in-house method numbers that were used for the sampling of the landfill supply gas to the engine are provided within Table 2.1. The list of analytical methods used by each laboratory (or sub-contracted laboratory) are provided within Table 2.2. Lab A provided a comparison between an in-situ determination of CO using a portable electrochemical cell detection system to that determined using an extracted sample (Gresham tube) analysed using an infrared (IR) analyser. Cross sensitivities within the electrochemical cell system (probably moisture and/or hydrogen) and a calibration check of the portable instrument indicate that the IR technique is the more accurate method.

Lab A uses a modified BS 3516 procedure, using a microburner, for the determination of total sulphur, chlorine and fluorine within the supply gas. This involves burning a sample of landfill gas, under controlled conditions, and collecting the condensed products of combustion for analysis by ion chromatography. The other two laboratories, Lab B and Lab C, use a sampling method based on the particulate determination (US EPA Method 5). Lab B uses a chilled scrubbing train containing sodium hydroxide solutions to absorb the chloride and fluoride components, whilst Lab C uses sulphuric acid.

Lab A and Lab C extracted samples of the inlet gas using Gresham tubes for the determination of the permanent/bulk gases (Table 2.1), whilst Lab B collected their sample using Tedlar bags.

Lab B and Lab C were not commissioned to sample for dioxins and furans within the supply gas, and so their sampling and analytical methods are not listed within Tables 2.1 or 2.2. Lab A attempted to sample for dioxins and furans in the supply gas in accordance with CEN 1948-1:1997. However, due to the high static pressure and difficulty of providing suitable sampling ports within the gas inlet duct, sampling was not carried out isokinetically. The sampling period (140 minutes) allowed a sufficient volume of gas to be sampled (1.9 m<sup>3</sup>), without saturating the resin traps with the relatively high levels of volatile organic compounds to be expected within the supply gas (c. 1000 mg/Nm<sup>3</sup>, moist gas). Analysis of the collected sample was carried out using high resolution gas chromatography/mass spectrometry (CG/MS). The spike recoveries reported by Lab A were between 78 and 124 %, whilst the extraction recoveries were between 69 and 89%. These are within the BS EN 1948:1996 limits.

**Table 2.1 Summary of sampling methods used on landfill supply gas**

<b>Determinand</b>	<b>Lab</b>	<b>Laboratory Method No.<sup>2</sup></b>	<b>Sampling Method</b>	<b>UKAS Status of lab method</b>
Permanent/Bulk Gases <sup>1</sup>	Lab A	AM 001 pt 4	Gresham tube	Yes
	Lab B	None	Tedlar bag	No
	Lab C	G1	Gresham tube	No
CO	Lab A	None	portable analyser, Gresham tube	No
	Lab B	None	Grab sample Tedlar bag	No
	Lab C	G1	Gresham tube	No
Total Cl, F & S <sup>3</sup>	Lab A	AM 001 pt 1	Based on BS 3156	Yes
	Lab B	SOP 6b, 10a and 11a (modified)	BS ISO 11632, US EPA Method 26	Yes
	Lab C	A52	US EPA Method 5 (H <sub>2</sub> SO <sub>4</sub> )	Yes
Speciated PCDFs/PCDDs	Lab A	AM 020	Based on CEN 1948	Yes
Moisture	Lab A	AM 001 pt 3	Silica gel	Yes
	Lab B	SOP 6b, 10a and 11a (modified)	BS ISO 11632, US EPA Method 26	Yes
	Lab C	A52	US EPA Method 5	Yes
Flow rate <sup>4</sup>	Lab A	AM 020 pt 1	Based on BS 3405:1983	Yes
	Lab B	SOP 2b	BS 6069	Yes
	Lab C	A52	US EPA Method 5	Yes

<sup>1</sup> Permanent/bulk gases defined as CH<sub>4</sub>, CO<sub>2</sub>, O<sub>2</sub>, H<sub>2</sub> and N<sub>2</sub>.<sup>2</sup> None means no laboratory method reference number provided.<sup>3</sup> Total S only determined by Lab A.<sup>4</sup> Includes determination of temperature and pressure.

**Table 2.2 Summary of analytical methods used on landfill supply gas**

<b>Determinand</b>	<b>Lab Code</b>	<b>Analytical Method</b>	<b>UKAS Status of lab method</b>
Permanent/Bulk Gases <sup>1</sup>	Lab A	Thermal conductivity gas chromatography	Yes
	Lab B	Gas chromatography/ Thermal conductivity	No
	Lab C	Alcontrol R210/211	No
CO	Lab A	(i) Electrochemical cell (ii) Infra-red analyser	No No
	Lab B	Gas chromatography/ Thermal conductivity	No
	Lab C	Alcontrol R210/211	No
Total Cl, F & S <sup>3</sup>	Lab A	Ion chromatography	Yes
	Lab B	Ion chromatography	Yes
	Lab C	Ion chromatography	Yes
Speciated PCDFs/PCDDs	Lab A	High resolution gas chromatography/ mass spectrometry	Yes
Moisture	Lab A	Gravimetric	Yes
	Lab B	Gravimetric	Yes
	Lab C	Gravimetric	Yes

<sup>1</sup> Permanent/bulk gases defined as CH<sub>4</sub>, CO<sub>2</sub>, O<sub>2</sub>, H<sub>2</sub> and N<sub>2</sub>.

<sup>2</sup> None means no laboratory method reference number provided.

<sup>3</sup> Total S only determined by Lab A.

<sup>4</sup> Includes determination of temperature and pressure.

## 2.2 Engine exhaust emissions

The list of test methods and in-house method numbers that were used for the sampling of the engine exhaust emissions are provided within Table 2.3. The list of analytical methods used by each laboratory (or sub-contracted laboratory) are provided within Table 2.4.

### 2.2.1 *Dioxins and furans*

Each of the laboratories sampled dioxins and furans in accordance with their own UKAS accredited method based upon CEN 1948-1:1997, with a field blank per sampling campaign taken. Gas velocities and temperatures were determined during the course of the test to ensure sampling was carried out isokinetically. During the course of sampling for dioxins and furans

Lab A used two spiked resin traps and combined this sample for analysis by their analytical laboratory. This decision was taken to avoid possible saturation of the first resin trap by volatile organic (or other) compounds due to discolouration of the resin, which may have impeded recovery of the dioxins and furans. This decision was taken on the advice of Lab A's analytical laboratory. Lab A and Lab B fulfilled the procedural requirements of CEN 1948-1:1997 in terms of the volume of exhaust gas and period sampled. Lab C had to reduce their sampling period due to the engine shutdown experienced towards the end of the testing period (at 337.5 minutes of the 360 minute test), so that only 3.6 Nm<sup>3</sup> (dry basis) of exhaust gas was collected, instead of the minimum volume required in the standard of 5 Nm<sup>3</sup>.

Lab A state that the sample recovery data for the dioxin and furan spikes for the exhaust sample can not be relied upon because two resin traps were provided for analysis. This required a larger volume of raw extract to be sampled (c. 1200 ml), whereas only the standard volume of internal standards had been added for the spiking (extraction standards). Consequently, lower than usual spike recoveries (added during the sample extraction) are reported (25 – 38%). These are all outside the BS EN 1948:1996 limits. However, the signal to noise ratios for the internal standards exceeded 20:1 and the data are considered to be valid.

Lab C report spike recoveries of 94 – 106 %, with extraction standards recoveries of between 66 and 104 %. Lab B reported spike recoveries of 60 - 77 %, extraction standards recovery efficiencies were not reported. These are within the BS EN 1948:1996 limits.

Although, the CEN 1948:1997 method does not actually use the resin spike recovery information in any quantitative way, it can provide an indication of the sampling efficiency and breakthrough. The extraction standards can provide an indication of the extraction and clean-up efficiency.

### **2.2.2 Other analytes**

Similar sampling methods and almost identical analytical methods (although different instruments) were employed by each laboratory for all of the other analytes determined within the engine exhaust gas (Table 2.3 and 2.4).

**Table 2.3 Summary of sampling methods used on exhaust emissions**

<b>Determinand</b>	<b>Lab Code</b>	<b>Laboratory Method No.<sup>2</sup></b>	<b>Sampling Method</b>	<b>UKAS Status</b>
Speciated PCDFs/PCDDs	Lab A	AM 020	CEN 1948-1:1997	Yes
	Lab B	SOP 18b	CEN 1948-1:1997	Yes
	Lab C	A47	CEN 1948-1:1997	Yes
Total particulates	Lab A	AM 020	BS 3405	Yes
	Lab B	SOP 2b	BS 6069: 1992	Yes
	Lab C	A52	BS 6069:1992 4.3 and BS 3405	Yes
HCl	Lab A	AM 2002	Based on US EPA Method 26	Yes
	Lab B	SOP 10b	US EPA Method 26/26A, BS EN 1911-1	Yes
	Lab C	A53	US EPA Method 26	Yes
HF	Lab A	AM 2001	Based on CERAM Method	Yes
	Lab B	SOP 11b	US EPA Method 26/26A	Yes
	Lab C	A53	US EPA Method 26	Yes
NO <sub>x</sub>	Lab A	ML 001	Continuous analyser	Yes
	Lab B	SOP 7	US EPA Method 7E	Yes
	Lab C	A44	US EPA Methods 7E (continuous analyser)	Yes
SO <sub>2</sub>	Lab C	A44	US EPA Methods 10 and 6C	Yes
CO	Lab A	ML 001	Continuous analyser	Yes
	Lab B	SOP 5	US EPA Method 10	Yes
	Lab C	A44	US EPA Method 10 (continuous analyser)	Yes
THC	Lab A	ML 001	Continuous analyser	Yes
	Lab B	SOP 8	BS EN 12619:1999	No
	Lab C	A6	US EPA Method 25A (continuous analyser)	Yes
O <sub>2</sub>	Lab A	AM 020	Continuous analyser	Yes
	Lab B	SOP 4	US EPA Method 3A	Yes
	Lab C	A32	Continuous analyser	Yes
CO <sub>2</sub>	Lab A	AM 2011	Infra-red	Yes
	Lab B	SOP 3	US EPA Method 3A	Yes
	Lab C	None	Infra-red	Yes
Flow <sup>1</sup>	Lab A	AM 020 pt 1	BS 3405	Yes
	Lab B	SOP 2b	BS 6069: 1992	Yes
	Lab C	A52	BS 3405	Yes

<sup>1</sup> Permanent/bulk gases defined as CH<sub>4</sub>, CO<sub>2</sub>, O<sub>2</sub>, H<sub>2</sub> and N<sub>2</sub>.<sup>2</sup> None means no laboratory method reference number provided.

**Table 2.4 Summary of exhaust emission analytical methods used by Lab A, Lab B and Lab C**

<b>Determinand</b>	<b>Analytical Method</b>	<b>UKAS Status</b>
Speciated PCDFs/PCDDs	High resolution gas chromatography/mass spectrometry	Yes
Total particulates	Gravimetric	Yes
HCl	Ion chromatography	Yes
HF	Ion chromatography	Yes
NO <sub>x</sub>	Chemiluminescent continuous analyser	Yes
SO <sub>2</sub>	Infra-red continuous analyser (Lab C only)	Yes
CO	Infra-red continuous analyser	Yes
THC	Flame Ionisation Detector continuous analyser	Yes
O <sub>2</sub>	Paramagnetic gas analyser	Yes
CO <sub>2</sub>	Infra-red (Lab A and Lab C)	Yes
	Not determined (Lab B)	Yes

<sup>1</sup> Permanent/bulk gases defined as CH<sub>4</sub>, CO<sub>2</sub>, O<sub>2</sub>, H<sub>2</sub> and N<sub>2</sub>; <sup>2</sup> None means no laboratory method reference number provided.

### 2.3 Ambient air and exhaust dust

The ambient air, in close proximity to the engine air inlet, was sampled for dioxins and furans in accordance with CEN 1948-1:1997. However, the sampling could not be carried out isokinetically because of the practical difficulties of the sampling regime, requiring the inlet air to be sampled overnight (19:37 on the 09/09/02 until 08:55 on the 10/09/02). A control blank was also taken during this separate sampling campaign. The same analytical method, as used for the analysis of the exhaust gas sample, was employed. The spike recoveries on the ambient air sample reported by Lab A were between 75 and 108 %, whilst the extraction recoveries were between 68 and 90%. These are within the BS EN 1948:1996 limits.

A sample of the exhaust dust from the inside of the exhaust section that was originally fitted to the silencer outlet was obtained. A total of 5.5 g of dust was collected (5 g of which was analysed) for the analysis of dioxins and furans. It is understood that the original exhaust was fitted just prior to a previous monitoring campaign (early December 2001), so that the dust collected represents the build-up over the subsequent 9-month period. The same analytical method as used for the analysis of the exhaust gas sample, was employed. The spike recoveries on the field blank exhaust dust sample reported (Lab A) were between 91 and 120 % (no spike recoveries were obtainable from the solid sample submitted), whilst the extraction recoveries were between 61 and 89% (within the BS EN 1948:1996 limits).

### **3 LANDFILL GAS ENGINE AND SITE PERFORMANCE**

#### **3.1 Summary of engine performance**

##### **3.1.1 Background**

The spark ignition engine tested was first commissioned in December 1999 and at the start of the monitoring program by Lab A in September 2002 had been operational for 22467 h. The lubricating oil change frequency is typically 1400 h as reported by the site operator, using Texaco HD40 grade oil, and consumption is typically 5 L per day. The oil had been changed and new spark plugs fitted 90 h before the start of any monitoring.

Cylinder head overhaul is normally at 12000/15000 h intervals and two of these (9 and 15) had been overhauled 90 h prior to the onset of the monitoring program. New piston rings had been fitted 7120 h previously.

The crankcase emissions were vented to the atmosphere via a Vokes filter and no visible plume was visible from either this source or the engine exhaust stack during the course of the monitoring program.

The engine logs were used to determine operating parameters and any deviations from the norm. An example extract is shown in Annex 1 below.

##### **3.1.2 Lab A monitoring period (9-10 September 2002)**

The average engine load during the period of testing was 998 kW<sub>e</sub> (range of 986 – 1021 kW<sub>e</sub>), with a relatively steady throttle position (degree of opening) around 49° (45-52°), suggesting that the gas quality (CH<sub>4</sub>) was relatively stable. Logged cylinder temperatures were steady between 576 and 602 °C, with an average of 592 °C.

Based on the measured inlet landfill gas flow measurement (509 Nm<sup>3</sup>/h, moist gas) and methane content (59% v/v), average engine load (998 kW<sub>e</sub>) and calorific value of methane (35.89 MJ/m<sup>3</sup>) the average thermal efficiency of the engine over the period of monitoring by Lab A is estimated at 33%. This value is typical of nominal 1MW<sub>e</sub> containerised engines.

The engine appeared to operate within its normal operating parameters, with no engine shutdowns experienced over the monitoring period for Lab A. The recorded temperature variation of the exhaust stack by Lab A during the testing period was between 463 and 476°C, with an exhaust flow rate of 3543 Nm<sup>3</sup>/h (dry gas, 5% O<sub>2</sub>).

The air-to-fuel ratio is estimated to be 7.9:1.

The above information is summarised within Annex 2.

### **3.1.3 Lab B monitoring period (12 September 2002)**

The average engine load during the period of testing was 998 kW<sub>e</sub> (range of 986 – 1021 kW<sub>e</sub>), with a relatively steady throttle position (degree of opening) around 50° (45-54°), suggesting that the gas quality (CH<sub>4</sub>) was relatively stable. The slightly higher throttle position, as compared to the period 9-10 September, may suggest methane content was slightly lower. Logged cylinder temperatures were steady between 582 and 602 °C, with an average of 593°C.

Based on the measured inlet landfill gas flow measurement (623 Nm<sup>3</sup>/h, moist gas) and methane content (48% v/v), average engine load (998 kW<sub>e</sub>) and calorific value of methane (35.89 MJ/m<sup>3</sup>) the average thermal efficiency of the engine over the period of monitoring by Lab B is also estimated at 33%.

The engine appeared to operate within its normal operating parameters, with no engine shutdowns experienced over the monitoring period for Lab B. The recorded temperature variation of the exhaust stack by Lab B during the testing period was between 470 and 483°C, with an exhaust flow rate of 3534 Nm<sup>3</sup>/h (dry gas, 5% O<sub>2</sub>).

The air-to-fuel ratio during this monitoring period is estimated to be 6.3:1.

The above information is summarised within Annex 2.

### **3.1.4 Lab C monitoring period (17-18 September 2002)**

The average engine load during the period of testing was 996 kW<sub>e</sub> (range of 986 – 1021 kW<sub>e</sub>), with a relatively steady throttle position (degree of opening) around 48° (45-51°), over the period of the actual monitoring program. This suggests that the gas quality (CH<sub>4</sub>) was relatively stable during the monitoring period. However, there was an engine shutdown at 15:14 on 17 September 2002, as a consequence of air ingress into the engine gas inlet supply line, following pipe damage within the gas field. During this event, the O<sub>2</sub> content rose from <0.1% to 1.6% (recorded at 16:29) and the methane content fell from 60.5 to 54%. This resulted in the throttle position opening to accommodate the lower methane quality gas and lower prevailing combustion temperatures, with a recorded throttle position at 59° and average cylinder temperature of 546 °C logged at 15:14:17, outside of the normal operational range of the engine. Lab C report that the dioxin and furan monitoring test was suspended at 15:18, 4 minutes later than the start of the logged fault with the engine. Comparison of the monitoring team operative's watch with the engine clock indicates the former (Lab C clock) was 2 minutes ahead of the latter (engine clock), suggesting there could have been up to a 2 minute period of sampling when the engine would not have been burning all of the landfill gas under normal operating conditions. No other emissions or inlet gas monitoring was

continued until the gas field had been rectified with the landfill gas quality back up to normal levels by 10:00 on the 18 September 2002 (CH<sub>4</sub> 60.9%, CO<sub>2</sub> 39.1% and O<sub>2</sub> 0.0%).

Logged cylinder temperatures were steady between 582 and 602 °C, with an average of 590°C, for the actual period of emissions testing.

Based on the measured inlet landfill gas flow measurement (794 Nm<sup>3</sup>/h, moist gas) and methane content (52% v/v), average engine load (996 kW<sub>e</sub>) and calorific value of methane (35.89 MJ/m<sup>3</sup>) the average thermal efficiency of the engine over the period of monitoring by Lab C is estimated at 25%, this value is much lower than would be expected for a 1MW<sub>e</sub> containerised engine. The value of the inlet flow rate calculated by Lab C is 794 Nm<sup>3</sup>/h (moist gas), much higher than that quantified by either Lab A or Lab B which explains the lower calculated engine thermal efficiency.

The recorded temperature variation of the exhaust stack by Lab C during the testing period was between 432 and 482 °C, with an exhaust flow rate of 3922 Nm<sup>3</sup>/h (dry gas, 5% O<sub>2</sub>). The exhaust flow rate is comparable to that quantified by Lab A and Lab B, whilst the exhaust stack temperatures show a higher degree of variability in comparison to the other laboratories. Stack temperatures varied between 432 and 457 °C across the last three positions of the dioxin and furan test (292.5 to 337.5 minutes). This may be indicative of a cooling effect close to the stack wall or of the silencer system affected by external weather conditions, a lower combustion temperature, or other unknown sources of uncertainty. Lab C report that the temperature requirements of the CEN 1948:1997 standard were met and the variation in stack temperature gives no cause for concern.

The air-to-fuel ratio is estimated to be 5.3:1. This represents a lower value than expected.

The above information is summarised within Annex 2.

### **3.2 Engine oil analysis**

The engine oil analysis data for the period 18 July to 4 October 2002 were provided to LQM by the site operator. Oil samples were taken during the monitoring campaign for each of the laboratories (10, 12 and 18 September 2002) to investigate the consistency of the lubrication oil of the engine.

The oil viscosity, Total Acid Number (TAN) and Total Base Number (TBN) were at a cautionary level on the 29 August 2002 (oil life of 1204 h), indicating the neutralising capacity of the engine oil for the acidic combustion products (sulphuric, organic and nitric acids) was being depleted by the acidic components within the landfill gas supply (largely considered to be chlorine and sulphur compounds). The relatively low TBN and high TAN/viscosity is indicative of the presence of corrosive components within the engine oil.

However, the oil analysis over the period of all the monitoring indicates that all of the reported critical engine oil parameters (Table 3.1) were within the normal operating range for this engine type. Table 3.1 shows that the Cl uptake rate was between 56 and 164 ppm/100 h. The average value for the two month period prior to (and over) the monitoring period was 59 ppm/100 h (range of 8 - 164 ppm/100 h). These values are typical of those experienced by this type of engine at other sites, experiencing similar chlorine loading from the supply gas. The oil analysis shows higher Cl levels within the oil during the monitoring period for Lab C (500 ppm) as compared to  $\leq 100$  ppm for Lab A and Lab B, although the other parameters are generally consistent and the oil condition is reported as being satisfactory. The comparatively higher levels of Cl within the engine oil during the sampling period by Lab C is not supported by the relatively low level of Cl (as HCl) within the supply gas that they report ( $0.6 \text{ mg/m}^3$ , 18 September 2002), as compared to levels reported by Lab A ( $50 \text{ mg/m}^3$ , 9 September 2002). Lubricating oil consumption is reported by the site operator as being about 5 L per day and at this rate is not considered to provide a significant source of sulphur for the emissions of  $\text{SO}_2$  from the engine exhaust.

**Table 3.1 Oil engine parameters indicating oil status prior to and during the emissions monitoring**

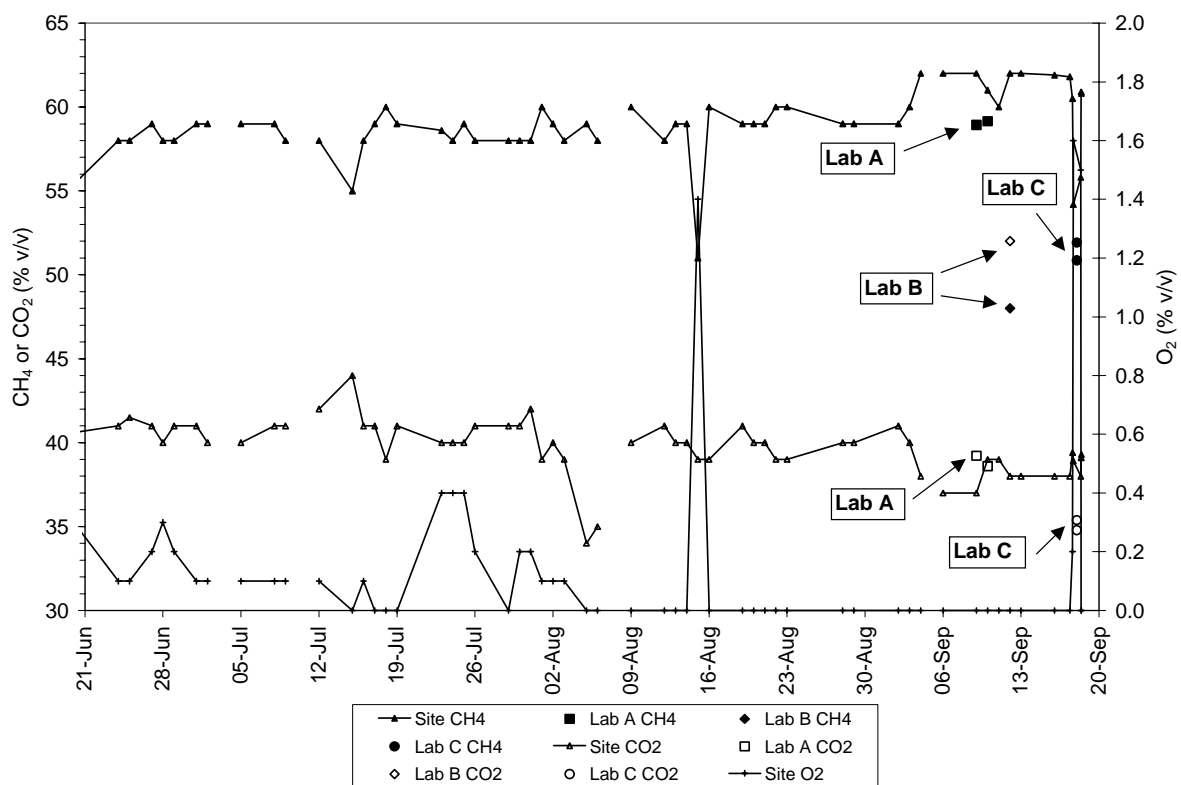
Sample Date	Oil Life (h)	CI (ppm)	CI (ppm/100 h)	TAN	TBN	pH	Oxidation	Nitration	Viscosity (cST 40C)
10/08/01	344	300	87	2.6	6.0	6.7	0	0	149
21/08/01	597	700	117	4.3	5.9	5.8	0	0	152
31/08/01	834	800	96	2.9	5.2	5.6	0	0	157
07/09/01	994	800	80	4.0	5.6	5.2	1	0	157
14/09/01	1162	nd	0	nd	5.2	nd	1	0	157
21/09/01	1330	900	68	2.8	3.7	4.7	2	0	163
02/05/02	1469	200	14	3.2	5.7	5.9	5	4	165
14/05/02	286	100	35	2.0	6.1	6.8	0	0	157
24/05/02	519	<100	<19	2.2	5.7	6.3	0	0	161
31/05/02	694	200	29	3.4	4.7	5.6	3	2	158
08/06/02	874	400	46	3.1	4.9	5.4	4	3	158
24/06/02	1254	600	48	3.9	4.4	4.4	9	8	170
05/07/02	1520	500	33	4.5	3.7	4.6	11	9	178
12/07/02	87	<100	<115	1.5	6.1	7.7	2	1	148
18/07/02	221	100	45	2.2	6.4	6.5	2	2	151
26/07/02	414	200	48	2.5	5.2	6.7	4	3	153
02/08/02	585	100	17	2.8	5.0	6.1	4	4	161
09/08/02	737	300	41	3.2	4.5	5.8	6	5	160
20/08/02	1006	<100	10	3.5	3.7	4.6	7	4	175
29/08/02*	1204	<100	<8	4.6	4.1	4.0	8	6	174
10/09/02	117	<100	<85	2.1	7.4	7.6	2	1	155
12/09/02	167	100	60	2.3	7.2	7.3	2	3	155
18/09/02	304	500	164	2.9	6.2	6.5	2	3	158
28/09/02	537	300	56	3.3	6.0	6.2	1	2	160
04/10/02	681	400	59	3	6.4	5.7	3	4	162

Notes: nd – not determined; TAN, Total Acid Number (measure of organic & inorganic acid contamination); TBN, Total Base Number (decreases with high sulphur fuel levels & other acidic components within landfill gas); Oxidation leads to formation of gums, lacquers and sludge resulting in increased acidity and viscosity; Nitration, arising from attack of the oil by nitrous oxides, associated with increases in viscosity, deposits formation and oxidation; Viscosity at 40°C (increases with ageing due to oxidation and thermal degradation or buildup of insolubles); \* viscosity high and TAN/TBN at cautionary level.

### 3.3 Landfill gas quality

The historical record of the landfill gas quality since 21 June 2002 is presented in Figure 3.1. This has been collected on more or less a continuous daily basis by the site operator, using a Geotechnical Instruments GEM500 combined gas analyser. Instrument calibration was checked on 17 September 2002 and found to match the calibration gas specification within 0.2% and 1% for CH<sub>4</sub> and CO<sub>2</sub>, respectively. The methane quality of the engine inlet gas has increased from about 55% in June to the present value of between 60 and 61%, with a fall in the CO<sub>2</sub> from above 40% to about 38 - 39% at the present time. Levels of O<sub>2</sub> are generally less than 0.1%, unless air ingress into the main gas field takes places (e.g. 15 August and 17-18 September 2002) when it rises to about 1.5%.

The landfill gas quality determined by each laboratory during their monitoring programs are also included in Figure 3.1 (see also Table 4.1 and Section 4.1 for a discussion of the results).



**Figure 3.1 Gas inlet quality prior to and during the engine monitoring period**

## 4 RESULTS

### 4.1 Landfill gas engine inlet

#### 4.1.1 *CH<sub>4</sub>, CO<sub>2</sub>, O<sub>2</sub> and CO*

The Lab A data closely matches the CH<sub>4</sub> and CO<sub>2</sub> recorded by the site operator at the gas engine inlet with average values of 59% (CH<sub>4</sub> v/v) and 39% (CO<sub>2</sub> v/v), respectively (Figure 3.1, Table 4.1). In comparison, both Lab B and Lab C under report the level of CH<sub>4</sub> within the supply gas at 48% (CH<sub>4</sub> v/v) and 52% (CH<sub>4</sub> v/v), respectively. Lab B also report the CO<sub>2</sub> at 52% (CO<sub>2</sub> v/v), much higher than that reported by the site operator or other two laboratories (35 – 39 %). The levels of O<sub>2</sub> and N<sub>2</sub> are similar for both Lab A and Lab C, so it is not clear how this discrepancy arises, although Lab B's sampling method for the inlet gas used a Tedlar bag as compared to the other laboratories use of Gresham tubes (Table 2.1). Lab C also reported a relatively high value for N<sub>2</sub> (and other gases) of close to 14%.

Lab A report that the accepted concentration of CO is 43 mg/Nm<sup>3</sup> (or 0.004% v/v), whilst Lab B and Lab C only report CO to be below their laboratories detection limits (< 0.02% and 0.01% v/v). Reporting of CO as below analytical detection limits will not help investigations into the use of CO as a potential indicator for the presence of underground landfill fires, which may act as a potential source of dioxins and furans within the supply gas.

Levels of O<sub>2</sub> determined are similar to that reported by the operator (0.01 – 0.1 %v/v), with N<sub>2</sub> and H<sub>2</sub> at around 2% (N<sub>2</sub> v/v) and 0.02% (H<sub>2</sub> v/v), as determined by Lab A. Moisture levels are reported to be relatively consistent across laboratories at 1.9, 2.2 and 3.4% H<sub>2</sub>O for Lab A, Lab B and Lab C, respectively.

#### 4.1.2 *Total Cl, F and S*

The determination by Lab A of the total chlorine and fluorine content within the supply gas (as HCl and HF, respectively) gave results typical of other sites tested by Lab A, with values of 50 mg/Nm<sup>3</sup> (total HCl, moist gas) and 16 mg/Nm<sup>3</sup> (total HF, moist gas). The subsequent gas aggressiveness index for the level of CH<sub>4</sub> determined by Lab A was calculated to be 140 (i.e. the site is classified as aggressive). This is a value typical of other landfill sites accepting similar waste types. In contrast, the values of total Cl and F reported by Lab B and Lab C are all < 1 mg/Nm<sup>3</sup> (total HCl or HF, moist gas), close to and below the detection limit of the method and the calculated gas aggressiveness index is < 4 (i.e. classified as a very mild site). It would appear that the methods employed for the detection of total halides within the supply gas do not give realistic values and are not as effective at trapping all of the Cl and F within the supply gas, as the microburner combustion technique employed by Lab A.

**Table 4.1 Gas supply inlet quality and parameters as measured by each laboratory and the operator**

Determinand	Lab A	Operator	Lab B	Operator	Lab C	Operator
	(9-10/09/02)		(12/09/02)		(18/09/02)	
CH <sub>4</sub> (% v/v)	59	61-62	48	62	52	56-61
CO <sub>2</sub> (% v/v)	39	37-39	52	38	35	38-39
CO (% v/v) <sup>1</sup>	0.004	nd	<0.02	nd	<0.01	nd
CO (mg/Nm <sup>3</sup> ) Electrochemical cell	94.6	nd	nd	nd	nd	nd
CO (mg/Nm <sup>3</sup> ) Infra-red	43.8	nd	nd	nd	nd	nd
O <sub>2</sub> (% v/v)	0.07	0	0.1	0	<0.01	0 – 1.5
N <sub>2</sub> (% v/v)	1.9	nd	0.5	nd	13.8	nd
H <sub>2</sub> (% v/v)	0.02	nd	nd	nd	nd	nd
H <sub>2</sub> O (% v/v)	1.9	nd	2.2	nd	3.4	nd
Total Cl (HCl), mg/Nm <sup>3</sup> (moist gas)	50.0	nd	< 0.6, < 0.6	nd	0.50, 0.61	nd
Total F (HF), mg/Nm <sup>3</sup> (moist gas)	16.3	nd	< 0.6	nd	< 0.31, < 0.19	nd
Total S, mg/Nm <sup>3</sup> (moist gas)	83	nd	nd	nd	nd	nd
Flow rate (Nm <sup>3</sup> /h, moist gas)	509	nd	623	nd	794	nd
Temperature (°C)	51	nd	57	nd	55	nd
Static pressure (kPa)	21.2	nd	21.9	nd	21.1	nd

nd – not determined

<sup>1</sup> CO % for Lab A determined using the infra-red CO figure

Consideration of the mass balances for Cl and F into and out of the gas engine support this interpretation (Section 4.3).

Lab A determined the inlet total S content at 83 mg/Nm<sup>3</sup> (moist gas), a value at the lower to middle of the range previously reported by this laboratory using this technique on similar sites (Gillett et al, 2002). This sulphur content is not considered to be especially high.

#### **4.1.3 Gas flow rate, temperature and delivery pressure**

The flow rates determined by each laboratory appear to vary quite considerably, between 509 and 794 Nm<sup>3</sup>/h (moist gas). Higher flow rates would be consistent with lower CH<sub>4</sub> quality supply gas to the engine to ensure efficient combustion temperatures and smooth running of the engine to maintain power output. However, the large difference observed in inlet flow rates between Lab B and Lab C (623 and 794 Nm<sup>3</sup>/h, respectively) at similar CH<sub>4</sub> qualities is not consistent with the measured methane levels reported. The methane flow rates to the engine estimated for Lab A and Lab B (Figure 4.1 and 4.2) of 300 and 299 Nm<sup>3</sup>/h are consistent, and much lower than that estimated for Lab C (408 Nm<sup>3</sup>/h, Figure 4.3).

The reported gas temperatures (51-57 °C) and delivery pressures (211-219 mbar) are similar for each laboratory.

## **4.2 Engine exhaust emissions**

The emissions and exhaust stack conditions from this study and comparative studies (on 1MW<sub>e</sub> or smaller spark ignition engines) are summarised in Table 4.2 and Figure 4.1 below, including the data collected for the Environment Agency as reported by Haigh et al (2002) (labelled as EA). Figure 4.1 also presents data for a dual fuel engine running on landfill gas and diesel and that collated from a variety of sources (labelled as database) including gas engine operators and regulators (Gillett et al, 2002).

The arithmetic mean site values for Lab A and Lab B (Lab AB) as well as for Lab A, Lab B and Lab C (Lab ABC) are also presented (Table 4.2). For the majority of exhaust analytes there is not a large impact on the average engine value. However, for the case of dioxins and furans, particulates, THC and HCl large differences can be seen (as described below).

### **4.2.1 Bulk emissions (CO, NO<sub>x</sub>, THC and SO<sub>2</sub>)**

The test average emissions of CO and NO<sub>x</sub> were reported as varying between 1075 – 1360 mg/Nm<sup>3</sup> (dry gas, 5% O<sub>2</sub>) and 539 – 620 mg/Nm<sup>3</sup> (dry gas, 5% O<sub>2</sub>), respectively (Table 4.1). This data is generally consistent with each other and the logged values for CO and NO<sub>x</sub> emissions (uncorrected for instrument drift) indicate emissions were relatively constant over

the 4 hour test period, except for a couple of spurious CO readings logged by Lab C (Figure 4.2 and 4.3). The mean site values (Lab AB and Lab ABC) appear to be consistent.

The average emissions of THC (as C) between laboratories showed greater variability, with test average emissions of 1280, 940 and 680 mg/Nm<sup>3</sup> (dry gas, 5% O<sub>2</sub>) for Lab A, Lab B and Lab C, respectively. The logged values for THC (uncorrected for instrument drift) indicate emissions were relatively constant for Lab A and Lab B, but there was a large step increase and decrease recorded in THC emissions approximately 1.75 and 3.25 h into the 4 h test logged by Lab C (Figure 4.4). The average THC emission logged over this period was 1110 mg/Nm<sup>3</sup>, a value more consistent with that reported by the other two laboratories. Lab C were not able to offer any possible explanation for these step changes in the THC log and report that the instrument calibration prior to the start, and, after completion of the testing period were consistent. The difference in mean site values (Lab AB and Lab ABC) for THC is 143 mg/Nm<sup>3</sup>.

Consideration of the logged engine parameters over this period do not indicate any significant changes in the engine performance (e.g. cylinder temperatures) or throttle position, suggesting that the gas supply quality was constant. The lower than average exhaust stack temperatures reported by Lab C, from about 14:20 (17/09/02) onwards during the dioxin test, are not consistent with the lower THC emissions logged in the period just prior to the end of the THC log (13:00 – 13:45, Figure 4.4).

Lab C also provided an estimate of the average SO<sub>2</sub> emission from the gas engine (86 mg/Nm<sup>3</sup>), the log was relatively constant over the 4h testing period between 34 and 122 mg/Nm<sup>3</sup> (Figure 4.5).

The most likely site emissions for the bulk exhaust emissions are considered to be: 86 mg/Nm<sup>3</sup> (SO<sub>2</sub>); 572 mg/Nm<sup>3</sup> (NO<sub>x</sub> as NO<sub>2</sub>); 1237 mg/Nm<sup>3</sup> (CO) and 1108 mg/Nm<sup>3</sup> (THC). These represent the average value of those reported by each laboratory, except for the THC's. The THC reported by Lab C is considered invalid because of the step change in the logged exhaust profile and so the average of the Lab A and Lab B values is reported.

All of these bulk emissions lie within the range previously reported for similar engine types (Gillett et al, 2002; Haigh et al, 2002; see Table 4.2).

#### *Compliance with proposed Emission standards for landfill gas engines*

Neither CO or NO<sub>x</sub> would exceed the currently proposed emission limits of 1500 mg/Nm<sup>3</sup> for CO or 650 mg/Nm<sup>3</sup> for NO<sub>x</sub> (Environment Agency, 2002). However, given the more stringent criteria proposed for landfill gas engines commissioned after 1 November 2004 (500 mg/Nm<sup>3</sup> for NO<sub>x</sub> and 1400 mg/Nm<sup>3</sup> for CO), the issue of inter-laboratory variation (and/or temporal variation) in exhaust emissions may become important when reporting close to or

just over the emission standard. This is because the draft engine monitoring protocol (Environment Agency, 2002) provides assessment criteria to consider the systematic and random uncertainties associated with monitoring methods, for assessing compliance with the standard (Environment Agency, 2002). For example, the NO<sub>x</sub> emissions reported by Lab A (539 mg/Nm<sup>3</sup>) and Lab C (557 mg/Nm<sup>3</sup>) would both comply with the draft 2004 emission limit corrected for by the compliance assessment for the analytical technique employed (560 mg/Nm<sup>3</sup>). The value reported by Lab B (620 mg/Nm<sup>3</sup>), would result in a non-compliant assessment for this engine.

The mean Lab AB result for THC of 1108 mg/Nm<sup>3</sup> (Table 4.2) would not comply with the proposed emission standard for THC (1000 mg/Nm<sup>3</sup>) for landfill gas engines commissioned after 1 November 2004. However, it would fall within the 95% confidence level for the proposed 2004 standard of 1000 mg/Nm<sup>3</sup> ± 12% (Environment Agency, 2002) and this engine would be compliant with uncertainty. Compliance Assessment Principles (Environment Agency, 2001) would be required to assist in determining whether the mean Lab AB value were significantly elevated. Inclusion of the Lab C result would result in an emission level (965 mg/Nm<sup>3</sup>) below the proposed THC emission standard and this engine would be compliant, although it still lies within the 95% confidence level.

#### **4.2.2 Halide emissions (HCl and HF)**

The average emission levels of HCl are relatively consistent for laboratories A and B with emissions of 3.6 and 6.2 mg/Nm<sup>3</sup> (dry gas, 5% O<sub>2</sub>), respectively. The higher HCl emission reported by Lab C (and 18.0 mg/Nm<sup>3</sup>) is consistent with the higher Cl levels reported within the engine oil (Table 3.1) and may be indicative of a higher Cl inlet loading. However, this is not supported by the comparatively low Cl levels within the supply gas as reported by Lab C (although this is considered to be an underestimate) and previous test results on similar nominal 1MWe engines (Table 4.2). The mean Lab ABC emission for HCl is nearly twice the value determined for Lab AB (Table 4.2).

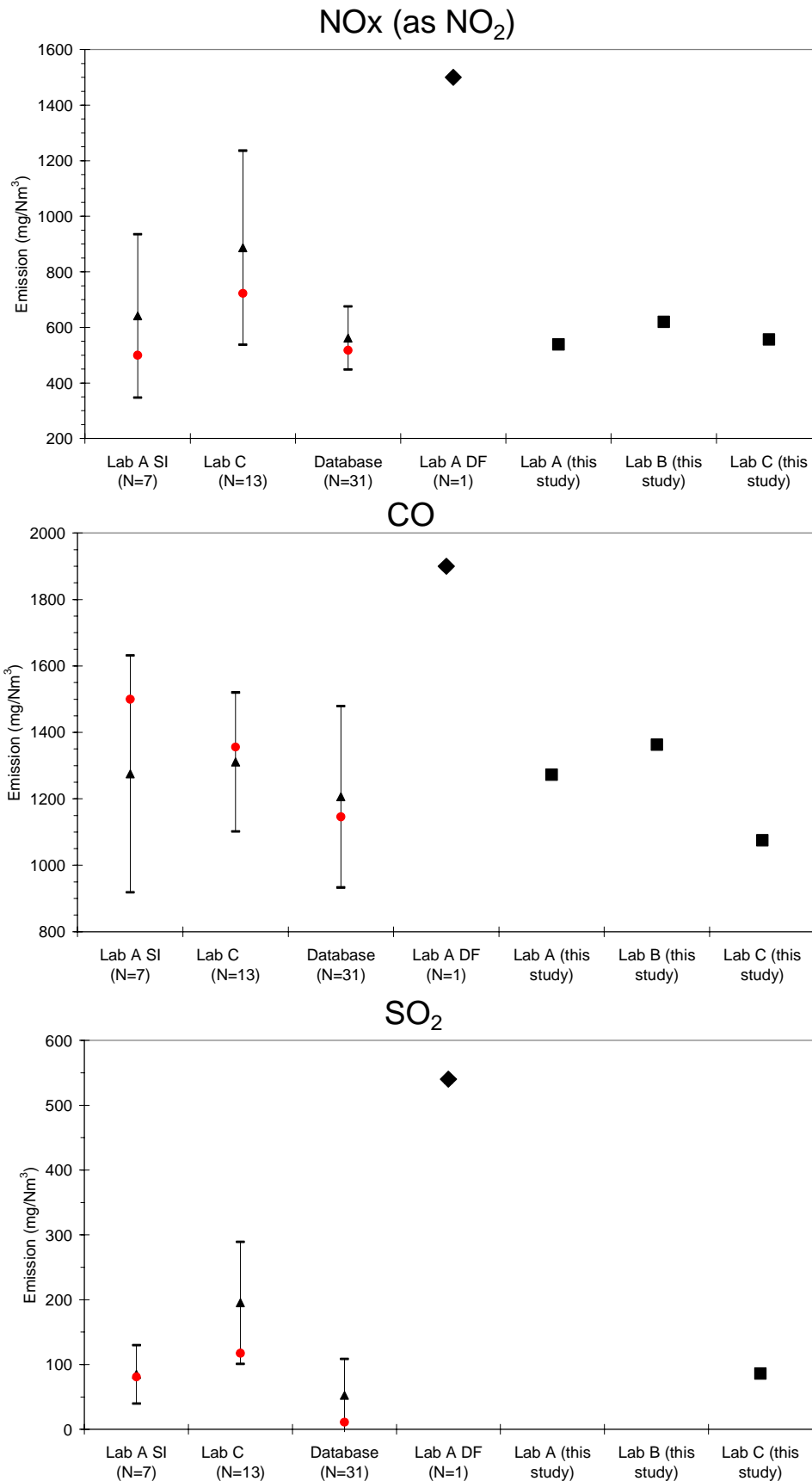
The average emission levels of HF are also relatively consistent with emissions of 1.5, 1.8 and 3.3 mg/Nm<sup>3</sup> (dry gas, 5% O<sub>2</sub>) for Lab A, Lab B and Lab C, respectively.

The mean Lab ABC emissions of both HCl and HF fall within the range previously reported for similar engine types (Gillett et al, 2002; Haigh et al, 2002; see Table 4.2, Figure 4.1), for sites classified as aggressive in terms of their Cl and F inlet loading.

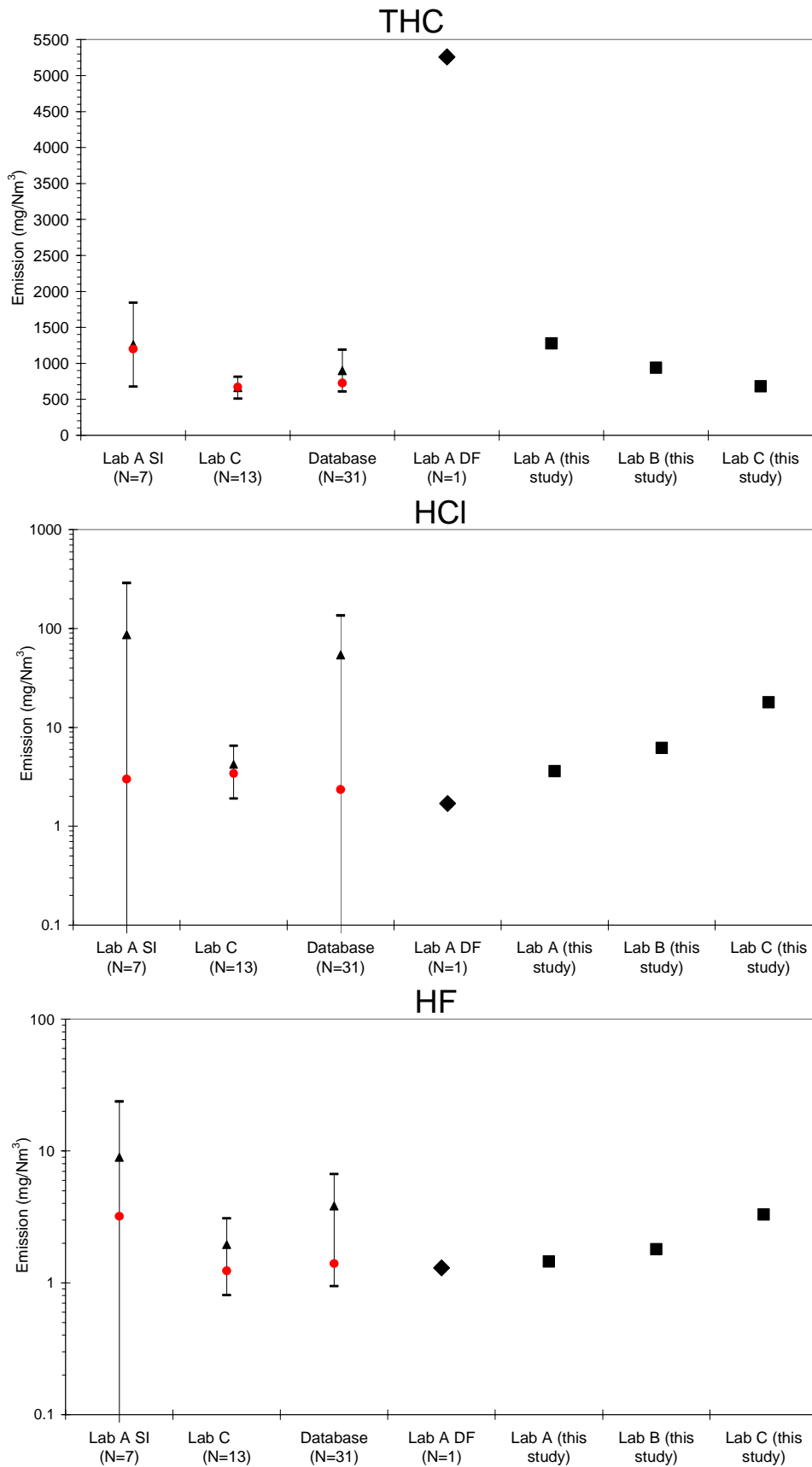
**Table 4.2 Bulk and trace exhaust gas emissions and additional stack parameters (comparative observations for 1MW<sub>e</sub> or smaller spark ignition engines included from other studies)**

Determinand	Lab A (09-10/09/02)	Lab B (12/09/02)	Lab C (17-18/09/02)	Mean site value (Lab A & B)	Mean site value (Lab A, B & C)	Gillett et al (2002)	Haigh et al (2002) <sup>1</sup>
SO <sub>2</sub>	nd	nd	86	<b>nd</b>	<b>86</b>	18 – 160	22 – 402
NO <sub>x</sub> (as NO <sub>2</sub> )	539	620	557	<b>580</b>	<b>572</b>	370 – 760	330 – 1741
CO	1273	1363	1075	<b>1318</b>	<b>1237</b>	1000 – >1500	962 – 1969
HCl	2.4, 4.8	6.2	14.0, 22.0	<b>4.9</b>	<b>9.3</b>	0.2 – 9.5	0.5 – 10.5
HF	1.4, 1.5	1.8	2.3, 4.3	<b>1.6</b>	<b>2.3</b>	< 0.4 – 6.2	0.8 – 6.8
Dioxins and furans	0.0041	0.0030	0.6054	<b>0.0036</b>	<b>0.2042</b>	0.0009 – 0.0046	0.0007 – 2.3000
Particulates	2.9, 3.2	2.4, 10.2	25, 51	<b>4.7</b>	<b>15.8</b>	1.7 – 4.9	1.2 – 12.5
CO <sub>2</sub> (% v/v)	11.3	nd	12.3	<b>11.3</b>	<b>11.8</b>	13.1 – 18.0	3.2 – 17.0
THC (as Carbon)	1277	939	680	<b>1108</b>	<b>965</b>	530 – 2350	307 – 1171
O <sub>2</sub> (% v/v)	8.3	8.4	7.9	<b>8.4</b>	<b>8.2</b>	7 – 10	6.1 – 8.9
H <sub>2</sub> O (% v/v)	9.3	12.6	7.9	<b>11.0</b>	<b>9.9</b>	11 – 13	n/a
Exhaust temperature average (range) °C	470 (463-476)	477 (470-483)	475 (432-482)	<b>474</b>	<b>474</b>	401 – 506	419 – 519
Velocity (m/s) (at duct conditions)	29.1	30.9	31.4	<b>30.0</b>	<b>30.5</b>	23.7 – 32.8	28 – 51
Flow (Nm <sup>3</sup> /h)	3543	3534	3922	<b>3539</b>	<b>3666</b>	2798 – 4093	1380 – 7200

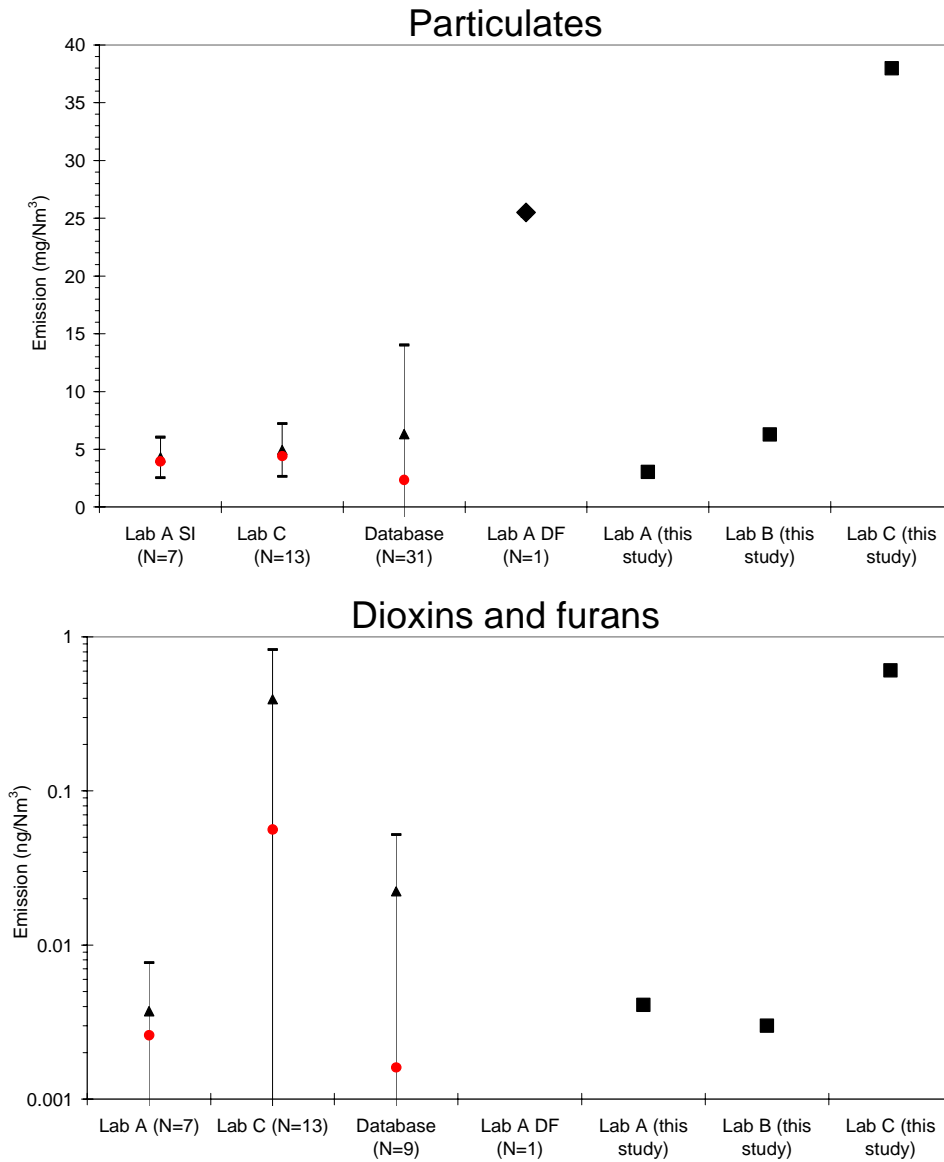
All emissions measurements are in mg/Nm<sup>3</sup> (STP, dry gas, 5% O<sub>2</sub>), except for dioxins and furans (ng-TEQ/Nm<sup>3</sup>, dry gas, 5% O<sub>2</sub>) and CO<sub>2</sub>, O<sub>2</sub> and H<sub>2</sub>O (% v/v); flow rate is corrected to STP (273 K, 101.3 kPa), dry gas and 5% O<sub>2</sub>; nd – not determined; n/a not available; <sup>1</sup> Engine A in Haigh et al (2002) not included.



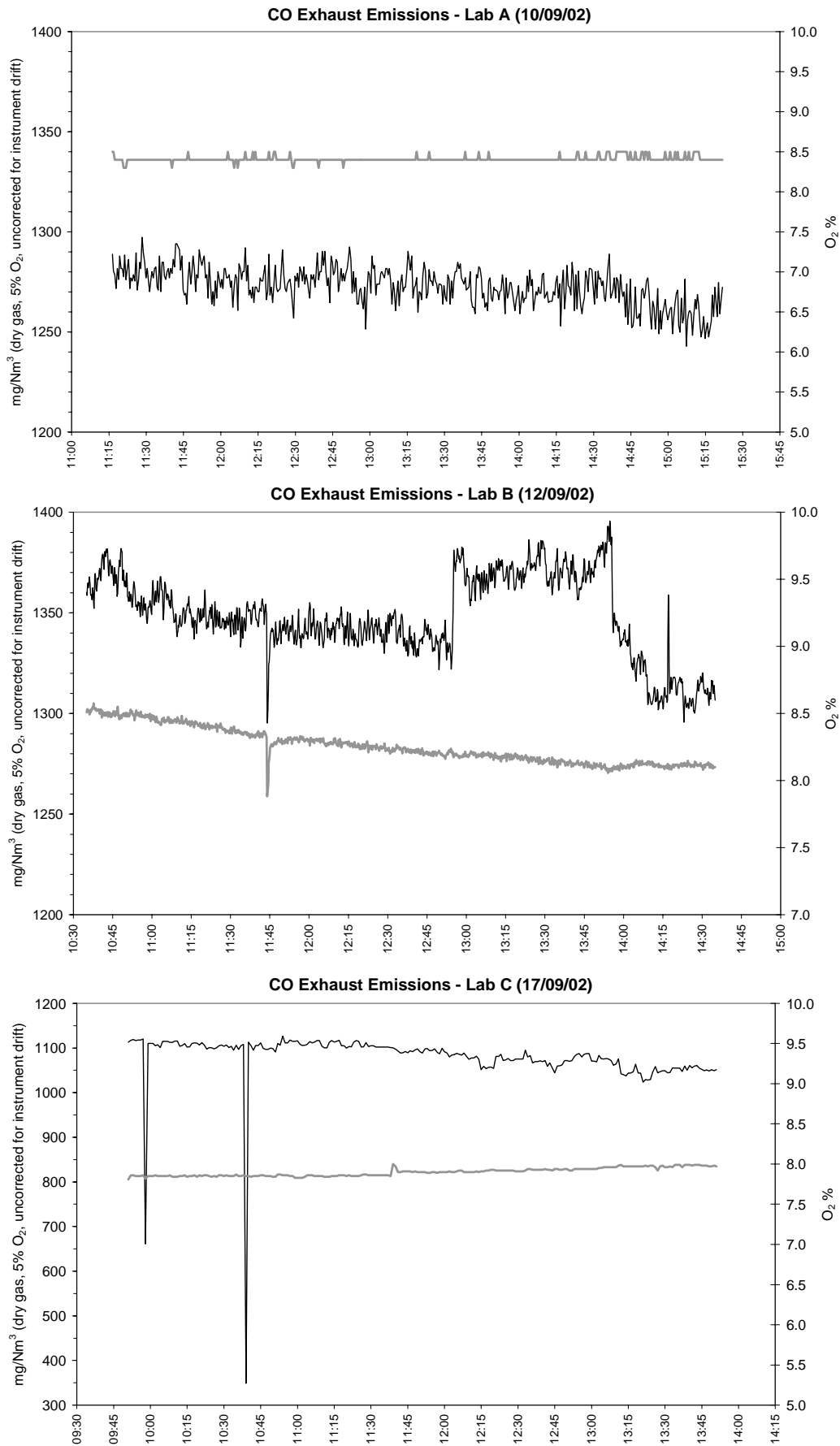
**Figure 4.1 Engine exhaust emissions from each laboratory in this study (■) compared to other studies on spark ignition engines (▲ mean; ● median; – upper and lower 95% confidence interval) and a dual fuel engine (◆); SI – spark ignition; DF – dual fuel**



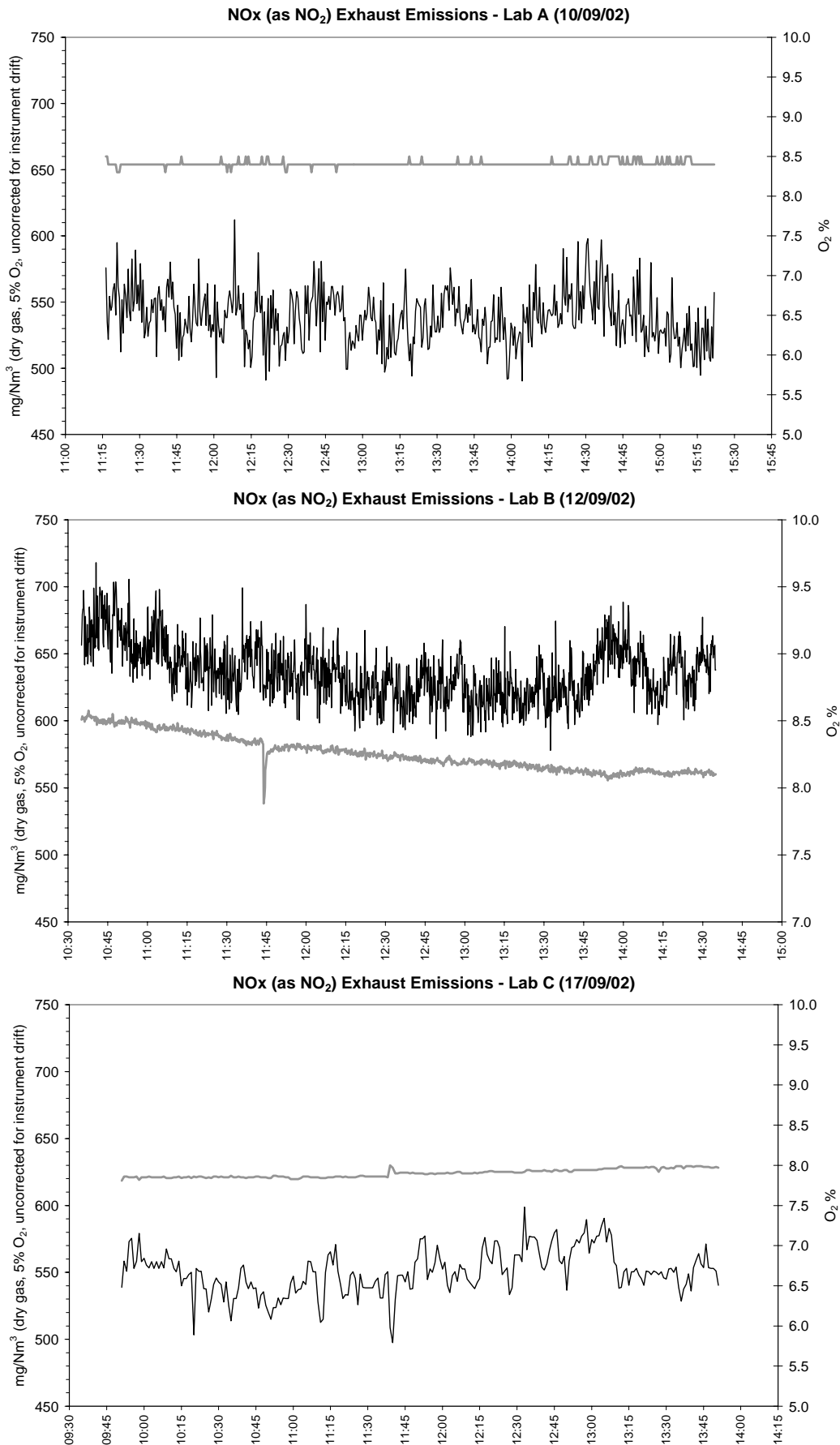
**Figure 4.1 (continued) Engine exhaust emissions from each laboratory in this study (■) compared to other studies on spark ignition engines (▲ mean; ● median; – upper and lower 95% confidence interval) and a dual fuel engine (◆); SI – spark ignition; DF – dual fuel**



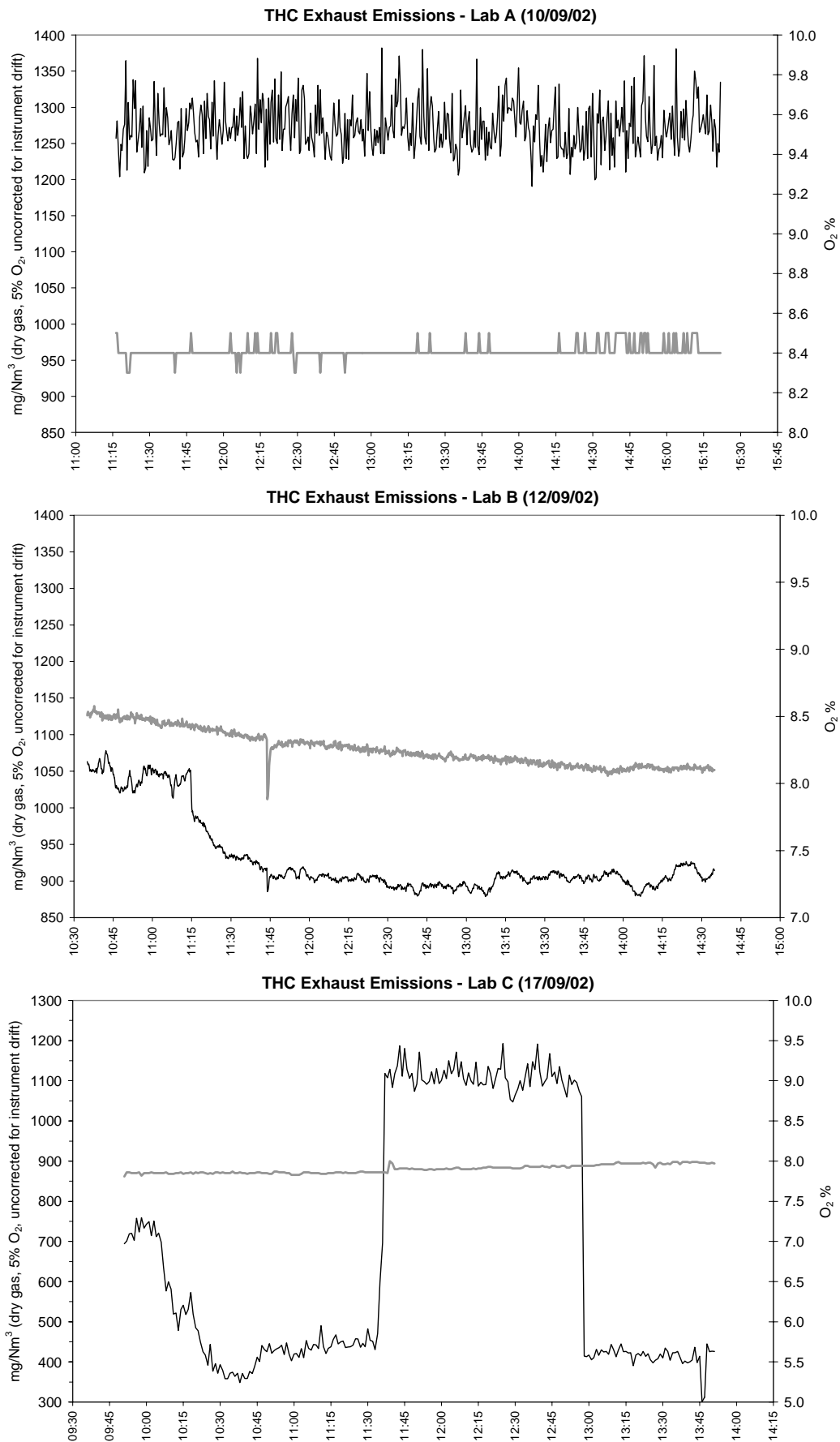
**Figure 4.1 (continued) Engine exhaust emissions from each laboratory in this study (■) compared to other studies on spark ignition engines (▲ mean; ● median; – upper and lower 95% confidence interval) and a dual fuel engine (◆); SI – spark ignition; DF – dual fuel**



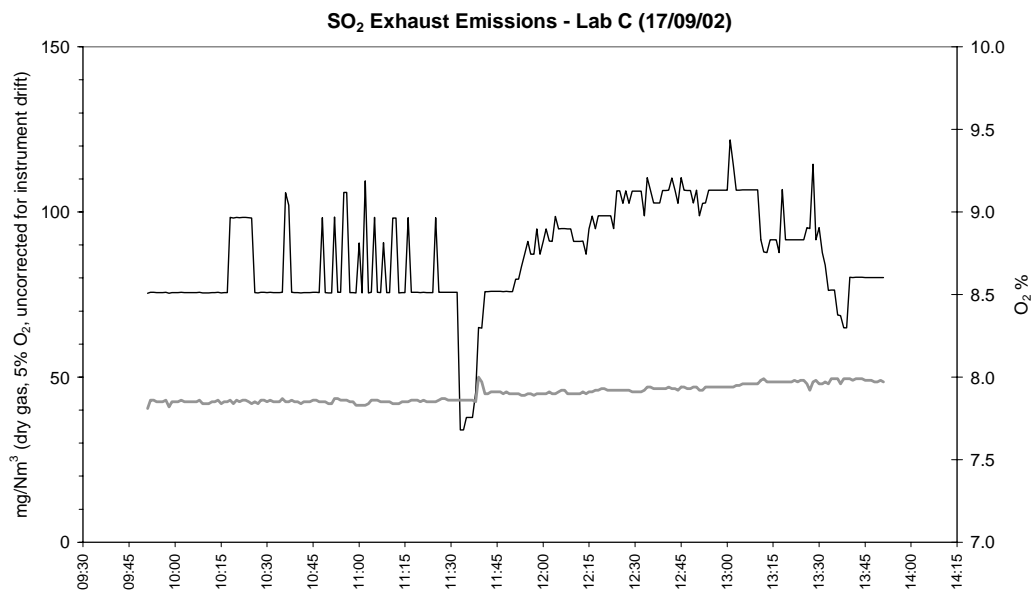
**Figure 4.2 Log of CO (—) exhaust emissions for each laboratory, O<sub>2</sub> % (—) also shown**



**Figure 4.3 Log of NOx as NO<sub>2</sub> (—) exhaust emissions for each laboratory, O<sub>2</sub> % (---) also shown**



**Figure 4.4 Log of THC (—) exhaust emissions for each laboratory, O<sub>2</sub> % (—) also shown**



**Figure 4.5 Log of SO<sub>2</sub> (—) exhaust emissions for laboratory C, O<sub>2</sub> % (—) also shown**

#### 4.2.3 Dioxin and furan exhaust emissions

The emissions of dioxins and furans reported by Lab A and Lab B were 0.004 and 0.003 ng-TEQ/Nm<sup>3</sup> (dry gas, 5% O<sub>2</sub>). These are 150 times (Lab A) and 200 times (Lab B) lower than that reported by Lab C (0.6054 ng-TEQ/Nm<sup>3</sup>, dry gas, 5% O<sub>2</sub>). The mean emissions for Lab AB and Lab ABC are 0.0036 and 0.2042 ng-TEQ/Nm<sup>3</sup> (dry gas, 5% O<sub>2</sub>), respectively. This represents a significant difference, over nearly two orders of magnitude.

Previous dioxin and furans emissions reported from this engine by Lab C have varied between 0.036 and 2.303 ng-TEQ/Nm<sup>3</sup> (dry gas, 5% O<sub>2</sub>) and their present result is within this range.

Given the level of spike recoveries reported by Lab A for the ambient air and exhaust dust samples submitted for dioxin and furan analysis (75 – 120%) and previous experience of their recovery efficiencies it is likely that their result of 0.004 ng-TEQ/Nm<sup>3</sup> for emissions of dioxins and furans from the combined sample is a valid one. This value is also very comparable to that reported by Lab B (0.003 ng-TEQ/Nm<sup>3</sup>), which had acceptable spike recovery efficiencies of 60 – 77%. The difference between Lab B and Lab C could not be accounted for by the higher recovery efficiency reported by Lab C (94 – 106%).

It is not clear at the present time the reason for the high level of discrepancy between the emission results, but some explanation might lie in the analysis of the congener breakdown (Section 5). However, Lab C did have to stop their dioxin test abruptly, as a consequence of air ingress into the supply gas and any sampling during a period of incomplete fuel combustion by the engine may have been a significant contributing factor to the differences between the analytical results.

Previous dioxin emissions testing on this engine on 17 April 2002 by Lab C (reported dioxin exhaust emission of 1.5 ng-TEQ/Nm<sup>3</sup>, Haigh et al, 2002) also coincided with a number of disruptions to the engine inlet gas quality in which air ingress took place, due to pipe damage within the gas field. A number of engine shutdowns during the monitoring period were experienced as a consequence.

Previous dioxin emission testing on this engine over the period 4 – 7 December 2001 by Lab C gave dioxin emissions of 0.034 ng-TEQ/Nm<sup>3</sup> (sampling location pre-fitted 4" BSP ports, Engine Reference E) and 2.3 ng-TEQ/Nm<sup>3</sup> (sampling location end-of-pipe, Engine Reference E2) (Haigh et al (2002)). There were no logged disruptions to the normal operation of the engine over this first period of emissions testing (Annex 3), with the engine running continuously at an average load of 1004 kW<sub>e</sub> (974 - 1033 kW<sub>e</sub>) and an average cylinder combustion temperature of 600 °C (589 – 621 °C). The possible correlation between engine shutdown and high dioxin emissions is therefore not proven.

### 4.3 Mass balances (Cl, F and S)

The mass balances on the supply gas and emissions data for chlorine and fluorine was performed using the data collected by each laboratory.

The mass balance derived using the supply gas concentrations for Cl and F and flow rates for the supply gas and exhaust reported by Lab A is considered to be reasonable. The calculated exhausted Cl and F is 51% and 67%, respectively, of that calculated as entering the engine through the supply gas (Figure A2.1, Annex 2). Values obtained for the mass balances of Cl and F by both Lab B and Lab C have been calculated at between 1730% and 17780% of the inlet supply (Figure A2.2 and A2.3, Annex 2). These are very unrealistic values and arise because of the very low values reported by each laboratory for the supply gas Cl and F. The emission levels of HCl and HF are relatively consistent across laboratories with ranges of 3.6 – 18.0 and 1.5 – 3.3 mg/Nm<sup>3</sup> (dry gas, 5% O<sub>2</sub>), respectively. The exhaust mass emission rates are also very similar (Figure A2.1 – A2.3, Annex 2).

An estimate of the mass balance for S can be performed by combining the inlet S data provided by Lab A and the exhaust SO<sub>2</sub> emission provided by Lab C, ignoring H<sub>2</sub>S and organo-sulphur emissions, which were not determined. It is a crude estimate because the data were collected by separate laboratories on different dates, not all sulphur species were determined and supply gas sulphur concentrations are known to vary with time.

The total S of the gas inlet was quantified at 83 mg/Nm<sup>3</sup> (moist gas) by Lab A, whilst the average SO<sub>2</sub> emission value was quantified at 86 mg/Nm<sup>3</sup> (dry gas, 5% O<sub>2</sub>) by Lab C. The outlet S mass balance is estimated to vary between 250% and 370% of the supply gas, depending on which laboratory volume flow rates (landfill and exhaust gas) are used in the

calculation. These values are of the right order of magnitude, despite the different sampling dates, and suggest again that the Lab A microburner technique is appropriate for supply gas analysis.

#### **4.4 Ambient air (dioxins and furans)**

The ambient air was sampled immediately next to the engine air inlet by Lab A for analysis of dioxins and furans, with the sampling location within 0.5m of the air inlet. The majority of the congeners were below the analytical limit of detection (LOD) and the overall total of 0.0004 ng-TEQ/Nm<sup>3</sup> (dry gas, 20.9% O<sub>2</sub>) is reported as being below the LOD (0.0006 ng-TEQ/Nm<sup>3</sup>).

The value quantified is similar to that obtained close to other 1MWe engines monitored previously by LQM (Gillett, 2002), of between 0.0006 and 0.0019 ng-TEQ/Nm<sup>3</sup> (dry gas, 20.9% O<sub>2</sub>). The congener breakdown (as %TEQ or toxic equivalent) is also very similar to that obtained for the same type of engine (LQM E2, Figure 4.6). The congener breakdown (%TEQ) of the ambient air is also very similar to the engine exhaust emissions, which may indicate the engine to be the main source of dioxins and furans in the vicinity of the site.

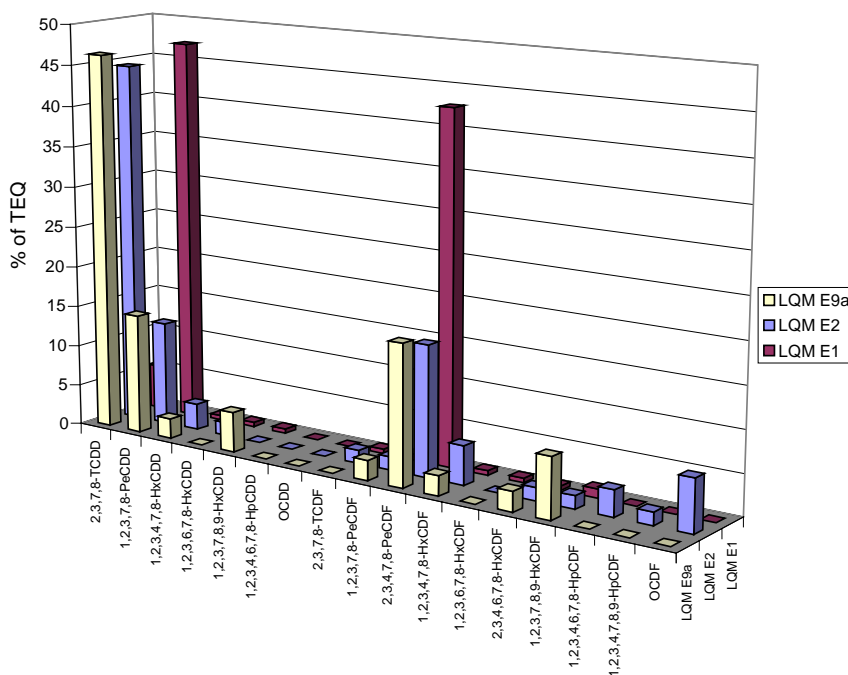
AEAT (1999) report UK levels of dioxins and furans within the ambient air for rural (mean 0.00001 ng-TEQ/m<sup>3</sup>, range 0.0000017 – 0.0000183 ng-TEQ/m<sup>3</sup>) and urban (mean 0.000103 ng-TEQ/m<sup>3</sup>, range 0.00002 – 0.000281 ng-TEQ/m<sup>3</sup>) locations. Therefore, the ambient air levels determined in this study (which were at the LOD for the sampling period used) are just above the maximum urban ambient air reported by AEAT (1999).

#### **4.5 Exhaust dust (dioxins and furans)**

Analysis of the dust collected from the inside of the original exhaust stack for dioxins and furans by Lab A indicate the concentration to be 248 ng-TEQ/kg dust (Table 4.2), much higher than the limit of analytical detection (5 ng-TEQ/kg dust). This value represents an integration of dust build up over a period of at least 9 months (potentially 6570 h). Over the course of a 6h dioxin and furan test, involving the movement of the sampling pitot tube in close proximity to the exhaust side walls, it is one possibility that if a significant quantity of the particulates could inadvertently be dislodged and collected it may help to explain the large differences in dioxin and furan emissions previously encountered at this site.

This information can be used to estimate the likely contribution of the particulate phase to the overall dioxin and furan emission from the exhaust stack. Table 4.2 presents the mean mass emission rates of particulates and dioxins and furans obtained from the emissions testing by each laboratory. The calculated mass emission of dioxins and furans derived using the particulate mass emission rate and dioxin and furan dust concentration is also presented. Lab A and Lab B show comparable results with mass emission rates of between 3 and 15 ng-TEQ/h, with the mass emission rate derived using the dioxin and furan emission result

between 2 and 5 times higher than that calculated using the dust concentration. However, for Lab C the difference is a factor of 64.

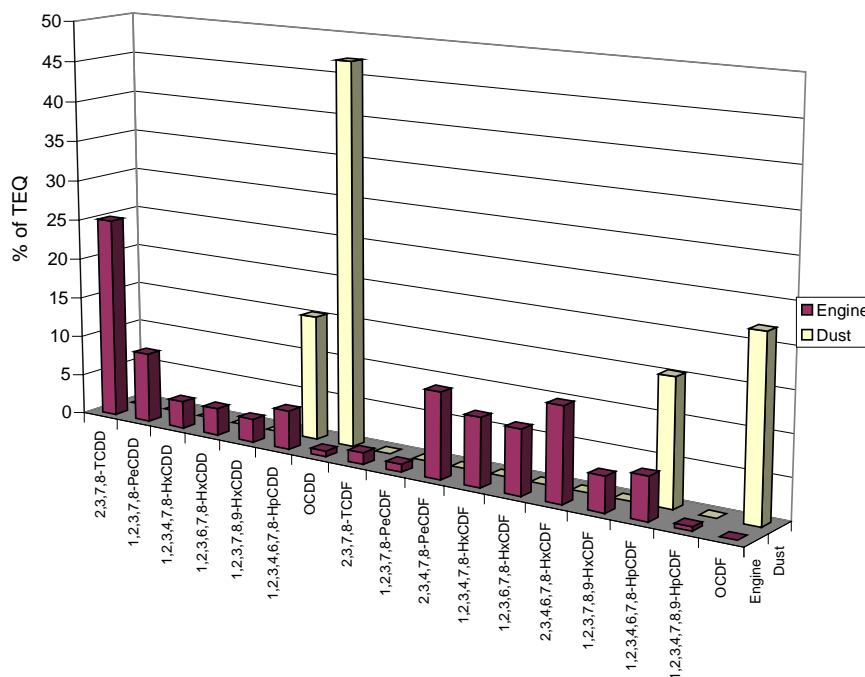


**Figure 4.6 Dioxin and furan congener breakdown (% of TEQ) within ambient air for this (LQM E9a) and previous studies (LQM E1 and E2), as determined by Lab A.**

**Table 4.2 Mass emission rates of particulates and dioxins and furans**

Laboratory	Particulate mass emission rate (g/h)	Exhaust dust dioxins/furans (ng-TEQ/g)	Dioxin mass emission rate (ng-TEQ/h) based on		Average mass of particulates collected (g)
			Exhaust dust <sup>1</sup>	Emission <sup>2</sup>	
Lab A	10.8	0.248	2.7	14.5	0.0014
Lab B	21.2	nd	5.3	10.6	0.0052
Lab C	149.0	nd	37.0	2353.0	0.0017

Notes: nd –not determined; <sup>1</sup> mass emission rate calculated using the particle mass emission rate determined by each laboratory and the exhaust dust dioxins/furans concentration determined by Lab A; <sup>2</sup> mass emission rate calculated using the exhaust volumetric flow rate and dioxins/furans emission determined by each laboratory.



**Figure 4.7 Dioxin and furan congener breakdown (% of TEQ) within exhaust emission and exhaust dust sample, as determined by Lab A**

#### 4.6 Summary and discussion (dioxins and furans)

The three principal mechanisms commonly proposed to explain the formation of dioxins and furans from combustion sources (USEPA, 2000; Cains and Dyke, 1993) are:

- dioxins and furans are present as contaminants within the combusted fuel itself and pass through the combustion zone and are emitted unaltered;
- dioxins and furans form from the thermal breakdown and molecular rearrangement of precursor ring compounds, with similar structures, arising from incomplete combustion (chlorinated aromatic hydrocarbons); and
- *de novo* synthesis from heterogeneous reactions on particulate matter involving carbon, oxygen, hydrogen, chlorine, and a transition metal catalyst (such as copper). Intermediate compounds with an aromatic ring structure are formed, which later evolve into dioxins and furans. These are formed downstream of the combustion zone.

One or more of the above mechanisms may ultimately be important in controlling exhaust emission levels and so the above mechanisms are not considered to be mutually exclusive. The second and third mechanisms occur within the post-combustion zone, which could be anywhere within the exhaust system for the case of landfill gas engines. Temperatures within the range of 200 – 450 °C are considered to be most conducive to dioxin and furan formation, with the maximum formation occurring at around 350 °C. The average exhaust stack temperature (and range) at the point of sampling (0.8 m) before the exhaust gas exits the

sampling sleeve) reported by each laboratory during the dioxin tests were: Lab A 473 °C (471-476 °C); Lab B 476 °C (470-483 °C) and Lab C 475 °C (432-482 °C).

There is conflicting evidence which both supports and invalidates the supposition that there are high dioxin emissions associated with this gas engine.

Three factors that could help to explain or confirm the comparatively high dioxin and furan emission results reported by independent laboratories include the following:

- The large difference between the two methods of estimating the dioxin and furan mass emission rates (based on the dioxin dust concentration or emission result) for Lab C (Table 4.2), as compared to both Lab A and Lab B, may suggest that Lab C is detecting an additional significant contribution due to gaseous phase dioxins and furans and/or that the particulate loading of dioxins and furans was significantly higher during their testing period. Routine analysis of the particulate sample collected during dioxin testing of landfill gas engine emissions could provide an indication of the likely variation to be expected across sites and engine types.
- The relatively high dioxin and furan emission results reported by Lab C, when sampling from 4" BSP ports (17 April 2002 and 17 September 2002) were both associated with disruptions to the normal running of the engine, involving gas supply problems. Sampling over a period of inefficient combustion by the engine may possibly lead to short term increases in dioxin and furan emissions (as well as other bulk and trace species). Therefore, such results may not be representative of the emissions to be expected under normal operating conditions and could suggest that the majority of dioxin emissions arise from short periods of inefficient combustion. Lab C (Haigh et al, 2002) reported dioxin and furan emissions of 0.034 ng-TEQ/Nm<sup>3</sup> when sampling from 4" BSP ports (4-7 December 2001), whilst the engine was operating under normal conditions. This level is much more comparable to those reported by both Lab A and Lab B from 4" BSP ports within this study.
- Lab C report higher particulate loadings within the exhaust stack as compared to Lab A and Lab B, by a factor of up to 20 (Table 4.2). In addition, exhaust stack temperatures recorded during the Lab C dioxin test (432 – 453 °C) were within the so-called *de novo* formation window (200 – 450 °C) over the last 45 minutes of the dioxin test. Lab A and Lab B reported exhaust stack temperatures between 470 and 483 °C during their dioxin tests. The shutdown experienced prior to the end of the dioxin test carried out by Lab C could have allowed unburnt landfill gas, lubrication oil and thereby the associated potential catalysts (such as Cl and possibly transition metals) to pass directly into the cooling exhaust system being sampled. The Cl level within the engine oil (500 ppm, Table 3.1), although not at a precautionary level (for engine maintenance purposes), was

considerably higher as compared to the testing period for either Lab A and Lab B ( $\leq 100$ ppm, Table 3.1). Therefore, the higher dioxin and furan emission reported by Lab C, in this study and on another occasion for the same engine (determined from 4" BSP ports), may be as a consequence of non-normal operating conditions of the landfill gas utilisation plant, associated with potential for a period of higher Cl and particulate loading (i.e. *de novo* synthesis of dioxins and furans).

Three factors that may invalidate the comparatively high dioxin and furan emission results reported by independent laboratories include the following:

- The average quantity of particulates collected during the two 1 hour particulate tests for each laboratory varied between 1 and 5 mg (Table 4.2). Assuming that the measured concentration of dioxins and furans within the exhaust dust (0.248 ng-TEQ/g particulates) is representative of that sampled by Lab C, then to fully explain the comparatively high dioxin and furan result reported by Lab C compared to Lab A or Lab B would take at least 200 – 1000 times the quantity of particulates routinely collected. Such an amount does not seem practical.
- Differences in the congener breakdown (% TEQ) of the engine exhaust emission and dust (Figure 4.7) is indicative that 'inflight' formation of dioxin and furan congener types is different to that on the exhaust surface. Therefore, it is unlikely that the source of the discrepancy in dioxin and furan emission results between laboratories could be accounted for by the inadvertent sampling of exhaust adhered particulates, and that some other (unexplained) mechanism is important.
- The end-of-pipe sampling location associated with the high dioxin emission measurement reported by Lab C (4-7 December 2001) does not meet the isokinetic sampling requirements of ISO 9096:1992 British Standard BS 6069 (BSI, 1992), since the location of the sampling plane is not 5D from the exhaust exit to the atmosphere. This is a minimum requirement for the sampling of dioxins and furans to BS EN 1948-1 (BSI, 1997), neither does it meet the 2D criteria downstream of the exhaust exit in accordance to BS 3405:1983 (BSI, 1983) as fulfilled within this and previous emissions studies (Gillett et al, 2002). However, this does not necessarily suggest that the exhaust gas velocity distribution was not sufficiently homogeneous for the emissions test, and not fulfilling these criteria during an emissions test does not necessarily invalidate the emission result. However, BSI (1992) does state that: '*Under adverse gas flow and particulate stratification conditions this could lead to an unacceptable increase of inaccuracy in the results.*' Therefore it is not certain whether the end-of-pipe sampling location gives valid results or not.

In conclusion, based on the information available here, it is not clear whether the high dioxin and furan measurements reported are or are not representative of normal engine operation.

*this page intentionally left blank*

## 5 COMPARISON OF DIOXINS AND FURANS EMISSIONS AND CONGENER BREAKDOWN OBTAINED IN THIS AND OTHER STUDIES

This section includes dioxin and furan emissions data collected by all three laboratories across a range of landfill gas engines from a number of different sites, which includes the emissions data previously reported by Lab C for the same engine tested within this study.

### 5.1 Dioxins and furans emissions database

All of the dioxin and furan data collated as part of this and previous studies is summarised in Table 5.1, which includes engine exhaust, ambient air, exhaust dust and landfill gas samples. Engine exhaust emission results from 39 engines are included within this dioxin and furan database. The inter-quartile range of the exhaust emissions is 0.0012 – 0.0326 ng-TEQ/Nm<sup>3</sup> (dry gas, 5% O<sub>2</sub>), the emissions obtained by both Lab A and Lab B lie within this range. The dioxin and furan emissions reported by Lab C (0.6053 ng-TEQ/Nm<sup>3</sup>, dry gas, 5% O<sub>2</sub>) are well above the upper quartile level (Table 5.1).

A lognormal distribution for the exhaust emissions of dioxins and furans was found to be the best fitting distribution type using the Crystal Ball™ software package. The fitted distribution is presented in Figure 5.1, along with the actual observed data. The parameters of the fitted distribution for the exhaust emissions for a nominal 1MWe landfill gas engine are:

- mean = 0.2071 ng-TEQ/Nm<sup>3</sup>; and
- standard deviation = 6.5720 ng-TEQ/Nm<sup>3</sup>.

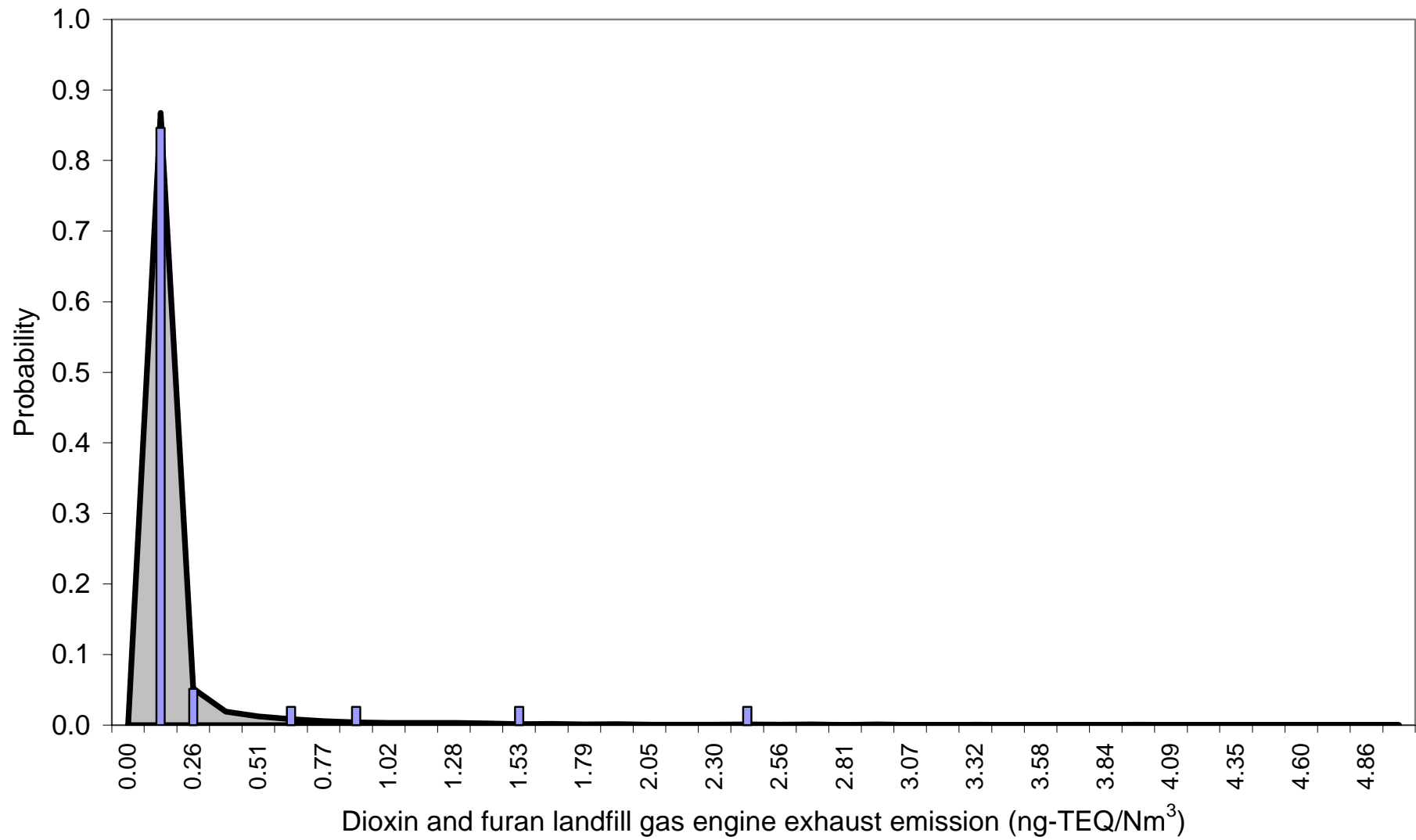
The estimated mean engine emission is 0.2354 ng-TEQ/Nm<sup>3</sup>, with a 95% probability that the engine emission is ≤ 0.5114 ng-TEQ/Nm<sup>3</sup>, a level comparable to that reported by Lab C. The distribution is clearly very positively skewed with a median emission of 0.0067 ng-TEQ/Nm<sup>3</sup>, a level comparable to those reported by Lab A and Lab B.

**Table 5.2 Summary of the dioxins and furans database and comparison with this study data**

Statistic	Exhaust emissions		Ambient Air		Exhaust Dust	Landfill Gas
	Database <sup>1</sup>	This study	Database <sup>1</sup>	This study	This study	This study
	ng-TEQ/Nm <sup>3</sup> (5% O <sub>2</sub> , dry gas)		ng-TEQ/Nm <sup>3</sup> (20.9% O <sub>2</sub> , dry gas)		ng-TEQ/kg	ng-TEQ/Nm <sup>3</sup> (1.82% moisture, <0.16% O <sub>2</sub> )
<b>N</b>	39	3	3	1	1	1
<b>Mean</b>	0.1509	0.2042	0.0010	0.0004	248	0.0032
<b>Median</b>	0.0042	0.0041	-	-	-	-
<b>Std Dev</b>	0.4498	0.3475	0.0008	-	-	-
<b>Min</b>	0.0001 <sup>2</sup>	0.003	0.0004	-	-	-
<b>25th percentile</b>	0.0012	-	-	-	-	-
<b>75th percentile</b>	0.0326	-	-	-	-	-
<b>Max</b>	2.3031	0.6054	0.0019	-	-	-

<sup>1</sup> The database includes the data collected as part of this study;

<sup>2</sup> Assumed LOD for two dioxin results that were reported as 0.0000 ng-TEQ/Nm<sup>3</sup> within the engine emissions report provided to the operator.



**Figure 5.1 Fitted and observed distribution of dioxin and furan exhaust emissions**

## 5.2 Dioxins and furans congener data

Congener breakdown (as % TEQ) data is presented which may help to explain some of the differences reported between the three laboratories.

Figure 5.2 presents the % TEQ congener breakdown for dioxin and furan engine exhaust emissions for the engine tested in this study. There appear to be differences in the congener breakdown between the three laboratories, with Lab A reporting a congener breakdown consistent with their previous tests on other landfill gas engines (Figure 5.3) and Lab C reporting a congener breakdown consistent with their previous tests on this engine (Figure 5.4). Engine tests Lab A (E1) (Figure 5.2) and Lab C (D) (Figure 5.4), were tests conducted on the same engine (separate to this study) within a week of each other, and highlight the difference in % TEQ congener breakdown generally found (i.e. that the lower chlorinated congeners dominate the %TEQ for Lab C more markedly as compared to Lab A and Lab B). However, for this separate site the overall exhaust emissions reported were of the same order of magnitude (0.0016 and 0.0073 ng-TEQ/Nm<sup>3</sup> for Lab A and Lab C, respectively), for emissions determined from 4" BSP ports.

The % TEQ congener breakdown for dioxin and furan engine exhaust emissions reported by Lab A in this and separate studies (Figure 5.3) indicates a generally consistent pattern.

Previous studies on separate engines by Lab B (Figure 5.4) would not appear to be consistent with the congener breakdown obtained within this study.

The % TEQ congener breakdown for dioxin and furan engine exhaust emissions reported by Lab C in this and separate studies (Figure 5.5) indicates a generally consistent pattern.

**Therefore, for the same engine studied by independent sampling/analytical laboratories there would appear to be differences in the reported congener breakdown (as %TEQ), whilst there is some internal consistency in the reported congener breakdown (as %TEQ) by each sampling/analytical laboratories across different engines (for Lab A and Lab C).**

Table 5.2 summarises the % TEQ congener breakdown for each laboratory, across all the engines they have tested and contained within the dioxin database (Section 5.1). The median and mean values of the % TEQ congener breakdown for the three main congeners reported by Lab A and Lab B are very similar (i.e. 2,3,7,8-TCDD, 1,2,3,7,8-PeCDD and 2,3,4,7,8-PeCDF with median values of 23-27%, 10-16% and 10-14%, respectively). All three of these congeners are mostly reported as being at the limit of detection (LOD) (Table 5.2), suggesting any differences between the congener breakdown reported by Lab A and Lab B (Figure 5.3 and 5.4) is probably as a consequence of differences in analytical laboratory quantification procedures and assignment of the LOD.

Lab C also report the two congeners of 1,2,3,7,8-PeCDD and 2,3,4,7,8-PeCDF as being consistently high across the different landfill gas engines they have tested with median values of 10 and 39%, respectively. In addition, Lab C report 2,3,7,8-TCDF as making a relatively significant contribution to the overall TEQ, with a median value of 9%. Therefore, the major difference between the Lab C and Lab A or Lab B congener breakdown is that the furan 2,3,4,7,8-PeCDF dominates the overall %TEQ across all of the landfill gas engines that Lab C have tested (Figure 5.5). Generally, in terms of % TEQ, the significant congeners reported by Lab C would appear to be above the LOD, although it was only possible to determine this to be the case for 9 of the 16 engines tested from the information provided to LQM.

Comparison of individual plant data by Cains and Dyke (1993) indicated that lower temperature conditions tended to favour the formation of lower chlorinated dioxins and furans congeners (i.e. the tetrachloro and pentachloro congeners). This effect would increase the overall TEQ value of the emission as these congeners are more toxic as compared to the higher chlorinated congeners (i.e. hexachloro, heptachloro and octachloro congeners). The lower than average exhaust stack temperatures reported by Lab C over a 45 minute period of their dioxin test within this study (432-452 °C) and the abnormal shutdown experienced just prior to the end of the test, is consistent with the above observation. Lab C report higher proportions of the tetrachloro- and pentachloro- furan congeners (17% and 49% TEQ, respectively) as compared to either Lab A or Lab B (< 2% and <4% TEQ, respectively) (Table 5.2).

Two clear findings come out of this analysis:

- There appears to be some internal consistency between the patterns of reported congener breakdown from individual laboratories on different gas engines. This internal consistency appears to dominate over the expected consistency in the congener pattern from a single site.
- Lab C data confirm the Cains and Dyke (1993) view that lower temperature conditions favour the formation of lower chlorinated dioxins and furans (tetrachloro and pentachloro congeners).

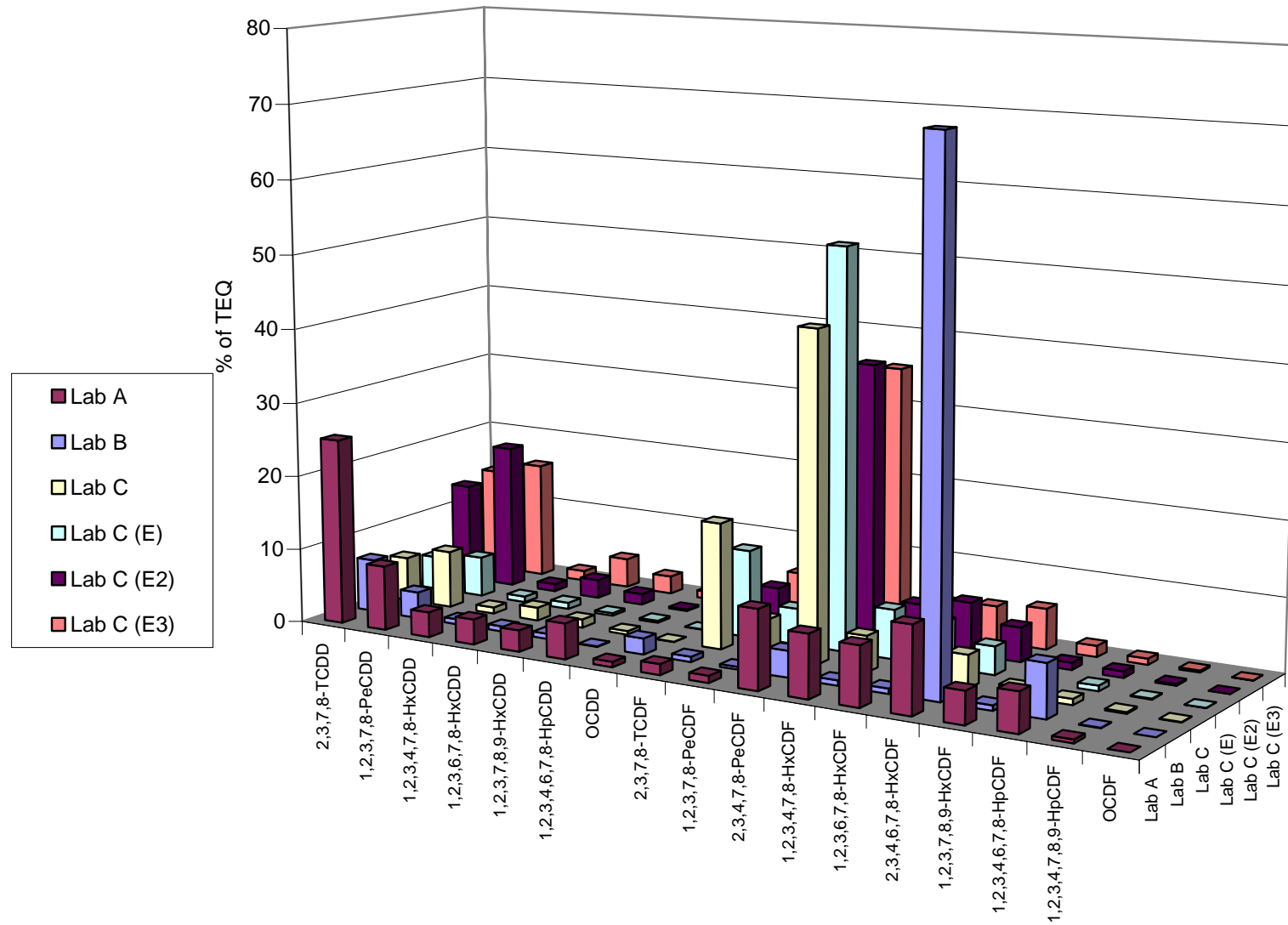


Figure 5.2 Congener breakdown (% TEQ) for each laboratory for engine exhaust emissions in this study

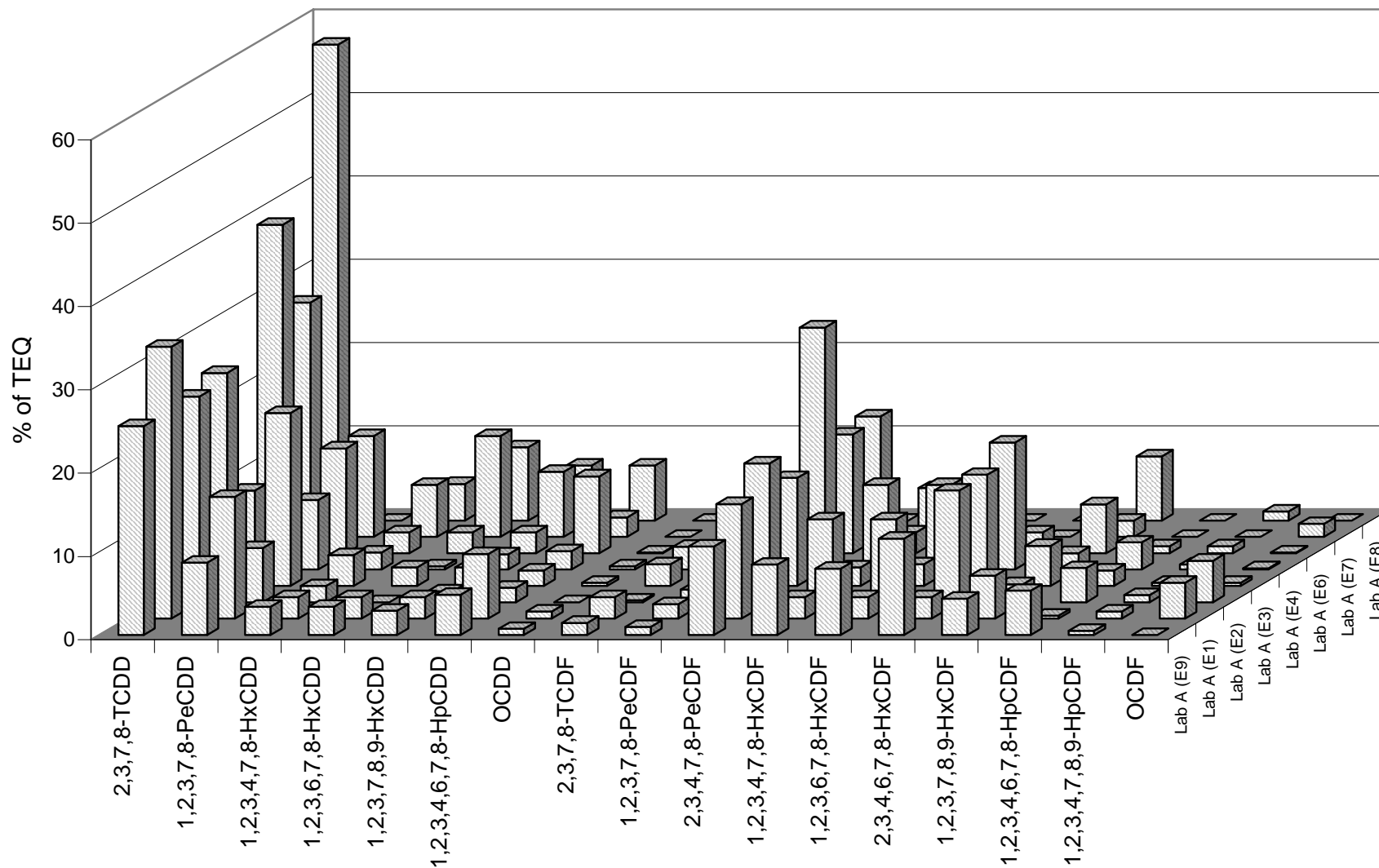


Figure 5.3 Congener breakdown (% TEQ) for Lab A for engine exhaust emissions in this (Lab A (E9)) and previous studies (n=7)

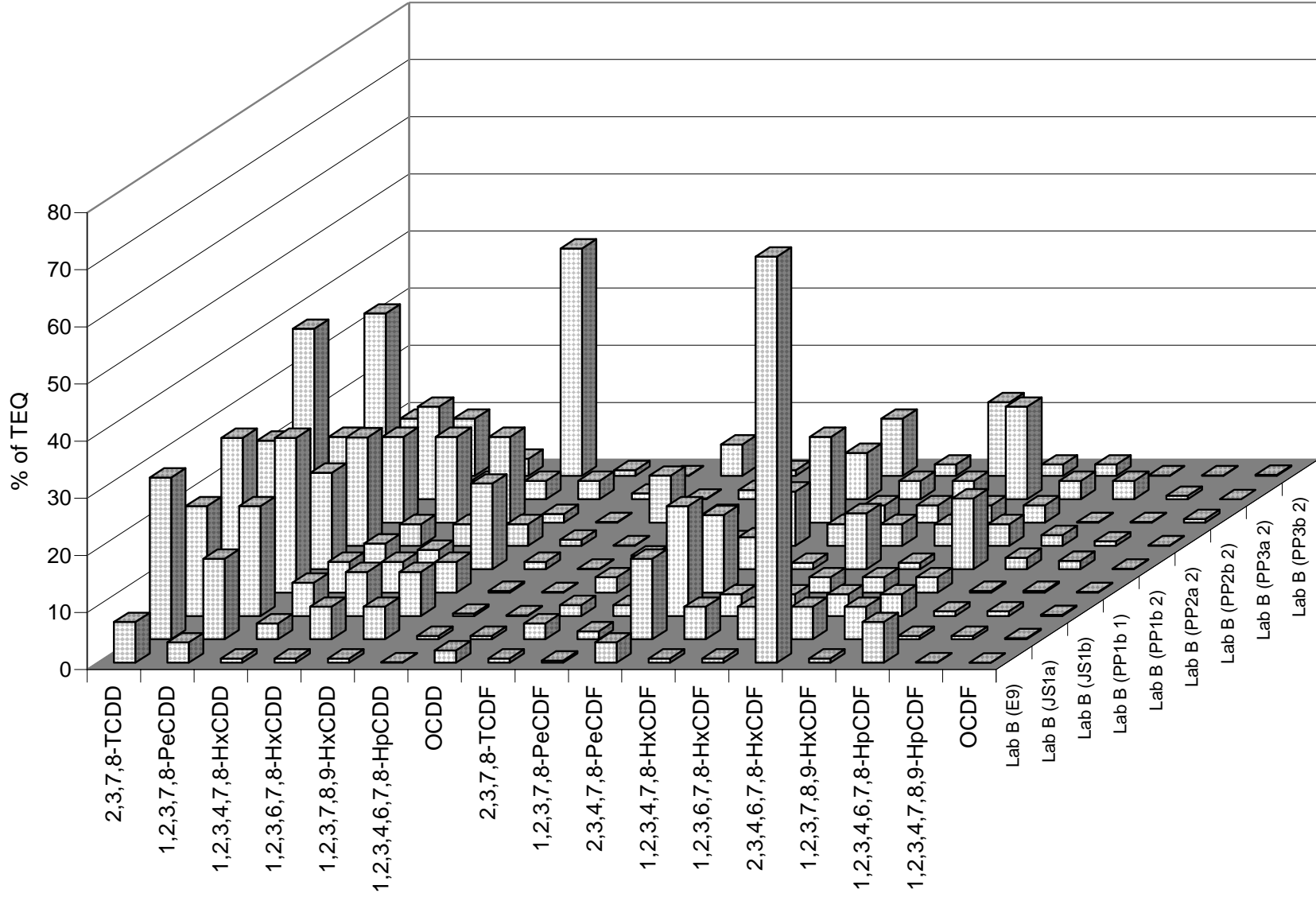


Figure 5.4 Congener breakdown (% TEQ) for Lab B for engine exhaust emissions in this (Lab B (E9)) and previous studies (n=8)

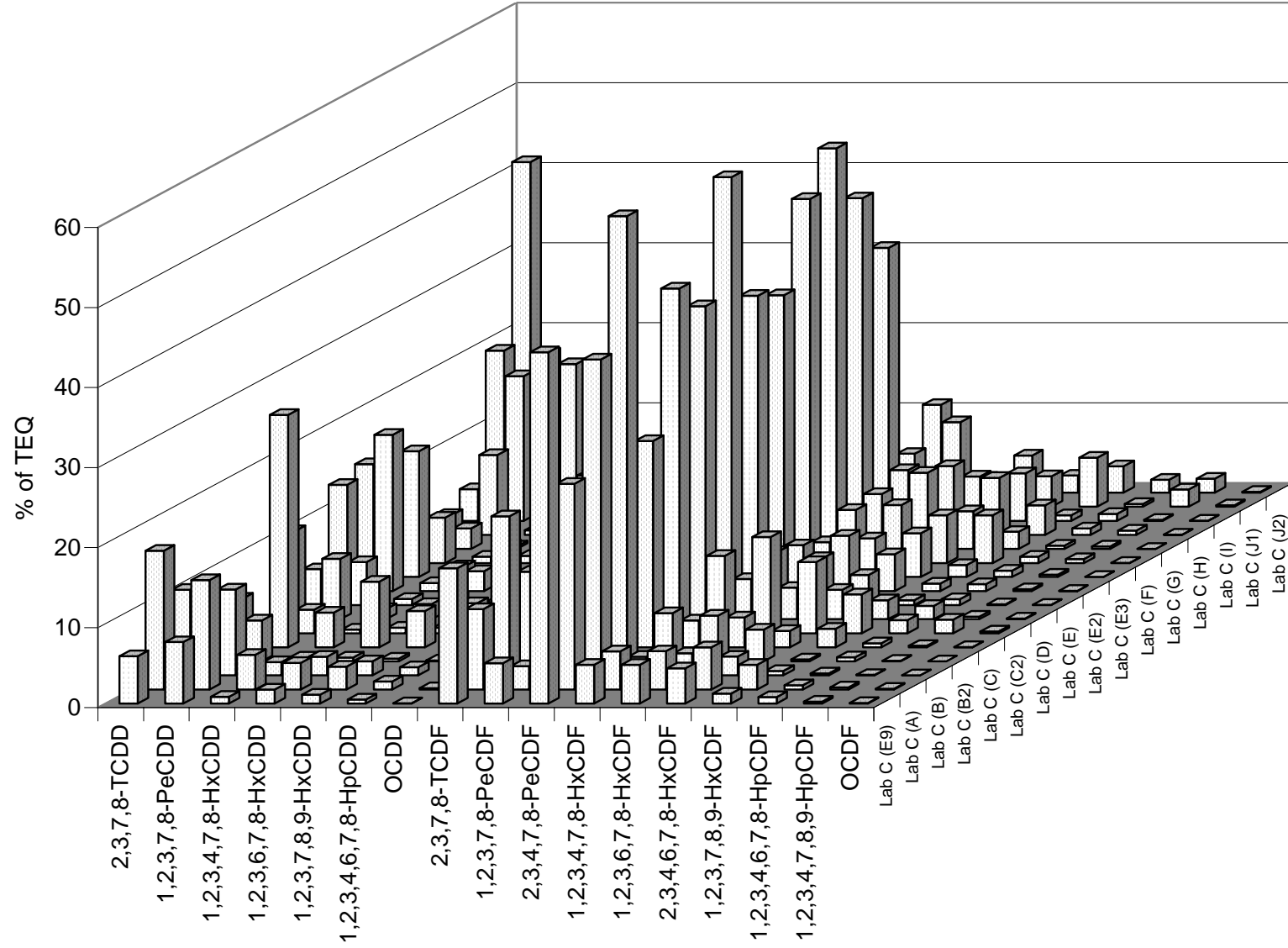


Figure 5.5 Congener breakdown (% TEQ) for Lab C for engine exhaust emissions in this (Lab C (E9)) and previous studies (n=15)

**Table 5.2 Summary statistics for the congener breakdown (% TEQ) for each laboratory**

Congener	Lab A							Lab B							Lab C <sup>1</sup>						
	N	Min	Max	Mean	Median	Skew	LOD	N	Min	Max	Mean	Median	Skew	LOD	N	Min	Max	Mean	Median	Skew	LOD
2,3,7,8-TCDD	8	9.5	57.1	30.3	26.8	0.8	6	9	7.1	38.0	22.2	22.5	0.0	9	16	1.0	41.3	10.2	6.0	2.2	3
1,2,3,7,8-PeCDD	8	0.0	20.7	10.4	10.4	0.0	7	9	3.6	27.1	15.7	16.2	-0.2	9	16	2.6	29.0	11.8	10.4	0.8	2
1,2,3,4,7,8-HxCDD	8	1.9	6.3	3.4	3.0	1.2	4	9	0.7	15.0	4.9	3.8	2.2	8	16	0.3	5.1	1.9	1.1	1.0	1
1,2,3,6,7,8-HxCDD	8	0.0	12.1	4.0	2.5	1.3	4	9	0.7	39.8	9.4	5.4	2.4	7	16	0.5	8.2	2.7	2.1	1.3	2
1,2,3,7,8,9-HxCDD	8	1.3	7.8	3.5	2.5	1.3	4	9	0.7	15.0	4.9	3.8	1.6	8	16	0.3	5.1	1.9	1.4	1.1	4
1,2,3,4,6,7,8-HpCDD	8	1.7	9.2	4.6	3.6	0.5	0	9	0.1	1.3	0.6	0.4	0.5	8	16	0.1	1.7	0.7	0.5	0.6	0
OCDD	8	0.0	0.9	0.3	0.2	0.7	3	9	0.1	8.2	1.9	0.1	1.7	7	16	0.0	0.3	0.1	0.1	1.8	0
2,3,7,8-TCDF	8	0.0	2.7	1.4	1.7	-0.3	5	9	0.7	2.8	1.8	1.9	-0.1	8	16	1.9	19.9	9.2	8.8	0.7	0
1,2,3,7,8-PeCDF	8	1.0	7.7	2.4	1.7	2.6	5	9	0.4	1.9	1.0	0.8	0.7	9	16	0.7	11.7	4.7	4.3	1.3	0
2,3,4,7,8-PeCDF	8	0.0	29.1	14.0	14.0	0.3	6	9	3.6	19.2	11.0	10.0	0.1	9	16	6.6	55.6	36.7	39.3	-0.9	1
1,2,3,4,7,8-HxCDF	8	0.0	10.2	5.2	4.2	0.2	4	9	0.7	5.7	2.9	3.0	0.3	9	16	1.8	10.6	5.7	5.4	0.5	0
1,2,3,6,7,8-HxCDF	8	0.0	10.2	5.0	3.4	0.4	4	9	0.7	12.9	5.1	3.8	1.3	7	16	2.8	12.0	5.9	5.2	1.1	1
2,3,4,6,7,8-HxCDF	8	0.0	15.3	7.3	7.1	0.0	4	9	1.1	71.1	12.2	3.8	2.8	8	16	2.0	8.9	4.6	4.5	0.6	0
1,2,3,7,8,9-HxCDF	8	2.0	7.7	4.2	4.6	0.3	8	9	0.7	12.4	4.1	3.2	2.1	8	16	0.2	6.1	2.5	2.2	0.8	3
1,2,3,4,6,7,8-HpCDF	8	0.0	5.3	2.0	1.3	0.6	4	9	0.1	7.1	1.8	0.8	1.9	7	16	0.2	1.7	0.8	0.8	1.0	1
1,2,3,4,7,8,9-HpCDF	8	0.0	1.1	0.6	0.7	-0.7	6	9	0.1	1.5	0.5	0.6	1.0	8	16	0.1	2.2	0.6	0.3	1.7	1
OCDF	8	0.0	5.0	1.4	0.3	1.2	2	9	0.0	0.6	0.2	0.1	2.0	9	16	0.0	0.2	0.1	0.0	1.7	0

Notes

LOD: number of tests for which the congener was quantified assigned as being at the limit of detection;

T: Tetrachloro; Pe: Pentachloro; Hx: Hexachloro; Hp: Heptachloro; O: Octachloro.

<sup>1</sup> for Lab C it was only possible to determine if congeners were above LOD for 9 of 16 tests from the information provided to LQM

## 6 CONCLUSIONS AND RECOMMENDATIONS

### 6.1 Conclusions

The following conclusions can be made for emissions monitoring at any site:

- Based on the results in this study the potential variation in the reported time averaged exhaust emissions, between individual laboratories, for the same landfill gas engine may be anticipated as follows:
  - **CO** up to 300 mg/Nm<sup>3</sup>;
  - **NO<sub>x</sub>** up to 80 mg/Nm<sup>3</sup>;
  - **THC** up 600 mg/Nm<sup>3</sup>;
  - **Dioxins and furans** up to 0.6 ng/Nm<sup>3</sup>;
  - **HCl** up to 14 mg/Nm<sup>3</sup>;
  - **HF** up to 2 mg/Nm<sup>3</sup>; and
  - **Particulates** up to 35 mg/Nm<sup>3</sup>.
- Based on results in this study the percentage difference between the reported time averaged exhaust emission by an individual laboratory and the mean value determined by a number of laboratories, for the same landfill gas engine, may be anticipated as follows:
  - **CO** up to ± 13% of the mean engine value;
  - **NO<sub>x</sub>** up to ± 8% of the mean engine value;
  - **THC** up to ± 32% of the mean engine value;
  - **Dioxins and furans** up to ± 197% of the mean engine value;
  - **HCl** up to ± 94% of the mean engine value;
  - **HF** up to ± 51% of the mean engine value; and
  - **Particulates** up to ± 141% of the mean engine value.
- The inter-laboratory variation (and/or temporal variation in exhaust emissions) observed within this study suggests that such variations, which are expected, may become a significant issue for the regulation of landfill gas engine emissions. For example, using the measurements made in this study some of the currently proposed emission limits for landfill gas engines commissioned after 1 November 2004 (Environment Agency, 2002), may or may not have been exceeded, dependent upon which laboratory had been chosen to test emissions. The uncertainty estimates given in the draft protocol (Environment Agency, 2002) consider uncertainty at the 95% confidence interval. The inter laboratory

variations observed in this study would indicate that the uncertainty estimates for bulk gas emissions are reasonable, but that uncertainty increases substantially for trace components.

- The large variation in reported dioxin and furan emissions (up to 150 – 200 times differences between laboratories) may have a very significant effect upon the assessment of these secondary monitoring parameters which are to be assessed on an individual site basis, based on a risk assessment and local environmental impact effects (Environment Agency, 2002). Previous work (e.g. Cains and Dyke, 1993) has suggested that the formation of the lower chlorinated congeners (i.e. tetrachloro and pentachloro congeners) are favoured by low temperature (within the 200 – 450 °C range) and poor combustion conditions. Such conditions were experienced during the dioxin monitoring program performed by Lab C, which report the relatively high dioxin emissions (dominated by the lower chlorinated tetra and pentachloro- furan congeners) for the engine in this study. Abnormal combustion conditions were also previously associated with a relatively high dioxin emission for the engine in this study.
- Routine analysis of the particulate sample collected during dioxin and furan testing of landfill gas engine emissions could provide a useful quality control check on the sampling and/or analytical techniques employed. However, a sufficient sample size should first be agreed with the analytical laboratory to ensure levels of detection are not compromised.
- Lab A's use of the microburner method for the determination of the halide concentrations (Cl and F) within the supply gas is considered to provide a more reliable method for determining the mass balances of the Cl and F than the methods used by Lab B or Lab C. Based on the results within this study, use of this technique could provide an estimate of the halide exhaust emissions to within a factor of about 2, whereas use of the halide inlet data reported by Lab B or Lab C would result in significant underestimates on the exhaust emissions.
- Inter laboratory variation in the methane concentration and volume flow rate of the supply gas reported can lead to large differences in the thermal efficiency of the engine being estimated, between 24 and 33%. The upper figure is more typical of the normal operating conditions of the type of engine tested within this study.
- Step changes in the emissions log of some of the bulk exhaust gases observed in this study have a large effect on the average reported engine emission for this site (e.g. THC, Lab C). No obvious explanation for such differences is presently available, either by consideration of the logged operational parameters of the engine management system or by consulting the monitoring laboratory. Such unexplained behaviour could potentially invalidate emissions measurements and require re-sampling.

The following conclusions can be made for emissions monitored at this specific site:

- The concentrations within the exhaust emissions and the pattern of congeners found within the engine exhaust are similar to those of the inlet air to the engine combustion chamber. This suggests that the dioxins emitted by the combustion plant are the main source of dioxins in the ambient air surrounding the plant.
- During normal periods of engine operation emissions of dioxins and furans determined via 4" BSP ports and reported by the three laboratories used within this study range from 0.003 – 0.036 ng-TEQ/Nm<sup>3</sup> for the same landfill gas engine. During periods associated with disruption to the normal operation of the engine (i.e. involving engine shutdown) the reported emissions range from 0.605 – 1.504 ng-TEQ/Nm<sup>3</sup>, whilst emissions from the end-of-pipe are reported to be 2.303 ng-TEQ/Nm<sup>3</sup>. These observations suggest that engine shutdowns could lead to conditions within the combustion zone and exhaust system associated with the *de novo* synthesis of dioxins and furans, with cooling of exhaust gases relatively slowly into the range 200 – 450 °C, with heterogeneous chemical reactions and flow at the end-of-pipe. This may explain some of the relatively high emissions that have been reported for the landfill gas engine in this study.
- Examination of the exhaust dust concentration for dioxins and furans indicated that for the dioxin and furan mass emission rates quantified by two of the laboratories (Lab A and Lab B) using exhaust flow rates and emissions could be attributable entirely to the particulate phase. However, Lab C data suggest various alternatives:
  - the gaseous phase may be an important source of dioxin and furan emissions;
  - disruptions to the normal operation of the engine may invalidate the emissions result;
  - analytical differences in the reporting of dioxins and furans in terms of the reporting of detection limits and discrimination of specific congeners.

A possible explanation for differences in the relative abundance of the light congeners (i.e. tetrachloro and pentachloro congeners) observed between Lab C and Lab A or B, may arise because these congeners are generally the most difficult to resolve and separate out within the chromatograph, and are most susceptible to noise interference effects (Ray James, personal communication).

- The reported concentration of dioxins and furans within the exhaust dust is not able to confirm that the source of the discrepancy in dioxin and furan emission results between the different laboratories could be accounted for by the inadvertent sampling of exhaust adhered particulates.

## 6.2 Recommendations

The following list of recommendations are made based on the findings of this study:

- The microburner technique used by Lab A in the determination of halide (and total sulphur) concentrations within the supply gas is preferred as a more reliable forecast of total Cl and F compared to the techniques employed by Lab B and Lab C. This appears to be influenced by the sampling method more than the analytical method.
- A concise log of any disruptions to the normal operation of the engine during any testing program should be provided by the monitoring laboratory, as well as the site/engine operator, and if this influences the analysis, then a repeat test should be performed. This should become a fundamental part of the '*Guidance for Monitoring Landfill Gas Engine Emissions*' (Environment Agency, 2002). Based on the observations made in this study this is not always current practice.
- A clear log of any variations in the stack conditions during testing should be clearly reported in order to inform the engine operator and Environment Agency of any possible changes of sampling conditions over the course of any emissions test. Plotting real time data collected during the monitoring period allows a ready visual inspection of the relative changes in measured parameters over the test period. Unexpected changes in either the operating conditions of the gas engine or the measured emissions values will be potentially identifiable by this inspection process. Explanations for these changes should be identified. Deviations from the expected performance should be noted and collected data removed from the calculation of the reported average emission over the monitoring period if the deviation is due to external influences not representative of the intended normal operating conditions of the test (e.g. inadvertent air ingress into the gas field, and resulting unplanned changes to engine operating settings).
- Continued collation of data such as that collected and reported in this study should be maintained in order to build up a more significant database on engine emissions than already exists. Combined with the detailed environmental monitoring site reports, such as those obtained within this study, will allow a greater understanding of the likely variations to be expected between different monitoring laboratories.
- Supervision (and in some cases independent supervision) of monitoring teams is likely to improve quality and subsequent usability of the data collected (akin to independent landfill CQA). Supervisors are more likely to be aware of site and other external factors (such as gas field or engine performance) and their likely effect upon emissions data.
- A gas balance between the supply gas and exhaust gas parameters should be performed because it adds quality and credibility to the emissions measurements.

### **6.3 Recommendations for future research**

The following recommendations for future research are made:

- Further research into the temporal response of monitoring equipment and emission test results in relation to changes in the engine operating parameters, engine maintenance cycle and variation within the supply gas is required. This should help to clarify some of the unexplained observations in this study (e.g. disparity in dioxin and furan emissions and step changes in the THC log) and provide a better understanding of the testing frequency required for this type of plant.
- Systems are currently available which claim to be capable of continuously sampling for dioxins and furans over periods of between 6 hours to 30 days. Such a system could help to clarify the likely variation of dioxin and furan emissions to be expected under different engine operating and/or gas supply conditions. This system could also be employed with other long-term exhaust gas monitoring equipment to consider possible synergistic effects.
- Additional analysis for some of the precursors associated with the formation of dioxins and furans (aromatics such as substituted benzenes and phenols, metal oxides such as copper oxides and particulates) may help to explain differences in emissions on a temporal and inter laboratory basis. This could also improve the understanding of the mechanisms important in the formation of dioxins and furans.

## 7 REFERENCES

- AEAT (1999). Compilation of EU Dioxin Exposure and Health Data, AEA Technology 1999.
- Cains, PW and Dyke, P. (1993). Chlorinated dibenzodioxins and dibenzofurans in waste combustion. Formation mechanisms and analysis of UK plant measurements. Energy Technology Support Unit Report ETSU-R-80. December 1993.
- Environment Agency (2001). National Compliance Assessment Service Client Board 7/6/01, Compliance Assessment Principles for IPC Releases. Environment Agency, Lancaster.
- Environment Agency (2002). *Guidance for Monitoring Landfill Gas Engine Emissions*. Draft for Consultation, November 2002.
- Gillett, AG, Gregory, RG, Blowes, JH and Hartnell G. (2002). Landfill Gas Engine Exhaust and Flare Emissions. Land Quality Management Ltd Final Report No. 158 to EB Nationwide, 2002. Available from: [www.r-p-a.org.uk](http://www.r-p-a.org.uk) and [www.lqm.co.uk](http://www.lqm.co.uk)
- Gregory, RG, Gillett, AG and Blowes, J.H. (2002). Development of a Sampling Protocol and Standards for UK landfill gas Generating Set Emissions. In Proceedings *Solid Waste Association of North America's 25<sup>th</sup> Annual Landfill Gas Symposium*, pp 177-192. Monterey, California, 25-28 March, 2002.
- Haigh, C, Cope, D and Deed, C. (2002). Development of monitoring protocol for stack emissions from landfill gas utilisation systems. In Conference Proceedings of Waste 2002: *Integrated Waste Management and Pollution Control: Research, Policy and Practice*, 375-385. Stratford-upon-Avon, Warwickshire, UK, 24-26 September 2002.
- USEPA (2000). Exposure and Human Health Reassessment of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin (TCDD) and Related Compounds. Volume 2: Sources of Dioxin-Like Compounds in the United States. Draft Final Report, USEPA, Washington, DC.

**ANNEX 1**  
**ENGINE LOG EXTRACTS**  
**(17/09/02 – 18/09/02)**

17/09/02 Engine Log Extract

```

*****
Unit No: 673 Unit Type: 16C35TN1 Log No: 12
*****
Time of Log          17/ 9 14:36:41 Jacket Water pressure (bar)      2.1
Time of Sync        5/ 9 19:36:25 Manifold Press / bar            1.7
Fuel / kW / kWhr    0      0      Oil Press / bar                 3.9
Elec / kW / kWhr    986  63882 After Cooler Water Pressure/bar  2.1
Throttle / *        49                               Gas pressure / (mbar)          187
Exh 1,2,3,4 / *C    589 602 589 589 Analog Calib                    99
Exh 5,6,7,8 / *C    582 582 595 582
Exh 9,10,11,12 / *C 589 582 595 595 Switches 0-15                   0000000000000000
Exh 13,14,15,16 / *C 595 595 589 589 Switches 16-23                  00000000
RH Turbo In, Out / *C      0 506 Engine Speed / rpm              1500
LH Turbo In, Out / *C      0 506 Mains Freq / Hz                 50.0
After Cooler Water In / *C  54 Power (R,Y,B) / kW             328.6 328.6 328.6
Jacket Water In, Out / *C 109 113 Power Calib                     102
Manifold Air Temp / *C     73 Power (R,Y,B) / kVA            330.5 326.6 339.1
Oil / *C                 104 Power Factors (R,Y,B)          0.99 1.00 0.97
Enclosure Ambient / *C     29 Volts (R,Y,B,Gen) / V          239 239 237 230
Gen Temps (R,Y,B) / *C    102 102 102 Current (R,Y,B) / A             1383 1367 1432
RMS Calib                                     100
    
```

```

Last Trip 131 Low exh 14
CPU Status 8 >>> CURRENT STATUS 255 Normal running <<<
Modulation: No modulation State 8 ON LOAD
    
```

```

Sw 0: Mains Under Freq      0 Sw 16: Deltec Tecjet Fail      0
Sw 1: Mains Over Freq      0 Sw 17: Oil Level/Flow         0
Sw 2: Mains Under Voltage  0 Sw 18: DV Regulator Fault     0
Sw 3: Mains Over Voltage   0 Sw 19: EISM Shutdown          0
Sw 4: Fire / Gas Alarm     0 Sw 20: Contactor Sense        0
Sw 5: Low Oil Pressure     0 Sw 21: Pastor trip            0
Sw 6: External On/Off     0 Sw 22: Exhaust Back Pressure  0
Sw 7: Emergency Stop       0 Sw 23: Trip Sense             0
Sw 8: Engine Thermostat   0
Sw 9: Governor Stop       0
Sw 10: Gas Pressure        0
Sw 11: Phase Rotation      0
Sw 12: Motor Overload      0
Sw 13: Motor Overload Warning 0
Sw 14: PLC General Trip    0
Sw 15: Single Phase Failure 0
    
```

```

*****
Unit No: 673 Unit Type: 16C35TN1 Log No: 13
*****
Time of Log          17/ 9 15:14:17 Jacket Water pressure (bar)      2.1
Time of Sync        5/ 9 19:36:25 Manifold Press / bar            1.2
Fuel / kW / kWhr    0      0      Oil Press / bar                 4.0
Elec / kW / kWhr    516  64502 After Cooler Water Pressure/bar  2.0
Throttle / *        59                               Gas pressure / (mbar)          206
Exh 1,2,3,4 / *C    525 570 557 570 Analog Calib                    99
Exh 5,6,7,8 / *C    544 557 570 544
    
```

Exh 9,10,11,12 / *C	512 544 525 570	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	570 563 474 538	Switches 16-23	00000100
RH Turbo In, Out / *C	0 474	Engine Speed / rpm	1500
LH Turbo In, Out / *C	0 493	Mains Freq / Hz	50.0
After Cooler Water In / *C	54	Power (R,Y,B) / kW	164.3 187.8 164.3
Jacket Water In, Out / *C	108 112	Power Calib	101
Manifold Air Temp / *C	71	Power (R,Y,B) / kVA	186.6 175.0 114.5
Oil / *C	103	Power Factors (R,Y,B)	0.88 1.00 1.00
Enclosure Ambient / *C	28	Volts (R,Y,B,Gen) / V	239 239 235 228
Gen Temps (R,Y,B) / *C	102 102 102	Current (R,Y,B) / A	781 732 488
		RMS Calib	100

Last Trip 90 Pastor Trip  
 CPU Status 8 >>> CURRENT STATUS 90 Pastor Trip <<<  
 Modulation: No modulation State 8 ON LOAD

Sw 0: Mains Under Freq	0	Sw 16: Deltec Tecjet Fail	0
Sw 1: Mains Over Freq	0	Sw 17: Oil Level/Flow	0
Sw 2: Mains Under Voltage	0	Sw 18: DV Regulator Fault	0
Sw 3: Mains Over Voltage	0	Sw 19: EISM Shutdown	0
Sw 4: Fire / Gas Alarm	0	Sw 20: Contactor Sense	0
Sw 5: Low Oil Pressure	0	Sw 21: Pastor trip	1
Sw 6: External On/Off	0	Sw 22: Exhaust Back Pressure	0
Sw 7: Emergency Stop	0	Sw 23: Trip Sense	0
Sw 8: Engine Thermostat	0		
Sw 9: Governor Stop	0		
Sw 10: Gas Pressure	0		
Sw 11: Phase Rotation	0		
Sw 12: Motor Overload	0		
Sw 13: Motor Overload Warning	0		
Sw 14: PLC General Trip	0		
Sw 15: Single Phase Failure	0		

\*\*\*\*\*  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 14  
 \*\*\*\*\*  
 Time of Log 17/ 9 15:19:44 Jacket Water pressure (bar) 0.7  
 Time of Sync 0/ 0 0: 0: 0 Manifold Press / bar -0.2  
 Fuel / kW / kWhr 0 0 Oil Press / bar -0.1  
 Elec / kW / kWhr 12 0 After Cooler Water Pressure/bar 0.7  
 Throttle / \* 57 Gas pressure / (mbar) 9  
 Exh 1,2,3,4 / \*C 211 211 218 224 Analog Calib 100  
 Exh 5,6,7,8 / \*C 211 211 230 218  
 Exh 9,10,11,12 / \*C 237 218 224 218 Switches 0-15 0000000000000000  
 Exh 13,14,15,16 / \*C 205 218 205 211 Switches 16-23 00001010  
 RH Turbo In, Out / \*C 0 179 Engine Speed / rpm 0  
 LH Turbo In, Out / \*C 0 179 Mains Freq / Hz 50.0  
 After Cooler Water In / \*C 54 Power (R,Y,B) / kW 0.0 11.7 0.0  
 Jacket Water In, Out / \*C 62 109 Power Calib 101  
 Manifold Air Temp / \*C 86 Power (R,Y,B) / kVA 0.0 0.0 0.0  
 Oil / \*C 100 Power Factors (R,Y,B) 0.00 0.00 0.00  
 Enclosure Ambient / \*C 30 Volts (R,Y,B,Gen) / V 235 235 232 0  
 Gen Temps (R,Y,B) / \*C 93 93 94 Current (R,Y,B) / A 0 0 0  
 RMS Calib 100

Last Trip 90 Pastor Trip
CPU Status 8 >>> CURRENT STATUS 255 Normal running <<<
Modulation: Unit is tripped State 1 TRIPPED

Sw 0: Mains Under Freq 0 Sw 16: Deltec Tecjet Fail 0
Sw 1: Mains Over Freq 0 Sw 17: Oil Level/Flow 0
Sw 2: Mains Under Voltage 0 Sw 18: DV Regulator Fault 0
Sw 3: Mains Over Voltage 0 Sw 19: EISM Shutdown 0
Sw 4: Fire / Gas Alarm 0 Sw 20: Contactor Sense 1
Sw 5: Low Oil Pressure 0 Sw 21: Pastor trip 0
Sw 6: External On/Off 0 Sw 22: Exhaust Back Pressure 1
Sw 7: Emergency Stop 0 Sw 23: Trip Sense 0
Sw 8: Engine Thermostat 0
Sw 9: Governor Stop 0
Sw 10: Gas Pressure 0
Sw 11: Phase Rotation 0
Sw 12: Motor Overload 0
Sw 13: Motor Overload Warning 0
Sw 14: PLC General Trip 0
Sw 15: Single Phase Failure 0

\*\*\*\*\*
Unit No: 673 Unit Type: 16C35TN1 Log No: 15
\*\*\*\*\*

Time of Log 17/ 9 15:21:16 Jacket Water pressure (bar) 1.2
Time of Sync 0/ 0 0: 0: 0 Manifold Press / bar 0.0
Fuel / kW / kWhr 0 0 Oil Press / bar 4.1
Elec / kW / kWhr 0 0 After Cooler Water Pressure/bar 1.5
Throttle / \* 13 Gas pressure / (mbar) 215
Exh 1,2,3,4 / \*C 205 230 224 224 Analog Calib 99
Exh 5,6,7,8 / \*C 224 224 243 230
Exh 9,10,11,12 / \*C 237 230 224 218 Switches 0-15 0000000000000000
Exh 13,14,15,16 / \*C 211 224 198 211 Switches 16-23 00001010
RH Turbo In, Out / \*C 0 243 Engine Speed / rpm 1277
LH Turbo In, Out / \*C 0 237 Mains Freq / Hz 50.0
After Cooler Water In / \*C 52 Power (R,Y,B) / kW 0.0 0.0 0.0
Jacket Water In, Out / \*C 91 103 Power Calib 101
Manifold Air Temp / \*C 82 Power (R,Y,B) / kVA 0.0 0.0 0.0
Oil / \*C 99 Power Factors (R,Y,B) 0.00 0.00 0.00
Enclosure Ambient / \*C 29 Volts (R,Y,B,Gen) / V 235 235 232 180
Gen Temps (R,Y,B) / \*C 91 91 92 Current (R,Y,B) / A 0 0 0
RMS Calib 100

Last Trip 90 Pastor Trip
CPU Status 8 >>> CURRENT STATUS 255 Normal running <<<
Modulation: Synchronising State 6 SYNC'ING

Sw 0: Mains Under Freq 0 Sw 16: Deltec Tecjet Fail 0
Sw 1: Mains Over Freq 0 Sw 17: Oil Level/Flow 0
Sw 2: Mains Under Voltage 0 Sw 18: DV Regulator Fault 0
Sw 3: Mains Over Voltage 0 Sw 19: EISM Shutdown 0
Sw 4: Fire / Gas Alarm 0 Sw 20: Contactor Sense 1
Sw 5: Low Oil Pressure 0 Sw 21: Pastor trip 0
Sw 6: External On/Off 0 Sw 22: Exhaust Back Pressure 1

Sw 7: Emergency Stop	0	Sw 23: Trip Sense	0
Sw 8: Engine Thermostat	0		
Sw 9: Governor Stop	0		
Sw 10: Gas Pressure	0		
Sw 11: Phase Rotation	0		
Sw 12: Motor Overload	0		
Sw 13: Motor Overload Warning	0		
Sw 14: PLC General Trip	0		
Sw 15: Single Phase Failure	0		

```

*****
Unit No: 673 Unit Type: 16C35TN1 Log No: 16
*****
Time of Log          17/ 9 15:26:38 Jacket Water pressure (bar)      1.8
Time of Sync        0/ 0 0: 0: 0 Manifold Press / bar           -1.0
Fuel / kW / kWhr    0      0 Oil Press / bar                 4.4
Elec / kW / kWhr    0      0 After Cooler Water Pressure/bar  1.9
Throttle / *                14 Gas pressure / (mbar)           234
Exh 1,2,3,4 / *C      525 538 538 531 Analog Calib                     99
Exh 5,6,7,8 / *C      506 506 518 506
Exh 9,10,11,12 / *C   525 512 525 538 Switches 0-15                   0000000000000000
Exh 13,14,15,16 / *C  518 518 518 518 Switches 16-23                  00001010
RH Turbo In, Out / *C                0 448 Engine Speed / rpm              1508
LH Turbo In, Out / *C                0 448 Mains Freq / Hz                 50.0
After Cooler Water In / *C            55 Power (R,Y,B) / kW              0.0 0.0 0.0
Jacket Water In, Out / *C           108 109 Power Calib                      101
Manifold Air Temp / *C              76 Power (R,Y,B) / kVA             0.0 0.0 0.0

Oil / *C                                98 Power Factors (R,Y,B)          0.00 0.00 0.00
Enclosure Ambient / *C              26 Volts (R,Y,B,Gen) / V          235 235 232 235
Gen Temps (R,Y,B) / *C             83 82 84 Current (R,Y,B) / A              0 0 0
RMS Calib                                100
    
```

```

Last Trip 245 Sync too long
CPU Status 8 >>> CURRENT STATUS 245 Sync too long <<<
Modulation: Synchronising State 6 SYNC'ING
    
```

Sw 0: Mains Under Freq	0	Sw 16: Deltec Tecjet Fail	0
Sw 1: Mains Over Freq	0	Sw 17: Oil Level/Flow	0
Sw 2: Mains Under Voltage	0	Sw 18: DV Regulator Fault	0
Sw 3: Mains Over Voltage	0	Sw 19: EISM Shutdown	0
Sw 4: Fire / Gas Alarm	0	Sw 20: Contactor Sense	1
Sw 5: Low Oil Pressure	0	Sw 21: Pastor trip	0
Sw 6: External On/Off	0	Sw 22: Exhaust Back Pressure	1
Sw 7: Emergency Stop	0	Sw 23: Trip Sense	0
Sw 8: Engine Thermostat	0		
Sw 9: Governor Stop	0		
Sw 10: Gas Pressure	0		
Sw 11: Phase Rotation	0		
Sw 12: Motor Overload	0		
Sw 13: Motor Overload Warning	0		
Sw 14: PLC General Trip	0		
Sw 15: Single Phase Failure	0		

```

*****
Unit No: 673 Unit Type: 16C35TN1 Log No: 17
*****
Time of Log          17/ 9 15:26:50 Jacket Water pressure (bar)          0.7
Time of Sync         0/ 0  0: 0: 0  Manifold Press / bar              -0.1
Fuel / kW / kWhr     0      0      Oil Press / bar                    2.1
Elec / kW / kWhr     0      0      After Cooler Water Pressure/bar    0.9
Throttle / *        14      Gas pressure / (mbar)              -9
Exh 1,2,3,4 / *C    435 467 480 474 Analog Calib                       99
Exh 5,6,7,8 / *C    429 448 474 474
Exh 9,10,11,12 / *C 474 454 474 480 Switches 0-15                      0000000000000000
Exh 13,14,15,16 / *C 467 461 461 442 Switches 16-23                     00001010
RH Turbo In, Out / *C          0 410 Engine Speed / rpm                 471
LH Turbo In, Out / *C          0 422 Mains Freq / Hz                    50.0
After Cooler Water In / *C      55 Power (R,Y,B) / kW                 0.0  0.0  0.0
Jacket Water In, Out / *C     109 109 Power Calib                         101
Manifold Air Temp / *C        76 Power (R,Y,B) / kVA                0.0  0.0  0.0
Oil / *C                   98 Power Factors (R,Y,B)              0.00 0.00 0.00
Enclosure Ambient / *C        26 Volts (R,Y,B,Gen) / V             235 235 232  24
Gen Temps (R,Y,B) / *C       83  82  84 Current (R,Y,B) / A                0  0  0
RMS Calib                                                         100
    
```

```

Last Trip 245 Sync too long
CPU Status 8 >>> CURRENT STATUS 255 Normal running <<<
Modulation: Unit is tripped State 1 TRIPPED
    
```

```

Sw 0: Mains Under Freq          0 Sw 16: Deltec Tecjet Fail          0
Sw 1: Mains Over Freq           0 Sw 17: Oil Level/Flow              0
Sw 2: Mains Under Voltage       0 Sw 18: DV Regulator Fault          0
Sw 3: Mains Over Voltage        0 Sw 19: EISM Shutdown               0
Sw 4: Fire / Gas Alarm           0 Sw 20: Contactor Sense             1
Sw 5: Low Oil Pressure           0 Sw 21: Pastor trip                 0
Sw 6: External On/Off           0 Sw 22: Exhaust Back Pressure       1
Sw 7: Emergency Stop            0 Sw 23: Trip Sense                  0
Sw 8: Engine Thermostat         0
Sw 9: Governor Stop             0
Sw 10: Gas Pressure              0
Sw 11: Phase Rotation            0
Sw 12: Motor Overload            0
Sw 13: Motor Overload Warning    0
Sw 14: PLC General Trip          0
Sw 15: Single Phase Failure      0
    
```

```

*****
Unit No: 673 Unit Type: 16C35TN1 Log No: 18
*****
Time of Log          17/ 9 15:27: 2 Jacket Water pressure (bar)          0.7
Time of Sync         0/ 0  0: 0: 0  Manifold Press / bar              -0.2
Fuel / kW / kWhr     0      0      Oil Press / bar                    -0.0
Elec / kW / kWhr     0      0      After Cooler Water Pressure/bar    0.7
Throttle / *        14      Gas pressure / (mbar)              0
Exh 1,2,3,4 / *C    352 365 378 371 Analog Calib                       99
Exh 5,6,7,8 / *C    346 358 378 365
Exh 9,10,11,12 / *C 384 365 371 390 Switches 0-15                      0000000000000000
Exh 13,14,15,16 / *C 371 371 371 346 Switches 16-23                     00001010
    
```

RH Turbo In, Out / *C	0 352	Engine Speed / rpm	0
LH Turbo In, Out / *C	0 371	Mains Freq / Hz	49.9
After Cooler Water In / *C	54	Power (R,Y,B) / kW	0.0 0.0 0.0
Jacket Water In, Out / *C	110 109	Power Calib	101
Manifold Air Temp / *C	76	Power (R,Y,B) / kVA	0.0 0.0 0.0
Oil / *C	98	Power Factors (R,Y,B)	0.00 0.00 0.00
Enclosure Ambient / *C	26	Volts (R,Y,B,Gen) / V	235 235 232 0
Gen Temps (R,Y,B) / *C	83 82 83	Current (R,Y,B) / A	0 0 0
		RMS Calib	100

Last Trip 59 Low A'Cool Press  
 CPU Status 8 >>> CURRENT STATUS 59 Low A'Cool Press <<<  
 Modulation: Starting State 3 PRE-STARTUP

Sw 0: Mains Under Freq	0	Sw 16: Deltec Tecjet Fail	0
Sw 1: Mains Over Freq	0	Sw 17: Oil Level/Flow	0
Sw 2: Mains Under Voltage	0	Sw 18: DV Regulator Fault	0
Sw 3: Mains Over Voltage	0	Sw 19: EISM Shutdown	0
Sw 4: Fire / Gas Alarm	0	Sw 20: Contactor Sense	1
Sw 5: Low Oil Pressure	0	Sw 21: Pastor trip	0
Sw 6: External On/Off	0	Sw 22: Exhaust Back Pressure	1
Sw 7: Emergency Stop	0	Sw 23: Trip Sense	0
Sw 8: Engine Thermostat	0		
Sw 9: Governor Stop	0		
Sw 10: Gas Pressure	0		
Sw 11: Phase Rotation	0		
Sw 12: Motor Overload	0		
Sw 13: Motor Overload Warning	0		
Sw 14: PLC General Trip	0		
Sw 15: Single Phase Failure	0		

\*\*\*\*\*  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 19

\*\*\*\*\*

Time of Log	17/ 9 15:59:13	Jacket Water pressure (bar)	0.9
Time of Sync	0/ 0 0: 0: 0	Manifold Press / bar	-0.1
Fuel / kW / kWhr	0 0	Oil Press / bar	-0.0
Elec / kW / kWhr	0 0	After Cooler Water Pressure/bar	1.0
Throttle / *	4	Gas pressure / (mbar)	0
Exh 1,2,3,4 / *C	115 109 128 128	Analog Calib	99
Exh 5,6,7,8 / *C	122 122 128 122		
Exh 9,10,11,12 / *C	128 122 122 122	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	102 115 102 109	Switches 16-23	00001000
RH Turbo In, Out / *C	0 102	Engine Speed / rpm	0
LH Turbo In, Out / *C	0 102	Mains Freq / Hz	50.0
After Cooler Water In / *C	50	Power (R,Y,B) / kW	0.0 0.0 0.0
Jacket Water In, Out / *C	42 66	Power Calib	101
Manifold Air Temp / *C	95	Power (R,Y,B) / kVA	0.0 0.0 0.0
Oil / *C	80	Power Factors (R,Y,B)	0.00 0.00 0.00
Enclosure Ambient / *C	33	Volts (R,Y,B,Gen) / V	232 232 230 0
Gen Temps (R,Y,B) / *C	78 77 78	Current (R,Y,B) / A	0 0 0
		RMS Calib	100

Last Trip 59 Low A'Cool Press

CPU Status 8 >>> CURRENT STATUS 255 Normal running <<<
Modulation: Unit is tripped State 1 TRIPPED

Sw 0: Mains Under Freq 0 Sw 16: Deltec Tecjet Fail 0
Sw 1: Mains Over Freq 0 Sw 17: Oil Level/Flow 0
Sw 2: Mains Under Voltage 0 Sw 18: DV Regulator Fault 0
Sw 3: Mains Over Voltage 0 Sw 19: EISM Shutdown 0
Sw 4: Fire / Gas Alarm 0 Sw 20: Contactor Sense 1
Sw 5: Low Oil Pressure 0 Sw 21: Pastor trip 0
Sw 6: External On/Off 0 Sw 22: Exhaust Back Pressure 0
Sw 7: Emergency Stop 0 Sw 23: Trip Sense 0
Sw 8: Engine Thermostat 0
Sw 9: Governor Stop 0
Sw 10: Gas Pressure 0
Sw 11: Phase Rotation 0
Sw 12: Motor Overload 0
Sw 13: Motor Overload Warning 0
Sw 14: PLC General Trip 0
Sw 15: Single Phase Failure 0

\*\*\*\*\*
Unit No: 673 Unit Type: 16C35TN1 Log No: 20
\*\*\*\*\*

Time of Log 17/ 9 16: 0:46 Jacket Water pressure (bar) 1.8
Time of Sync 0/ 0 0: 0: 0 Manifold Press / bar -0.0
Fuel / kW / kWhr 0 0 Oil Press / bar 4.5
Elec / kW / kWhr 0 0 After Cooler Water Pressure/bar 1.8
Throttle / \* 14 Gas pressure / (mbar) 215
Exh 1,2,3,4 / \*C 154 166 173 166 Analog Calib 99
Exh 5,6,7,8 / \*C 160 166 173 154
Exh 9,10,11,12 / \*C 166 154 154 147 Switches 0-15 0000000000000000
Exh 13,14,15,16 / \*C 141 154 128 154 Switches 16-23 00001010
RH Turbo In, Out / \*C 0 154 Engine Speed / rpm 1230
LH Turbo In, Out / \*C 0 147 Mains Freq / Hz 50.0
After Cooler Water In / \*C 54 Power (R,Y,B) / kW 0.0 0.0 0.0
Jacket Water In, Out / \*C 87 67 Power Calib 101
Manifold Air Temp / \*C 88 Power (R,Y,B) / kVA 0.0 0.0 0.0
Oil / \*C 90 Power Factors (R,Y,B) 0.00 0.00 0.00
Enclosure Ambient / \*C 30 Volts (R,Y,B,Gen) / V 232 232 230 208
Gen Temps (R,Y,B) / \*C 77 77 78 Current (R,Y,B) / A 0 0 0
RMS Calib 100

Last Trip 59 Low A'Cool Press
CPU Status 8 >>> CURRENT STATUS 255 Normal running <<<
Modulation: Synchronising State 6 SYNC'ING

Sw 0: Mains Under Freq 0 Sw 16: Deltec Tecjet Fail 0
Sw 1: Mains Over Freq 0 Sw 17: Oil Level/Flow 0
Sw 2: Mains Under Voltage 0 Sw 18: DV Regulator Fault 0
Sw 3: Mains Over Voltage 0 Sw 19: EISM Shutdown 0
Sw 4: Fire / Gas Alarm 0 Sw 20: Contactor Sense 1
Sw 5: Low Oil Pressure 0 Sw 21: Pastor trip 0
Sw 6: External On/Off 0 Sw 22: Exhaust Back Pressure 1

Sw 7: Emergency Stop	0	Sw 23: Trip Sense	0
Sw 8: Engine Thermostat	0		
Sw 9: Governor Stop	0		
Sw 10: Gas Pressure	0		
Sw 11: Phase Rotation	0		
Sw 12: Motor Overload	0		
Sw 13: Motor Overload Warning	0		
Sw 14: PLC General Trip	0		
Sw 15: Single Phase Failure	0		

```

*****
Unit No: 673 Unit Type: 16C35TN1 Log No: 21
*****
Time of Log          17/ 9 16: 7: 2 Jacket Water pressure (bar)      2.2
Time of Sync        17/ 9 16: 6: 2 Manifold Press / bar           0.4
Fuel / kW / kWhr    0      0 Oil Press / bar                 4.3
Elec / kW / kWhr    540    3 After Cooler Water Pressure/bar  2.2
Throttle / *                37 Gas pressure / (mbar)          206
Exh 1,2,3,4 / *C      525 544 531 531 Analog Calib                    99
Exh 5,6,7,8 / *C      518 518 531 518
Exh 9,10,11,12 / *C  531 518 531 531 Switches 0-15                   0000000000000000
Exh 13,14,15,16 / *C 525 525 525 525 Switches 16-23                  00000000
RH Turbo In, Out / *C          0 442 Engine Speed / rpm              1500
LH Turbo In, Out / *C          0 461 Mains Freq / Hz                 50.0
After Cooler Water In / *C      55 Power (R,Y,B) / kW              176.1 176.1 187.8
Jacket Water In, Out / *C     105 112 Power Calib                      101
Manifold Air Temp / *C         70 Power (R,Y,B) / kVA             183.3 187.1 189.1
Oil / *C                       100 Power Factors (R,Y,B)           0.96 0.94 0.99
Enclosure Ambient / *C         26 Volts (R,Y,B,Gen) / V           235 235 232 226
Gen Temps (R,Y,B) / *C       72  71  72 Current (R,Y,B) / A              781  798  814
RMS Calib                                  100

```

```

Last Trip 59 Low A'Cool Press
CPU Status 8 >>> CURRENT STATUS 255 Normal running <<<
Modulation: No modulation State 8 ON LOAD

```

Sw 0: Mains Under Freq	0	Sw 16: Deltec Tecjet Fail	0
Sw 1: Mains Over Freq	0	Sw 17: Oil Level/Flow	0
Sw 2: Mains Under Voltage	0	Sw 18: DV Regulator Fault	0
Sw 3: Mains Over Voltage	0	Sw 19: EISM Shutdown	0
Sw 4: Fire / Gas Alarm	0	Sw 20: Contactor Sense	0
Sw 5: Low Oil Pressure	0	Sw 21: Pastor trip	0
Sw 6: External On/Off	0	Sw 22: Exhaust Back Pressure	0
Sw 7: Emergency Stop	0	Sw 23: Trip Sense	0
Sw 8: Engine Thermostat	0		
Sw 9: Governor Stop	0		
Sw 10: Gas Pressure	0		
Sw 11: Phase Rotation	0		
Sw 12: Motor Overload	0		
Sw 13: Motor Overload Warning	0		
Sw 14: PLC General Trip	0		
Sw 15: Single Phase Failure	0		

Unit No: 673 Unit Type: 16C35TN1 Log No: 22

\*\*\*\*\*
Time of Log 17/ 9 17: 7: 1 Jacket Water pressure (bar) 2.3
Time of Sync 17/ 9 16: 6: 2 Manifold Press / bar 1.7
Fuel / kW / kWhr 0 0 Oil Press / bar 3.9
Elec / kW / kWhr 1021 1002 After Cooler Water Pressure/bar 2.4
Throttle / \* 48 Gas pressure / (mbar) 187
Exh 1,2,3,4 / \*C 589 602 589 589 Analog Calib 99
Exh 5,6,7,8 / \*C 582 582 595 582
Exh 9,10,11,12 / \*C 589 582 595 602 Switches 0-15 0000000000000000
Exh 13,14,15,16 / \*C 595 595 589 589 Switches 16-23 00000000
RH Turbo In, Out / \*C 0 506 Engine Speed / rpm 1500
LH Turbo In, Out / \*C 0 506 Mains Freq / Hz 50.0
After Cooler Water In / \*C 54 Power (R,Y,B) / kW 340.4 340.4 340.4
Jacket Water In, Out / \*C 109 113 Power Calib 101
Manifold Air Temp / \*C 71 Power (R,Y,B) / kVA 335.2 327.5 328.3
Oil / \*C 104 Power Factors (R,Y,B) 1.00 1.00 1.00
Enclosure Ambient / \*C 28 Volts (R,Y,B,Gen) / V 237 237 235 228
Gen Temps (R,Y,B) / \*C 98 99 98 Current (R,Y,B) / A 1416 1383 1400
RMS Calib 100

Last Trip 59 Low A'Cool Press
CPU Status 8 >>> CURRENT STATUS 255 Normal running <<<
Modulation: No modulation State 8 ON LOAD

Sw 0: Mains Under Freq 0 Sw 16: Deltec Tecjet Fail 0
Sw 1: Mains Over Freq 0 Sw 17: Oil Level/Flow 0
Sw 2: Mains Under Voltage 0 Sw 18: DV Regulator Fault 0
Sw 3: Mains Over Voltage 0 Sw 19: EISM Shutdown 0
Sw 4: Fire / Gas Alarm 0 Sw 20: Contactor Sense 0
Sw 5: Low Oil Pressure 0 Sw 21: Pastor trip 0
Sw 6: External On/Off 0 Sw 22: Exhaust Back Pressure 0
Sw 7: Emergency Stop 0 Sw 23: Trip Sense 0
Sw 8: Engine Thermostat 0
Sw 9: Governor Stop 0
Sw 10: Gas Pressure 0
Sw 11: Phase Rotation 0
Sw 12: Motor Overload 0
Sw 13: Motor Overload Warning 0
Sw 14: PLC General Trip 0
Sw 15: Single Phase Failure 0

18/09/02 Engine Log Extract

\*\*\*\*\*
Unit No: 673 Unit Type: 16C35TN1 Log No: 6
\*\*\*\*\*
Time of Log 18/ 9 8: 6:57 Jacket Water pressure (bar) 2.2
Time of Sync 17/ 9 16: 6: 2 Manifold Press / bar 1.7
Fuel / kW / kWhr 0 0 Oil Press / bar 3.9
Elec / kW / kWhr 1009 15960 After Cooler Water Pressure/bar 2.2
Throttle / \* 46 Gas pressure / (mbar) 187
Exh 1,2,3,4 / \*C 589 595 589 589 Analog Calib 99
Exh 5,6,7,8 / \*C 582 582 595 582

Exh 9,10,11,12 / *C	589 582 595 595	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	589 595 589 589	Switches 16-23	000000010
RH Turbo In, Out / *C	0 506	Engine Speed / rpm	1500
LH Turbo In, Out / *C	0 499	Mains Freq / Hz	50.0
After Cooler Water In / *C	53	Power (R,Y,B) / kW	328.6 340.4 340.4
Jacket Water In, Out / *C	108 112	Power Calib	101
Manifold Air Temp / *C	70	Power (R,Y,B) / kVA	334.4 334.4 336.0
Oil / *C	103	Power Factors (R,Y,B)	0.98 1.00 1.00
Enclosure Ambient / *C	22	Volts (R,Y,B,Gen) / V	239 239 235 230
Gen Temps (R,Y,B) / *C	96 96 96	Current (R,Y,B) / A	1400 1400 1432
		RMS Calib	100

Last Trip 59 Low A'Cool Press  
CPU Status 8 >>> CURRENT STATUS 255 Normal running <<<  
Modulation: No modulation State 8 ON LOAD

Sw 0: Mains Under Freq	0	Sw 16: Deltec Tecjet Fail	0
Sw 1: Mains Over Freq	0	Sw 17: Oil Level/Flow	0
Sw 2: Mains Under Voltage	0	Sw 18: DV Regulator Fault	0
Sw 3: Mains Over Voltage	0	Sw 19: EISM Shutdown	0
Sw 4: Fire / Gas Alarm	0	Sw 20: Contactor Sense	0
Sw 5: Low Oil Pressure	0	Sw 21: Pastor trip	0
Sw 6: External On/Off	0	Sw 22: Exhaust Back Pressure	1
Sw 7: Emergency Stop	0	Sw 23: Trip Sense	0
Sw 8: Engine Thermostat	0		
Sw 9: Governor Stop	0		
Sw 10: Gas Pressure	0		
Sw 11: Phase Rotation	0		
Sw 12: Motor Overload	0		
Sw 13: Motor Overload Warning	0		
Sw 14: PLC General Trip	0		
Sw 15: Single Phase Failure	0		

\*\*\*\*\*  
Unit No: 673 Unit Type: 16C35TN1 Log No: 7  
\*\*\*\*\*  
Time of Log 18/ 9 8:56:46 Jacket Water pressure (bar) 2.2  
Time of Sync 17/ 9 16: 6: 2 Manifold Press / bar 1.7  
Fuel / kW / kWhr 0 0 Oil Press / bar 3.9  
Elec / kW / kWhr 998 16788 After Cooler Water Pressure/bar 2.2  
Throttle / \* 48 Gas pressure / (mbar) 187  
Exh 1,2,3,4 / \*C 589 595 589 589 Analog Calib 99  
Exh 5,6,7,8 / \*C 589 582 595 582  
Exh 9,10,11,12 / \*C 595 582 595 602 Switches 0-15 0000001000000000  
Exh 13,14,15,16 / \*C 595 595 595 589 Switches 16-23 00000000  
RH Turbo In, Out / \*C 0 506 Engine Speed / rpm 1508  
LH Turbo In, Out / \*C 0 506 Mains Freq / Hz 50.1  
After Cooler Water In / \*C 53 Power (R,Y,B) / kW 340.4 328.6 328.6  
Jacket Water In, Out / \*C 108 113 Power Calib 100  
Manifold Air Temp / \*C 70 Power (R,Y,B) / kVA 330.5 335.2 342.9  
Oil / \*C 103 Power Factors (R,Y,B) 1.00 0.98 0.96  
Enclosure Ambient / \*C 23 Volts (R,Y,B,Gen) / V 239 237 237 228  
Gen Temps (R,Y,B) / \*C 97 97 97 Current (R,Y,B) / A 1383 1416 1449  
RMS Calib 100

Last Trip 75 External on/off
CPU Status 8 >>> CURRENT STATUS 75 External on/off <<<
Modulation: No modulation State 8 ON LOAD

Sw 0: Mains Under Freq 0 Sw 16: Deltec Tecjet Fail 0
Sw 1: Mains Over Freq 0 Sw 17: Oil Level/Flow 0
Sw 2: Mains Under Voltage 0 Sw 18: DV Regulator Fault 0
Sw 3: Mains Over Voltage 0 Sw 19: EISM Shutdown 0
Sw 4: Fire / Gas Alarm 0 Sw 20: Contactor Sense 0
Sw 5: Low Oil Pressure 0 Sw 21: Pastor trip 0
Sw 6: External On/Off 1 Sw 22: Exhaust Back Pressure 0
Sw 7: Emergency Stop 0 Sw 23: Trip Sense 0
Sw 8: Engine Thermostat 0
Sw 9: Governor Stop 0
Sw 10: Gas Pressure 0
Sw 11: Phase Rotation 0
Sw 12: Motor Overload 0
Sw 13: Motor Overload Warning 0
Sw 14: PLC General Trip 0
Sw 15: Single Phase Failure 0

\*\*\*\*\*
Unit No: 673 Unit Type: 16C35TN1 Log No: 8
\*\*\*\*\*

Time of Log 18/ 9 9:25:35 Jacket Water pressure (bar) 0.9
Time of Sync 0/ 0 0: 0: 0 Manifold Press / bar -0.1
Fuel / kW / kWhr 0 0 Oil Press / bar -0.0
Elec / kW / kWhr 0 0 After Cooler Water Pressure/bar 0.9
Throttle / \* 4 Gas pressure / (mbar) 0
Exh 1,2,3,4 / \*C 134 122 147 147 Analog Calib 99
Exh 5,6,7,8 / \*C 141 141 147 141
Exh 9,10,11,12 / \*C 154 141 141 141 Switches 0-15 0000000000000000
Exh 13,14,15,16 / \*C 122 134 122 128 Switches 16-23 00001000
RH Turbo In, Out / \*C 0 122 Engine Speed / rpm 0
LH Turbo In, Out / \*C 0 122 Mains Freq / Hz 50.0
After Cooler Water In / \*C 50 Power (R,Y,B) / kW 0.0 0.0 0.0
Jacket Water In, Out / \*C 51 74 Power Calib 101
Manifold Air Temp / \*C 98 Power (R,Y,B) / kVA 0.0 0.0 0.0
Oil / \*C 83 Power Factors (R,Y,B) 0.00 0.00 0.00
Enclosure Ambient / \*C 30 Volts (R,Y,B,Gen) / V 230 230 228 0
Gen Temps (R,Y,B) / \*C 78 77 78 Current (R,Y,B) / A 0 0 0
RMS Calib 100

Last Trip 75 External on/off
CPU Status 8 >>> CURRENT STATUS 255 Normal running <<<
Modulation: Unit is tripped State 1 TRIPPED

Sw 0: Mains Under Freq 0 Sw 16: Deltec Tecjet Fail 0
Sw 1: Mains Over Freq 0 Sw 17: Oil Level/Flow 0
Sw 2: Mains Under Voltage 0 Sw 18: DV Regulator Fault 0
Sw 3: Mains Over Voltage 0 Sw 19: EISM Shutdown 0
Sw 4: Fire / Gas Alarm 0 Sw 20: Contactor Sense 1

Sw 5: Low Oil Pressure	0	Sw 21: Pastor trip	0
Sw 6: External On/Off	0	Sw 22: Exhaust Back Pressure	0
Sw 7: Emergency Stop	0	Sw 23: Trip Sense	0
Sw 8: Engine Thermostat	0		
Sw 9: Governor Stop	0		
Sw 10: Gas Pressure	0		
Sw 11: Phase Rotation	0		
Sw 12: Motor Overload	0		
Sw 13: Motor Overload Warning	0		
Sw 14: PLC General Trip	0		
Sw 15: Single Phase Failure	0		

```

*****
Unit No: 673 Unit Type: 16C35TN1 Log No: 9
*****
Time of Log          18/ 9  9:27: 8 Jacket Water pressure (bar)      1.9
Time of Sync         0/ 0  0: 0: 0 Manifold Press / bar            0.0
Fuel / kW / kWhr     0      0 Oil Press / bar                 4.4
Elec / kW / kWhr     0      0 After Cooler Water Pressure/bar  1.9
Throttle / *                12 Gas pressure / (mbar)           215
Exh 1,2,3,4 / *C       166 173 179 179 Analog Calib                     99
Exh 5,6,7,8 / *C       173 179 186 173
Exh 9,10,11,12 / *C   192 173 179 173 Switches 0-15                    0000000000000000
Exh 13,14,15,16 / *C  160 166 154 166 Switches 16-23                   00001000
RH Turbo In, Out / *C              0 179 Engine Speed / rpm              1327
LH Turbo In, Out / *C              0 173 Mains Freq / Hz                 50.1
After Cooler Water In / *C          54 Power (R,Y,B) / kW              0.0  0.0  0.0
Jacket Water In, Out / *C          92 73 Power Calib                     100
Manifold Air Temp / *C              91 Power (R,Y,B) / kVA             0.0  0.0  0.0
Oil / *C                          94 Power Factors (R,Y,B)          0.00 0.00 0.00
Enclosure Ambient / *C              26 Volts (R,Y,B,Gen) / V          230 228 226 215
Gen Temps (R,Y,B) / *C            77 77 78 Current (R,Y,B) / A             0 0 0
RMS Calib                                     100
    
```

```

Last Trip 75 External on/off
CPU Status 8 >>> CURRENT STATUS 255 Normal running <<<
Modulation: Synchronising State 6 SYNC'ING
    
```

Sw 0: Mains Under Freq	0	Sw 16: Deltec Tecjet Fail	0
Sw 1: Mains Over Freq	0	Sw 17: Oil Level/Flow	0
Sw 2: Mains Under Voltage	0	Sw 18: DV Regulator Fault	0
Sw 3: Mains Over Voltage	0	Sw 19: EISM Shutdown	0
Sw 4: Fire / Gas Alarm	0	Sw 20: Contactor Sense	1
Sw 5: Low Oil Pressure	0	Sw 21: Pastor trip	0
Sw 6: External On/Off	0	Sw 22: Exhaust Back Pressure	0
Sw 7: Emergency Stop	0	Sw 23: Trip Sense	0
Sw 8: Engine Thermostat	0		
Sw 9: Governor Stop	0		
Sw 10: Gas Pressure	0		
Sw 11: Phase Rotation	0		
Sw 12: Motor Overload	0		
Sw 13: Motor Overload Warning	0		
Sw 14: PLC General Trip	0		
Sw 15: Single Phase Failure	0		

\*\*\*\*\*

Unit No: 673 Unit Type: 16C35TN1 Log No: 10

\*\*\*\*\*

Time of Log	18/ 9 9:30: 2	Jacket Water pressure (bar)	2.1
Time of Sync	18/ 9 9:29: 7	Manifold Press / bar	0.0
Fuel / kW / kWhr	0 0	Oil Press / bar	4.3
Elec / kW / kWhr	352 2	After Cooler Water Pressure/bar	2.1
Throttle / *	33	Gas pressure / (mbar)	215
Exh 1,2,3,4 / *C	506 518 512 506	Analog Calib	99
Exh 5,6,7,8 / *C	493 499 506 493		
Exh 9,10,11,12 / *C	512 493 512 512	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	506 499 506 499	Switches 16-23	00000000
RH Turbo In, Out / *C	0 429	Engine Speed / rpm	1500
LH Turbo In, Out / *C	0 429	Mains Freq / Hz	50.0
After Cooler Water In / *C	56	Power (R,Y,B) / kW	117.4 117.4 117.4
Jacket Water In, Out / *C	106 76	Power Calib	101
Manifold Air Temp / *C	77	Power (R,Y,B) / kVA	128.6 121.0 119.9
Oil / *C	100	Power Factors (R,Y,B)	0.91 0.97 0.98
Enclosure Ambient / *C	23	Volts (R,Y,B,Gen) / V	232 232 230 226
Gen Temps (R,Y,B) / *C	74 74 75	Current (R,Y,B) / A	553 521 521
		RMS Calib	100

Last Trip 38 Low exh 8  
CPU Status 8 >>> CURRENT STATUS 38 Low exh 8 <<<  
Modulation: No modulation State 8 ON LOAD

Sw 0: Mains Under Freq	0	Sw 16: Deltec Tecjet Fail	0
Sw 1: Mains Over Freq	0	Sw 17: Oil Level/Flow	0
Sw 2: Mains Under Voltage	0	Sw 18: DV Regulator Fault	0
Sw 3: Mains Over Voltage	0	Sw 19: EISM Shutdown	0
Sw 4: Fire / Gas Alarm	0	Sw 20: Contactor Sense	0
Sw 5: Low Oil Pressure	0	Sw 21: Pastor trip	0
Sw 6: External On/Off	0	Sw 22: Exhaust Back Pressure	0
Sw 7: Emergency Stop	0	Sw 23: Trip Sense	0
Sw 8: Engine Thermostat	0		
Sw 9: Governor Stop	0		
Sw 10: Gas Pressure	0		
Sw 11: Phase Rotation	0		
Sw 12: Motor Overload	0		
Sw 13: Motor Overload Warning	0		
Sw 14: PLC General Trip	0		
Sw 15: Single Phase Failure	0		

\*\*\*\*\*

Unit No: 673 Unit Type: 16C35TN1 Log No: 11

\*\*\*\*\*

Time of Log	18/ 9 9:30: 7	Jacket Water pressure (bar)	2.1
Time of Sync	18/ 9 9:29: 7	Manifold Press / bar	0.1
Fuel / kW / kWhr	0 0	Oil Press / bar	4.3
Elec / kW / kWhr	387 2	After Cooler Water Pressure/bar	2.1
Throttle / *	29	Gas pressure / (mbar)	215
Exh 1,2,3,4 / *C	506 518 512 506	Analog Calib	99
Exh 5,6,7,8 / *C	499 499 506 493		
Exh 9,10,11,12 / *C	518 493 512 512	Switches 0-15	0000000000000000

Exh 13,14,15,16 / *C	506 499 512 499	Switches 16-23	00000000
RH Turbo In, Out / *C	0 429	Engine Speed / rpm	1500
LH Turbo In, Out / *C	0 435	Mains Freq / Hz	50.0
After Cooler Water In / *C	56	Power (R,Y,B) / kW	129.1 129.1 129.1
Jacket Water In, Out / *C	106 76	Power Calib	101
Manifold Air Temp / *C	76	Power (R,Y,B) / kVA	124.8 121.0 127.4
Oil / *C	100	Power Factors (R,Y,B)	1.00 1.00 1.00
Enclosure Ambient / *C	23	Volts (R,Y,B,Gen) / V	232 232 230 226
Gen Temps (R,Y,B) / *C	74 74 75	Current (R,Y,B) / A	537 521 553
		RMS Calib	100

Last Trip 38 Low exh 8  
CPU Status 8 >>> CURRENT STATUS 38 Low exh 8 <<<  
Modulation: Tripping State 8 ON LOAD

Sw 0: Mains Under Freq	0	Sw 16: Deltec Tecjet Fail	0
Sw 1: Mains Over Freq	0	Sw 17: Oil Level/Flow	0
Sw 2: Mains Under Voltage	0	Sw 18: DV Regulator Fault	0
Sw 3: Mains Over Voltage	0	Sw 19: EISM Shutdown	0
Sw 4: Fire / Gas Alarm	0	Sw 20: Contactor Sense	0
Sw 5: Low Oil Pressure	0	Sw 21: Pastor trip	0
Sw 6: External On/Off	0	Sw 22: Exhaust Back Pressure	0
Sw 7: Emergency Stop	0	Sw 23: Trip Sense	0
Sw 8: Engine Thermostat	0		
Sw 9: Governor Stop	0		
Sw 10: Gas Pressure	0		
Sw 11: Phase Rotation	0		
Sw 12: Motor Overload	0		
Sw 13: Motor Overload Warning	0		
Sw 14: PLC General Trip	0		
Sw 15: Single Phase Failure	0		

\*\*\*\*\*  
Unit No: 673 Unit Type: 16C35TN1 Log No: 12  
\*\*\*\*\*

Time of Log	18/ 9 9:33:51	Jacket Water pressure (bar)	1.1
Time of Sync	0/ 0 0: 0: 0	Manifold Press / bar	-0.1
Fuel / kW / kWhr	0 0	Oil Press / bar	2.6
Elec / kW / kWhr	0 0	After Cooler Water Pressure/bar	1.0
Throttle / *	4	Gas pressure / (mbar)	-9
Exh 1,2,3,4 / *C	448 486 493 486	Analog Calib	99
Exh 5,6,7,8 / *C	442 461 480 467		
Exh 9,10,11,12 / *C	486 467 486 499	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	480 474 493 480	Switches 16-23	00001000
RH Turbo In, Out / *C	0 416	Engine Speed / rpm	558
LH Turbo In, Out / *C	0 416	Mains Freq / Hz	50.0
After Cooler Water In / *C	55	Power (R,Y,B) / kW	0.0 0.0 0.0
Jacket Water In, Out / *C	110 110	Power Calib	101
Manifold Air Temp / *C	75	Power (R,Y,B) / kVA	0.0 0.0 7.5
Oil / *C	100	Power Factors (R,Y,B)	0.00 0.00 0.00
Enclosure Ambient / *C	22	Volts (R,Y,B,Gen) / V	230 230 230 43
Gen Temps (R,Y,B) / *C	70 70 71	Current (R,Y,B) / A	0 0 33
		RMS Calib	100

Last Trip 38 Low exh 8

CPU Status 8 >>> CURRENT STATUS 255 Normal running <<<
Modulation: Unit is tripped State 1 TRIPPED

Sw 0: Mains Under Freq 0 Sw 16: Deltec Tecjet Fail 0
Sw 1: Mains Over Freq 0 Sw 17: Oil Level/Flow 0
Sw 2: Mains Under Voltage 0 Sw 18: DV Regulator Fault 0
Sw 3: Mains Over Voltage 0 Sw 19: EISM Shutdown 0
Sw 4: Fire / Gas Alarm 0 Sw 20: Contactor Sense 1
Sw 5: Low Oil Pressure 0 Sw 21: Pastor trip 0
Sw 6: External On/Off 0 Sw 22: Exhaust Back Pressure 0
Sw 7: Emergency Stop 0 Sw 23: Trip Sense 0
Sw 8: Engine Thermostat 0
Sw 9: Governor Stop 0
Sw 10: Gas Pressure 0
Sw 11: Phase Rotation 0
Sw 12: Motor Overload 0
Sw 13: Motor Overload Warning 0
Sw 14: PLC General Trip 0
Sw 15: Single Phase Failure 0

\*\*\*\*\*

Unit No: 673 Unit Type: 16C35TN1 Log No: 13
\*\*\*\*\*
Time of Log 18/ 9 9:35:23 Jacket Water pressure (bar) 2.2
Time of Sync 0/ 0 0: 0: 0 Manifold Press / bar -0.9
Fuel / kW / kWhr 0 0 Oil Press / bar 4.4
Elec / kW / kWhr 0 0 After Cooler Water Pressure/bar 2.1
Throttle / \* 9 Gas pressure / (mbar) 234
Exh 1,2,3,4 / \*C 307 314 301 307 Analog Calib 99
Exh 5,6,7,8 / \*C 301 301 301 288
Exh 9,10,11,12 / \*C 314 288 307 301 Switches 0-15 0000000000000000
Exh 13,14,15,16 / \*C 288 294 288 314 Switches 16-23 00001000
RH Turbo In, Out / \*C 0 301 Engine Speed / rpm 1500
LH Turbo In, Out / \*C 0 288 Mains Freq / Hz 50.0
After Cooler Water In / \*C 57 Power (R,Y,B) / kW 0.0 0.0 0.0
Jacket Water In, Out / \*C 102 109 Power Calib 101
Manifold Air Temp / \*C 77 Power (R,Y,B) / kVA 0.0 0.0 0.0
Oil / \*C 99 Power Factors (R,Y,B) 0.00 0.00 0.00
Enclosure Ambient / \*C 24 Volts (R,Y,B,Gen) / V 232 230 230 235
Gen Temps (R,Y,B) / \*C 70 70 70 Current (R,Y,B) / A 0 0 0
RMS Calib 100

Last Trip 38 Low exh 8
CPU Status 8 >>> CURRENT STATUS 255 Normal running <<<
Modulation: Synchronising State 6 SYNC'ING

Sw 0: Mains Under Freq 0 Sw 16: Deltec Tecjet Fail 0
Sw 1: Mains Over Freq 0 Sw 17: Oil Level/Flow 0
Sw 2: Mains Under Voltage 0 Sw 18: DV Regulator Fault 0
Sw 3: Mains Over Voltage 0 Sw 19: EISM Shutdown 0
Sw 4: Fire / Gas Alarm 0 Sw 20: Contactor Sense 1
Sw 5: Low Oil Pressure 0 Sw 21: Pastor trip 0
Sw 6: External On/Off 0 Sw 22: Exhaust Back Pressure 0

Sw 7: Emergency Stop	0	Sw 23: Trip Sense	0
Sw 8: Engine Thermostat	0		
Sw 9: Governor Stop	0		
Sw 10: Gas Pressure	0		
Sw 11: Phase Rotation	0		
Sw 12: Motor Overload	0		
Sw 13: Motor Overload Warning	0		
Sw 14: PLC General Trip	0		
Sw 15: Single Phase Failure	0		

```

*****
Unit No: 673 Unit Type: 16C35TN1 Log No: 14
*****
Time of Log          18/ 9  9:37:50 Jacket Water pressure (bar)      2.1
Time of Sync        18/ 9  9:36:50 Manifold Press / bar             0.0
Fuel / kW / kWhr    0      0      Oil Press / bar                  4.3
Elec / kW / kWhr    317    2      After Cooler Water Pressure/bar  2.1
Throttle / *                31 Gas pressure / (mbar)            215
Exh 1,2,3,4 / *C      512 525 518 512 Analog Calib                      99
Exh 5,6,7,8 / *C      499 506 506 499
Exh 9,10,11,12 / *C  518 499 518 518 Switches 0-15                    0000000000000000
Exh 13,14,15,16 / *C 512 506 512 506 Switches 16-23                   00000000
RH Turbo In, Out / *C                0 454 Engine Speed / rpm                1500
LH Turbo In, Out / *C                0 461 Mains Freq / Hz                   50.0
After Cooler Water In / *C            54 Power (R,Y,B) / kW                105.6 105.6 105.6
Jacket Water In, Out / *C            106 111 Power Calib                        101
Manifold Air Temp / *C                71 Power (R,Y,B) / kVA               98.3 105.9 112.4
Oil / *C                            99 Power Factors (R,Y,B)             1.00 1.00 0.94
Enclosure Ambient / *C                22 Volts (R,Y,B,Gen) / V            232 232 230 228
Gen Temps (R,Y,B) / *C                68  67  69 Current (R,Y,B) / A               423 456 488
                                           RMS Calib                          100
    
```

```

Last Trip  38 Low exh 8
CPU Status  8 >>> CURRENT STATUS 255 Normal running <<<
Modulation: No modulation State 8 ON LOAD
    
```

Sw 0: Mains Under Freq	0	Sw 16: Deltec Tecjet Fail	0
Sw 1: Mains Over Freq	0	Sw 17: Oil Level/Flow	0
Sw 2: Mains Under Voltage	0	Sw 18: DV Regulator Fault	0
Sw 3: Mains Over Voltage	0	Sw 19: EISM Shutdown	0
Sw 4: Fire / Gas Alarm	0	Sw 20: Contactor Sense	0
Sw 5: Low Oil Pressure	0	Sw 21: Pastor trip	0
Sw 6: External On/Off	0	Sw 22: Exhaust Back Pressure	0
Sw 7: Emergency Stop	0	Sw 23: Trip Sense	0
Sw 8: Engine Thermostat	0		
Sw 9: Governor Stop	0		
Sw 10: Gas Pressure	0		
Sw 11: Phase Rotation	0		
Sw 12: Motor Overload	0		
Sw 13: Motor Overload Warning	0		
Sw 14: PLC General Trip	0		
Sw 15: Single Phase Failure	0		

```

*****
Unit No: 673 Unit Type: 16C35TN1 Log No: 15
*****
Time of Log          18/ 9  9:38:24 Jacket Water pressure (bar)      2.2
Time of Sync        18/ 9  9:36:50 Manifold Press / bar            0.5
Fuel / kW / kWhr    0      0      Oil Press / bar                  4.2
Elec / kW / kWhr    458    5      After Cooler Water Pressure/bar  2.1
Throttle / *                44   Gas pressure / (mbar)           215
Exh 1,2,3,4 / *C      506 531 525 525 Analog Calib                      99
Exh 5,6,7,8 / *C      525 525 531 518
Exh 9,10,11,12 / *C  512 518 518 531 Switches 0-15                    0000000000000000
Exh 13,14,15,16 / *C 531 525 486 512 Switches 16-23                   00000000
RH Turbo In, Out / *C                0 442 Engine Speed / rpm                1500
LH Turbo In, Out / *C                0 474 Mains Freq / Hz                   50.0
After Cooler Water In / *C            56 Power (R,Y,B) / kW   140.8 187.8 129.1
Jacket Water In, Out / *C           109 109 Power Calib                      102
Manifold Air Temp / *C                69 Power (R,Y,B) / kVA  239.8 309.2 202.3
Oil / *C                            99 Power Factors (R,Y,B)  0.59 0.61 0.64
Enclosure Ambient / *C                22 Volts (R,Y,B,Gen) / V  230 235 230 228
Gen Temps (R,Y,B) / *C       68   67   68 Current (R,Y,B) / A   1042 1318  879
                                           RMS Calib                      100

```

```

Last Trip 132 Low exh 15
CPU Status 8 >>> CURRENT STATUS 132 Low exh 15 <<<
Modulation: No modulation State 8 ON LOAD

```

```

Sw 0: Mains Under Freq 0 Sw 16: Deltec Tecjet Fail 0
Sw 1: Mains Over Freq 0 Sw 17: Oil Level/Flow 0
Sw 2: Mains Under Voltage 0 Sw 18: DV Regulator Fault 0
Sw 3: Mains Over Voltage 0 Sw 19: EISM Shutdown 0
Sw 4: Fire / Gas Alarm 0 Sw 20: Contactor Sense 0
Sw 5: Low Oil Pressure 0 Sw 21: Pastor trip 0
Sw 6: External On/Off 0 Sw 22: Exhaust Back Pressure 0
Sw 7: Emergency Stop 0 Sw 23: Trip Sense 0
Sw 8: Engine Thermostat 0
Sw 9: Governor Stop 0
Sw 10: Gas Pressure 0
Sw 11: Phase Rotation 0
Sw 12: Motor Overload 0
Sw 13: Motor Overload Warning 0
Sw 14: PLC General Trip 0
Sw 15: Single Phase Failure 0

```

```

*****
Unit No: 673 Unit Type: 16C35TN1 Log No: 16
*****
Time of Log          18/ 9  9:39:42 Jacket Water pressure (bar)      0.9
Time of Sync        0/ 0  0: 0: 0 Manifold Press / bar            -0.1
Fuel / kW / kWhr    0      0      Oil Press / bar                  -0.0
Elec / kW / kWhr    0      0      After Cooler Water Pressure/bar  0.8
Throttle / *                38   Gas pressure / (mbar)           0
Exh 1,2,3,4 / *C      262 275 269 275 Analog Calib                      99
Exh 5,6,7,8 / *C      269 275 288 275
Exh 9,10,11,12 / *C  294 275 282 288 Switches 0-15                    0000000000000000
Exh 13,14,15,16 / *C 282 282 262 269 Switches 16-23                   00001000

```

RH Turbo In, Out / *C	0 269	Engine Speed / rpm	0
LH Turbo In, Out / *C	0 282	Mains Freq / Hz	50.0
After Cooler Water In / *C	45	Power (R,Y,B) / kW	0.0 0.0 0.0
Jacket Water In, Out / *C	95 109	Power Calib	102
Manifold Air Temp / *C	74	Power (R,Y,B) / kVA	0.0 0.0 0.0
Oil / *C	98	Power Factors (R,Y,B)	0.00 0.00 0.00
Enclosure Ambient / *C	25	Volts (R,Y,B,Gen) / V	232 232 230 0
Gen Temps (R,Y,B) / *C	68 67 69	Current (R,Y,B) / A	0 0 0
		RMS Calib	100

Last Trip 132 Low exh 15  
CPU Status 8 >>> CURRENT STATUS 255 Normal running <<<  
Modulation: Unit is tripped State 1 TRIPPED

Sw 0: Mains Under Freq	0	Sw 16: Deltec Tecjet Fail	0
Sw 1: Mains Over Freq	0	Sw 17: Oil Level/Flow	0
Sw 2: Mains Under Voltage	0	Sw 18: DV Regulator Fault	0
Sw 3: Mains Over Voltage	0	Sw 19: EISM Shutdown	0
Sw 4: Fire / Gas Alarm	0	Sw 20: Contactor Sense	1
Sw 5: Low Oil Pressure	0	Sw 21: Pastor trip	0
Sw 6: External On/Off	0	Sw 22: Exhaust Back Pressure	0
Sw 7: Emergency Stop	0	Sw 23: Trip Sense	0
Sw 8: Engine Thermostat	0		
Sw 9: Governor Stop	0		
Sw 10: Gas Pressure	0		
Sw 11: Phase Rotation	0		
Sw 12: Motor Overload	0		
Sw 13: Motor Overload Warning	0		
Sw 14: PLC General Trip	0		
Sw 15: Single Phase Failure	0		

\*\*\*\*\*  
Unit No: 673 Unit Type: 16C35TN1 Log No: 17  
\*\*\*\*\*

Time of Log	18/ 9 9:41:14	Jacket Water pressure (bar)	2.2
Time of Sync	0/ 0 0: 0: 0	Manifold Press / bar	-0.9
Fuel / kW / kWhr	0 0	Oil Press / bar	4.4
Elec / kW / kWhr	0 0	After Cooler Water Pressure/bar	2.1
Throttle / *	9	Gas pressure / (mbar)	243
Exh 1,2,3,4 / *C	282 282 275 282	Analog Calib	99
Exh 5,6,7,8 / *C	282 275 275 269		
Exh 9,10,11,12 / *C	288 269 282 275	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	269 269 256 288	Switches 16-23	00001000
RH Turbo In, Out / *C	0 282	Engine Speed / rpm	1515
LH Turbo In, Out / *C	0 269	Mains Freq / Hz	50.1
After Cooler Water In / *C	56	Power (R,Y,B) / kW	0.0 0.0 0.0
Jacket Water In, Out / *C	81 90	Power Calib	100
Manifold Air Temp / *C	76	Power (R,Y,B) / kVA	0.0 0.0 0.0
Oil / *C	98	Power Factors (R,Y,B)	0.00 0.00 0.00
Enclosure Ambient / *C	28	Volts (R,Y,B,Gen) / V	235 235 235 235
Gen Temps (R,Y,B) / *C	67 67 68	Current (R,Y,B) / A	0 0 0
		RMS Calib	100

Last Trip 132 Low exh 15

CPU Status 8 >>> CURRENT STATUS 255 Normal running <<<
Modulation: Synchronising State 6 SYNC'ING

Sw 0: Mains Under Freq 0 Sw 16: Deltec Tecjet Fail 0
Sw 1: Mains Over Freq 0 Sw 17: Oil Level/Flow 0
Sw 2: Mains Under Voltage 0 Sw 18: DV Regulator Fault 0
Sw 3: Mains Over Voltage 0 Sw 19: EISM Shutdown 0
Sw 4: Fire / Gas Alarm 0 Sw 20: Contactor Sense 1
Sw 5: Low Oil Pressure 0 Sw 21: Pastor trip 0
Sw 6: External On/Off 0 Sw 22: Exhaust Back Pressure 0
Sw 7: Emergency Stop 0 Sw 23: Trip Sense 0
Sw 8: Engine Thermostat 0
Sw 9: Governor Stop 0
Sw 10: Gas Pressure 0
Sw 11: Phase Rotation 0
Sw 12: Motor Overload 0
Sw 13: Motor Overload Warning 0
Sw 14: PLC General Trip 0
Sw 15: Single Phase Failure 0

\*\*\*\*\*

Unit No: 673 Unit Type: 16C35TN1 Log No: 18
\*\*\*\*\*
Time of Log 18/ 9 9:43:47 Jacket Water pressure (bar) 2.2
Time of Sync 18/ 9 9:42:51 Manifold Press / bar -0.1
Fuel / kW / kWhr 0 0 Oil Press / bar 4.3
Elec / kW / kWhr 305 2 After Cooler Water Pressure/bar 2.1
Throttle / \* 30 Gas pressure / (mbar) 215
Exh 1,2,3,4 / \*C 512 518 512 512 Analog Calib 99
Exh 5,6,7,8 / \*C 499 506 506 493
Exh 9,10,11,12 / \*C 518 493 512 512 Switches 0-15 0000000000000000
Exh 13,14,15,16 / \*C 506 506 506 506 Switches 16-23 00000000
RH Turbo In, Out / \*C 0 454 Engine Speed / rpm 1500
LH Turbo In, Out / \*C 0 454 Mains Freq / Hz 50.0
After Cooler Water In / \*C 53 Power (R,Y,B) / kW 105.6 93.9 105.6
Jacket Water In, Out / \*C 98 85 Power Calib 102
Manifold Air Temp / \*C 70 Power (R,Y,B) / kVA 91.6 87.0 103.1
Oil / \*C 98 Power Factors (R,Y,B) 1.00 1.00 1.00
Enclosure Ambient / \*C 23 Volts (R,Y,B,Gen) / V 235 232 235 230
Gen Temps (R,Y,B) / \*C 66 66 66 Current (R,Y,B) / A 391 374 439
RMS Calib 101

Last Trip 38 Low exh 8
CPU Status 8 >>> CURRENT STATUS 38 Low exh 8 <<<
Modulation: No modulation State 8 ON LOAD

Sw 0: Mains Under Freq 0 Sw 16: Deltec Tecjet Fail 0
Sw 1: Mains Over Freq 0 Sw 17: Oil Level/Flow 0
Sw 2: Mains Under Voltage 0 Sw 18: DV Regulator Fault 0
Sw 3: Mains Over Voltage 0 Sw 19: EISM Shutdown 0
Sw 4: Fire / Gas Alarm 0 Sw 20: Contactor Sense 0
Sw 5: Low Oil Pressure 0 Sw 21: Pastor trip 0
Sw 6: External On/Off 0 Sw 22: Exhaust Back Pressure 0
Sw 7: Emergency Stop 0 Sw 23: Trip Sense 0

Sw 8: Engine Thermostat 0  
 Sw 9: Governor Stop 0  
 Sw 10: Gas Pressure 0  
 Sw 11: Phase Rotation 0  
 Sw 12: Motor Overload 0  
 Sw 13: Motor Overload Warning 0  
 Sw 14: PLC General Trip 0  
 Sw 15: Single Phase Failure 0

\*\*\*\*\*  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 19  
 \*\*\*\*\*  
 Time of Log 18/ 9 9:43:51 Jacket Water pressure (bar) 2.2  
 Time of Sync 18/ 9 9:42:51 Manifold Press / bar -0.1  
 Fuel / kW / kWhr 0 0 Oil Press / bar 4.3  
 Elec / kW / kWhr 305 2 After Cooler Water Pressure/bar 2.1  
 Throttle / \* 26 Gas pressure / (mbar) 215  
 Exh 1,2,3,4 / \*C 512 525 512 512 Analog Calib 99  
 Exh 5,6,7,8 / \*C 499 506 506 499  
 Exh 9,10,11,12 / \*C 518 499 518 518 Switches 0-15 0000000000000000  
 Exh 13,14,15,16 / \*C 512 506 512 506 Switches 16-23 00000000  
 RH Turbo In, Out / \*C 0 454 Engine Speed / rpm 1500  
 LH Turbo In, Out / \*C 0 461 Mains Freq / Hz 50.0  
 After Cooler Water In / \*C 53 Power (R,Y,B) / kW 93.9 105.6 105.6  
 Jacket Water In, Out / \*C 99 85 Power Calib 100  
 Manifold Air Temp / \*C 70 Power (R,Y,B) / kVA 96.3 96.3 104.0  
 Oil / \*C 98 Power Factors (R,Y,B) 0.97 1.00 1.00  
 Enclosure Ambient / \*C 23 Volts (R,Y,B,Gen) / V 237 237 237 228  
 Gen Temps (R,Y,B) / \*C 66 66 67 Current (R,Y,B) / A 407 407 439  
 RMS Calib 100

Last Trip 38 Low exh 8  
 CPU Status 8 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: Tripping State 8 ON LOAD

Sw 0: Mains Under Freq 0 Sw 16: Deltec Tecjet Fail 0  
 Sw 1: Mains Over Freq 0 Sw 17: Oil Level/Flow 0  
 Sw 2: Mains Under Voltage 0 Sw 18: DV Regulator Fault 0  
 Sw 3: Mains Over Voltage 0 Sw 19: EISM Shutdown 0  
 Sw 4: Fire / Gas Alarm 0 Sw 20: Contactor Sense 0  
 Sw 5: Low Oil Pressure 0 Sw 21: Pastor trip 0  
 Sw 6: External On/Off 0 Sw 22: Exhaust Back Pressure 0  
 Sw 7: Emergency Stop 0 Sw 23: Trip Sense 0  
 Sw 8: Engine Thermostat 0  
 Sw 9: Governor Stop 0  
 Sw 10: Gas Pressure 0  
 Sw 11: Phase Rotation 0  
 Sw 12: Motor Overload 0  
 Sw 13: Motor Overload Warning 0  
 Sw 14: PLC General Trip 0  
 Sw 15: Single Phase Failure 0

\*\*\*\*\*  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 20

```

*****
Time of Log          18/ 9  9:47:44  Jacket Water pressure (bar)          0.9
Time of Sync        0/ 0  0: 0: 0  Manifold Press / bar                 -0.1
Fuel / kW / kWhr    0      0      Oil Press / bar                       -0.0
Elec / kW / kWhr    0      0      After Cooler Water Pressure/bar       0.8
Throttle / *                4      Gas pressure / (mbar)                 0
Exh 1,2,3,4 / *C      352 378 390 378  Analog Calib                          99
Exh 5,6,7,8 / *C      352 365 390 371
Exh 9,10,11,12 / *C   390 371 378 397  Switches 0-15                        0000000000000000
Exh 13,14,15,16 / *C  384 378 378 352  Switches 16-23                       00001000
RH Turbo In, Out / *C                0 352  Engine Speed / rpm                    0
LH Turbo In, Out / *C                0 371  Mains Freq / Hz                       50.1
After Cooler Water In / *C              51  Power (R,Y,B) / kW                    0.0  0.0  0.0
Jacket Water In, Out / *C             109 109  Power Calib                           100
Manifold Air Temp / *C                 72  Power (R,Y,B) / kVA                   0.0  0.0  0.0
Oil / *C                               98  Power Factors (R,Y,B)                 0.00 0.00 0.00
Enclosure Ambient / *C                 22  Volts (R,Y,B,Gen) / V                 235 235 232  0
Gen Temps (R,Y,B) / *C                64  64  65  Current (R,Y,B) / A                   0  0  0
                                           RMS Calib                             99

```

```

Last Trip  38 Low exh 8
CPU Status 8 >>> CURRENT STATUS 255 Normal running <<<
Modulation: Unit is tripped State 1 TRIPPED

```

```

Sw 0: Mains Under Freq 0 Sw 16: Deltec Tecjet Fail 0
Sw 1: Mains Over Freq 0 Sw 17: Oil Level/Flow 0
Sw 2: Mains Under Voltage 0 Sw 18: DV Regulator Fault 0
Sw 3: Mains Over Voltage 0 Sw 19: EISM Shutdown 0
Sw 4: Fire / Gas Alarm 0 Sw 20: Contactor Sense 1
Sw 5: Low Oil Pressure 0 Sw 21: Pastor trip 0
Sw 6: External On/Off 0 Sw 22: Exhaust Back Pressure 0
Sw 7: Emergency Stop 0 Sw 23: Trip Sense 0
Sw 8: Engine Thermostat 0
Sw 9: Governor Stop 0
Sw 10: Gas Pressure 0
Sw 11: Phase Rotation 0
Sw 12: Motor Overload 0
Sw 13: Motor Overload Warning 0
Sw 14: PLC General Trip 0
Sw 15: Single Phase Failure 0

```

```

*****
Unit No: 673 Unit Type: 16C35TN1 Log No: 21
*****
Time of Log          18/ 9  9:49:16  Jacket Water pressure (bar)          2.1
Time of Sync        0/ 0  0: 0: 0  Manifold Press / bar                 -1.0
Fuel / kW / kWhr    0      0      Oil Press / bar                       4.4
Elec / kW / kWhr    0      0      After Cooler Water Pressure/bar       2.1
Throttle / *                10      Gas pressure / (mbar)                 234
Exh 1,2,3,4 / *C      320 320 307 314  Analog Calib                          99
Exh 5,6,7,8 / *C      314 307 307 294
Exh 9,10,11,12 / *C   320 301 307 314  Switches 0-15                        0000000000000000
Exh 13,14,15,16 / *C  301 307 301 326  Switches 16-23                       00001000
RH Turbo In, Out / *C                0 314  Engine Speed / rpm                    1508
LH Turbo In, Out / *C                0 288  Mains Freq / Hz                       50.0

```

After Cooler Water In / *C	55	Power (R,Y,B) / kW	0.0	0.0	0.0
Jacket Water In, Out / *C	107 109	Power Calib			101
Manifold Air Temp / *C	75	Power (R,Y,B) / kVA	0.0	0.0	0.0
Oil / *C	98	Power Factors (R,Y,B)	0.00	0.00	0.00
Enclosure Ambient / *C	23	Volts (R,Y,B,Gen) / V	235	235	232 232
Gen Temps (R,Y,B) / *C	63 63 64	Current (R,Y,B) / A	0	0	0
		RMS Calib			99

Last Trip 38 Low exh 8  
 CPU Status 8 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: Synchronising State 6 SYNC'ING

Sw 0: Mains Under Freq	0	Sw 16: Deltec Tecjet Fail	0
Sw 1: Mains Over Freq	0	Sw 17: Oil Level/Flow	0
Sw 2: Mains Under Voltage	0	Sw 18: DV Regulator Fault	0
Sw 3: Mains Over Voltage	0	Sw 19: EISM Shutdown	0
Sw 4: Fire / Gas Alarm	0	Sw 20: Contactor Sense	1
Sw 5: Low Oil Pressure	0	Sw 21: Pastor trip	0
Sw 6: External On/Off	0	Sw 22: Exhaust Back Pressure	0
Sw 7: Emergency Stop	0	Sw 23: Trip Sense	0
Sw 8: Engine Thermostat	0		
Sw 9: Governor Stop	0		
Sw 10: Gas Pressure	0		
Sw 11: Phase Rotation	0		
Sw 12: Motor Overload	0		
Sw 13: Motor Overload Warning	0		
Sw 14: PLC General Trip	0		
Sw 15: Single Phase Failure	0		

\*\*\*\*\*  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 22  
 \*\*\*\*\*  
 Time of Log 18/ 9 9:52: 2 Jacket Water pressure (bar) 2.1  
 Time of Sync 18/ 9 9:51: 2 Manifold Press / bar -0.1  
 Fuel / kW / kWhr 0 0 Oil Press / bar 4.3  
 Elec / kW / kWhr 340 2 After Cooler Water Pressure/bar 2.1  
 Throttle / \* 31 Gas pressure / (mbar) 215  
 Exh 1,2,3,4 / \*C 518 531 525 525 Analog Calib 99  
 Exh 5,6,7,8 / \*C 506 512 518 506  
 Exh 9,10,11,12 / \*C 531 506 525 525 Switches 0-15 0000000000000000  
 Exh 13,14,15,16 / \*C 518 518 518 512 Switches 16-23 00000000  
 RH Turbo In, Out / \*C 0 467 Engine Speed / rpm 1508  
 LH Turbo In, Out / \*C 0 474 Mains Freq / Hz 50.0  
 After Cooler Water In / \*C 54 Power (R,Y,B) / kW 105.6 117.4 117.4  
 Jacket Water In, Out / \*C 109 110 Power Calib 100  
 Manifold Air Temp / \*C 70 Power (R,Y,B) / kVA 115.6 116.7 114.5  
 Oil / \*C 99 Power Factors (R,Y,B) 0.91 1.00 1.00  
 Enclosure Ambient / \*C 22 Volts (R,Y,B,Gen) / V 237 239 235 228  
 Gen Temps (R,Y,B) / \*C 62 62 63 Current (R,Y,B) / A 488 488 488  
 RMS Calib 100

Last Trip 38 Low exh 8  
 CPU Status 8 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD

Sw 0: Mains Under Freq	0	Sw 16: Deltec Tecjet Fail	0
Sw 1: Mains Over Freq	0	Sw 17: Oil Level/Flow	0
Sw 2: Mains Under Voltage	0	Sw 18: DV Regulator Fault	0
Sw 3: Mains Over Voltage	0	Sw 19: EISM Shutdown	0
Sw 4: Fire / Gas Alarm	0	Sw 20: Contactor Sense	0
Sw 5: Low Oil Pressure	0	Sw 21: Pastor trip	0
Sw 6: External On/Off	0	Sw 22: Exhaust Back Pressure	0
Sw 7: Emergency Stop	0	Sw 23: Trip Sense	0
Sw 8: Engine Thermostat	0		
Sw 9: Governor Stop	0		
Sw 10: Gas Pressure	0		
Sw 11: Phase Rotation	0		
Sw 12: Motor Overload	0		
Sw 13: Motor Overload Warning	0		
Sw 14: PLC General Trip	0		
Sw 15: Single Phase Failure	0		

\*\*\*\*\*

Unit No: 673 Unit Type: 16C35TN1 Log No: 23

\*\*\*\*\*

Time of Log	18/ 9 10:52: 1	Jacket Water pressure (bar)	2.2
Time of Sync	18/ 9 9:51: 2	Manifold Press / bar	1.7
Fuel / kW / kWhr	0 0	Oil Press / bar	3.9
Elec / kW / kWhr	998 995	After Cooler Water Pressure/bar	2.3
Throttle / *	47	Gas pressure / (mbar)	187
Exh 1,2,3,4 / *C	589 595 589 589	Analog Calib	99
Exh 5,6,7,8 / *C	582 582 595 582		
Exh 9,10,11,12 / *C	589 582 595 595	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	589 595 589 589	Switches 16-23	00000000
RH Turbo In, Out / *C	0 506	Engine Speed / rpm	1500
LH Turbo In, Out / *C	0 499	Mains Freq / Hz	50.0
After Cooler Water In / *C	53	Power (R,Y,B) / kW	328.6 340.4 328.6
Jacket Water In, Out / *C	109 113	Power Calib	101
Manifold Air Temp / *C	70	Power (R,Y,B) / kVA	331.4 331.4 339.8
Oil / *C	104	Power Factors (R,Y,B)	0.99 1.00 0.97
Enclosure Ambient / *C	27	Volts (R,Y,B,Gen) / V	237 237 235 228
Gen Temps (R,Y,B) / *C	95 95 94	Current (R,Y,B) / A	1400 1400 1449
		RMS Calib	100

Last Trip 38 Low exh 8  
 CPU Status 8 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD

Sw 0: Mains Under Freq	0	Sw 16: Deltec Tecjet Fail	0
Sw 1: Mains Over Freq	0	Sw 17: Oil Level/Flow	0
Sw 2: Mains Under Voltage	0	Sw 18: DV Regulator Fault	0
Sw 3: Mains Over Voltage	0	Sw 19: EISM Shutdown	0
Sw 4: Fire / Gas Alarm	0	Sw 20: Contactor Sense	0
Sw 5: Low Oil Pressure	0	Sw 21: Pastor trip	0
Sw 6: External On/Off	0	Sw 22: Exhaust Back Pressure	0
Sw 7: Emergency Stop	0	Sw 23: Trip Sense	0
Sw 8: Engine Thermostat	0		
Sw 9: Governor Stop	0		
Sw 10: Gas Pressure	0		

Sw 11: Phase Rotation	0
Sw 12: Motor Overload	0
Sw 13: Motor Overload Warning	0
Sw 14: PLC General Trip	0
Sw 15: Single Phase Failure	0



**ANNEX 2**  
**ENGINE SUMMARY**  
**EMISSION AND DATA**  
**SHEETS**

**GAS SUPPLY AND EXHAUST EMISSION SUMMARY WORK SHEET FOR LABORATORY A (9-10 September 2002)**

User inputs indicated by  
ENGINE E9 Laboratory A

ENGINE E9 Laboratory A

Air <sup>1</sup>	mg/Nm <sup>3</sup>	% v/v
Oxygen	271,530	21
Nitrogen	1,009,187	78.05
Argon	12,284	0.95
	1,293,000	100

Traces of  
CO<sub>2</sub>, Krypton, xenon, neon and helium

Gas <sup>1</sup>	mg/Nm <sup>3</sup>	% v/v
Methane	421,526	59.04
Other VOCs	nd	
Sulphur (total)	83	
Chlorine (as HCl)	50	
Fluorine (as HF)	16	
CO	43	
PCDDs/PCDFs	3.20E-09	
Hydrogen	18	0.02
Oxygen	1,142	0.16
CO <sub>2</sub>	763,963	38.91
Nitrogen	24,489	1.96
Moisture	14,618	1.82
	1,225,948	100.09

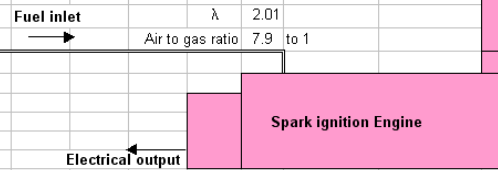
<sup>1</sup> %v/v converted using: (%v/v/100) \* (Mw/Vm) \* 1000, Mw = molecular weight, Vm = molar volume  
nd - not determined

**Air to fuel ratio calculation**

Supply gas	Average
Flow rate moist (m <sup>3</sup> /h)	499
Moisture content (%v/v)	1.82
Temperature (°C)	51.0 T <sub>inlet</sub>
Delivery pressure (kPa)	21.2
Total pressure (kPa)	122.5 P <sub>inlet</sub>
Flow rate moist (Nm <sup>3</sup> /h) <sup>1</sup>	509
Flow rate dry @ measured O <sub>2</sub> (Nm <sup>3</sup> /h) <sup>1</sup>	500

Exhaust gas	
Flow rate moist (m <sup>3</sup> /h)	13165
Oxygen (%v/v)	8.2
Moisture content (%v/v)	9.3
Temperature (°C)	467 T <sub>exhaust</sub>
Total pressure (kPa)	102.0 P <sub>exhaust</sub>
Flow rate moist (Nm <sup>3</sup> /h) <sup>1</sup>	4890
Flow rate dry @ 5% O <sub>2</sub> (Nm <sup>3</sup> /h)	3543

Combustion air required moist (Nm <sup>3</sup> /h)	4381	A/F ratio	7.88 to 1
Flow rate dry @ exhaust O <sub>2</sub> (Nm <sup>3</sup> /h)	4435		
Combustion air required dry (Nm <sup>3</sup> /h)	3936		



Key Engine Parameters	Average	Range (over test periods)
Fuel admission timing	30	- ° BTDC
Average cylinder temp	592	576 - 602 ° C
Throttle position	49.2	44.7 - 52.2 °
Crankcase	Vokes filter	-
Average load	986	986 - 1021 kWe
Ambient air temp	29	24 - 34 ° C
Gas flow (moist)	509	- Nm <sup>3</sup> /hr
Methane content <sup>1</sup>	59.0	- % v/v
Methane flow	300	- Nm <sup>3</sup> /hr
Heat value at 35.89MJ/m <sup>3</sup>	10783	- MJ/hr
Average thermal efficiency	33.3%	-

<sup>1</sup> Value obtained from gas analysis

Mass Balances
CI OUT = 51 % of CI IN
F OUT = 67 % of F IN
S OUT = nd % of S IN

**Comments on engine performance during testing period for Laboratory A**

Engine appeared to run normally throughout the duration of testing by Laboratory A.  
Recorded load varied between 986 and 1021 kWe, throttle position between 45 and 52°.  
No engine shutdowns or difficulties were experienced.  
The recorded temperature variation of the exhaust stack by Laboratory A during the testing period was 463 - 476 °C.

Exhaust	mg/Nm <sup>3</sup> dry STP (5% O <sub>2</sub> )	Measured	mg/kWe-hr	Mass emission rates
CO <sub>2</sub>	277768	985546	984.1	kg/h
CO	1273	4517	4.5	kg/h
N <sub>2</sub>	1259231	4467861	4461	kg/h
THC (as C)	1277	4531	4.5	kg/h
NOx (as NO <sub>2</sub> )	539	1912	1.9	kg/h
SOx (as SO <sub>2</sub> )	nd	nd	nd	kg/h
HCl	3.6	12.8	12.8	g/h
HF	1.5	5.1	5.1	g/h
Particulates	3.05	10.8	10.8	g/h
PCDDs/PCDFs	4.10E-09	1.5E-08	14.5	ng-TEQ/h

**Ambient Air** mg/Nm<sup>3</sup> dry STP (20.9% O<sub>2</sub>)

Measured	
PCDDs/PCDFs	4.00E-10

**Exhaust Dust** ng/kg

Measured	
PCDDs/PCDFs	248

**λ - calculation from measured O<sub>2</sub> content in exhaust**

$$\lambda = 1 + (V_{min,ex} \times O_{2ex}) / (21 - O_{2ex}) \times \lambda_{min} = 2.01$$

V<sub>min,ex</sub>: minimum dry volume of exhaust

O<sub>2ex</sub>: measured dry content of O<sub>2</sub> in exhaust

λ<sub>min</sub>: minimum dry volume of air to burn 1 m<sup>3</sup> landfill gas

**Gas aggressiveness index** 140

Mild site	<30	mg/Nm <sup>3</sup>
Mildly aggressive	30 to 100	mg/Nm <sup>3</sup>
Aggressive	100 to 250	mg/Nm <sup>3</sup>
Very aggressive	>250	mg/Nm <sup>3</sup>
Average lube oil life	1400	hrs

**Figure A2.1 Gas supply and exhaust emissions summary for Lab A (9-10/09/02)**

**GAS SUPPLY AND EXHAUST EMISSION SUMMARY WORK SHEET FOR LABORATORY B (12 September 2002)**

User inputs indicated by  
ENGINE E9 Laboratory B

ENGINE E9 Laboratory B

Air <sup>1</sup>	mg/Nm <sup>3</sup>	% v/v
Oxygen	271,530	21
Nitrogen	1,009,187	78.05
Argon	12,284	0.95
	1,293,000	100

Traces of  
CO<sub>2</sub>, Krypton, xenon, neon and helium

Gas <sup>1</sup>	mg/Nm <sup>3</sup>	% v/v
Methane	342,704	48
Other VOCs	nd	
Sulphur (total)	nd	
Chlorine (as HCl)	LOD	0.6
Fluorine (as HF)	LOD	0.6
CO	<	250 0.02
PCDDs/PCDFs	nd	
Hydrogen	nd	nd
Oxygen	714	0.10
CO <sub>2</sub>	1,020,973	52
Nitrogen	6,247	0.50
Moisture	17,671	2.20
	1,388,560	100.62

<sup>1</sup> %v/v converted using: (%w/v/100) \* (Mw/Vm) \* 1000, Mw = molecular weight, Vm = molar volume  
nd - not determined, LOD - limit of detection

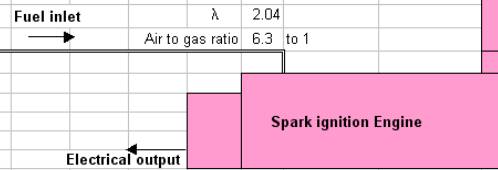
**Air to fuel ratio calculation**

Supply gas	Average
Flow rate moist (m <sup>3</sup> /h)	612
Moisture content (%w/v)	2.2
Temperature (°C)	57.0 T <sub>inlet</sub>
Delivery pressure (kPa)	21.9
Total pressure (kPa)	124.6 P <sub>inlet</sub>
Flow rate moist (Nm <sup>3</sup> /h) <sup>1</sup>	623
Flow rate dry @ measured O <sub>2</sub> (Nm <sup>3</sup> /h) <sup>1</sup>	609

Exhaust gas	
Flow rate moist (m <sup>3</sup> /h)	13979
Oxygen (%w/v)	8.3
Moisture content (%w/v)	12.6
Temperature (°C)	476 T <sub>exhaust</sub>
Total pressure (kPa)	101.4 P <sub>exhaust</sub>
Flow rate moist (Nm <sup>3</sup> /h) <sup>1</sup>	5102
Flow rate dry @ 5% O <sub>2</sub> (Nm <sup>3</sup> /h)	3534

<sup>1</sup> at STP (273 K, 101.3 kPa)

Combustion air required moist (Nm <sup>3</sup> /h)	4479	A/F ratio	6.32 to 1
Flow rate dry @ exhaust O <sub>2</sub> (Nm <sup>3</sup> /h)	4459		
Combustion air required dry (Nm <sup>3</sup> /h)	3850		



Key Engine Parameters	Average	Range (over test periods)
Fuel admission timing	30	- ° BTDC
Average cylinder temp	593	582 - 602 ° C
Throttle position	50.0	45.3 - 54.0 °
Crankcase	Vokes filter	-
Average load	996	986 - 1021 kWe
Ambient air temp	31	28 - 34 ° C
Gas flow (moist)	623	- Nm <sup>3</sup> /hr
Methane content <sup>1</sup>	48.0	- % v/v
Methane flow	299	- Nm <sup>3</sup> /hr
Heat value at 35.89MJ/m <sup>3</sup>	10734	- MJ/hr
Average thermal efficiency	33.5%	-

<sup>1</sup> Value obtained from gas analysis

**Mass Balances**

CI OUT =	5966.6 % of CI IN
F OUT =	1732.2 % of F IN
S OUT =	nd % of S IN

**Comments on engine performance during testing period for Laboratory B**

Engine appeared to run normally throughout the duration of testing by Laboratory B.  
Recorded load varied between 986 and 1021 kWe, throttle position between 45 and 54°.  
No engine shutdowns or difficulties were experienced.  
The recorded temperature variation of the exhaust stack by Laboratory B during the testing period was 470 - 483 °C.

Exhaust	mg/Nm <sup>3</sup> dry STP (5% O <sub>2</sub> )		
	Measured	mg/kWe-hr	Mass emission rates
CO <sub>2</sub>	nd	nd	nd kg/h
CO	1363	4827	4.8 kg/h
N <sub>2</sub>	nd	nd	nd kg/h
THC (as C)	939	3326	3.3 kg/h
NOx (as NO <sub>2</sub> )	620	2196	2.2 kg/h
SOx (as SO <sub>2</sub> )	nd	nd	nd kg/h
HCl	6.2	22.0	21.9 g/h
HF	1.8	6.4	6.4 g/h
Particulates	6.0	21.2	21.2 g/h
PCDDs/PCDFs	3.00E-09	1.1E-08	10.6 ng-TEQ/h

Ambient Air mg/Nm<sup>3</sup> dry STP (20.9% O<sub>2</sub>)

Measured

PCDDs/PCDFs	nd
-------------	----

Exhaust Dust ng/kg

Measured

PCDDs/PCDFs	nd
-------------	----

**λ - calculation from measured O<sub>2</sub> content in exhaust**

$$\lambda = 1 + (V_{\text{min, tr}} \times O_{2\text{tr}}) / (21 - O_{2\text{tr}}) \times I_{\text{min}} = 2.04$$

V<sub>min, tr</sub>: minimum dry volume of exhaust

O<sub>2tr</sub>: measured dry content of O<sub>2</sub> in exhaust

I<sub>min, tr</sub>: minimum dry volume of air to burn 1 m<sup>3</sup> landfill gas

**Gas aggressiveness index**

Mild site	<input checked="" type="checkbox"/>	<30	mg/Nm <sup>3</sup>
Mildly aggressive	<input type="checkbox"/>	30 to 100	mg/Nm <sup>3</sup>
Aggressive	<input type="checkbox"/>	100 to 250	mg/Nm <sup>3</sup>
Very aggressive	<input type="checkbox"/>	>250	mg/Nm <sup>3</sup>
Average lube oil life		1400	hrs

**Figure A2.2 Gas supply and exhaust emissions summary for Lab B (12/09/02)**

**GAS SUPPLY AND EXHAUST EMISSION SUMMARY WORK SHEET FOR LABORATORY C (17-18 September 2002)**

User inputs indicated by  
ENGINE E9 Laboratory C

ENGINE E9 Laboratory C

Air <sup>1</sup>	mg/Nm <sup>3</sup>	% w/v
Oxygen	271,530	21
Nitrogen	1,009,187	78.05
Argon	12,284	0.95
	1,293,000	100

Traces of  
CO<sub>2</sub>, Krypton, xenon, neon and helium

Gas <sup>1</sup>	mg/Nm <sup>3</sup>	% w/v
Methane	366,908	51
Other VOCs	nd	
Sulphur (total)	nd	
Chlorine (as HCl)	0.5	
Fluorine (as HF)	<	0.2
CO	<	125 0.01
PCDDs/PCDFs	nd	
Hydrogen	nd	nd
Oxygen	<	714 0.10
CO <sub>2</sub>	688,764	35
Nitrogen & other gases	172,985	13.85
Moisture	27,309	3.4
	1,256,806	100.43

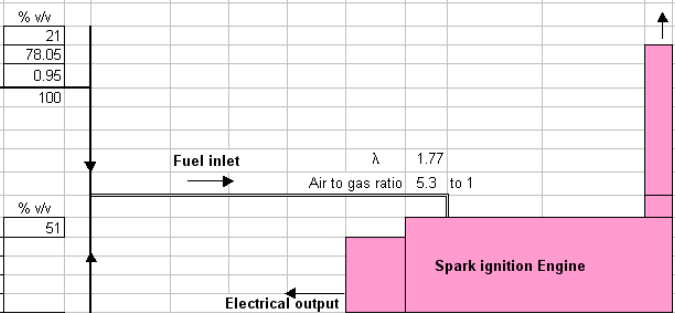
<sup>1</sup> %w/v converted using: (%w/v/100) \* (Mw/Vm) \* 1000, Mw = molecular weight, Vm = molar volume  
nd - not determined, LOD - limit of detection

**Air to fuel ratio calculation**

Supply gas	Average
Flow rate moist (m <sup>3</sup> /h)	778
Moisture content (%w/v)	3.4
Temperature (°C)	54.0 T <sub>inlet</sub>
Delivery pressure (kPa)	21
Total pressure (kPa)	123.8 P <sub>inlet</sub>
Flow rate moist (Nm <sup>3</sup> /h) <sup>1</sup>	794
Flow rate dry @ measured O <sub>2</sub> (Nm <sup>3</sup> /h) <sup>1</sup>	767

**Exhaust gas**

Flow rate moist (m <sup>3</sup> /h)	14205
Oxygen (%w/v)	7.9
Moisture content (%w/v)	7.9
Temperature (°C)	475 T <sub>exhaust</sub>
Total pressure (kPa)	101.8 P <sub>exhaust</sub>
Flow rate moist (Nm <sup>3</sup> /h) <sup>1</sup>	5208
Flow rate dry @ 5% O <sub>2</sub> (Nm <sup>3</sup> /h)	3922
<sup>1</sup> at STP (273 K, 101.3 kPa)	
Combustion air required moist (Nm <sup>3</sup> /h)	4415
Flow rate dry @ exhaust O <sub>2</sub> (Nm <sup>3</sup> /h)	4797
Combustion air required dry (Nm <sup>3</sup> /h)	4030



Key Engine Parameters	Average	Range (over test periods)
Fuel admission timing	30	- ° BTDC
Average cylinder temp	590	582 - 602 ° C
Throttle position	47.5	45.3 - 51.3 °
Crankcase	Vokes filter	-
Average load	996	986 - 1021 kWe
Ambient air temp	26	24 - 29 ° C
Gas flow (moist)	794	- Nm <sup>3</sup> /hr
Methane content <sup>1</sup>	51.4	- % w/v
Methane flow	408	- Nm <sup>3</sup> /hr
Heat value at 35.89MJ/m <sup>3</sup>	14636	- MJ/hr
Average thermal efficiency	24.5%	-

<sup>1</sup> Value obtained from gas analysis

**Mass Balances**

CI OUT =	17782	% of CI IN
F OUT =	8150	% of F IN
S OUT =	nd	% of S IN

**Comments on engine performance during testing period for Laboratory C**

Engine appeared to run normally for the duration of the particulate, halide, NO<sub>x</sub>, CO, THC emissions testing by Laboratory C. However, the engine stalled (as a consequence of air ingress into the gas supply line within the gas field) at 15:14 on 17/09/02 (see Annex 5). Laboratory C monitoring staff reported that the dioxin test was stopped immediately (337.5 minutes through the 360 minute test). On that basis, the recorded load varied between 986 and 1021 kWe with the throttle position between 45 and 54° for the period of the testing of all of the determinands. The recorded temperature variation of the exhaust stack by Laboratory C during the testing period was 432 - 482 °C.

Exhaust	mg/Nm <sup>3</sup> dry STP (5% O <sub>2</sub> )		
	Measured	mg/kWe-hr	Mass emission rates
CO <sub>2</sub>	295372	1162551	1158.4 kg/h
CO	1075	4231	4.2 kg/h
N <sub>2</sub>	nd	nd	nd kg/h
THC (as C)	680	2676	2.7 kg/h
NO <sub>x</sub> (as NO <sub>2</sub> )	557	2192	2.2 kg/h
SO <sub>x</sub> (as SO <sub>2</sub> )	86	338	0.3 kg/h
HCl	18	70.8	70.6 g/h
HF	3.3	13.0	12.9 g/h
Particulates	38.0	149.6	149.0 g/h
PCDDs/PCDFs	6.00E-07	2.4E-06	2353.1 ng-TEQ/h

**Ambient Air** mg/Nm<sup>3</sup> dry STP (20.9% O<sub>2</sub>)

Measured	
PCDDs/PCDFs	nd

**Exhaust Dust** ng/kg

Measured	
PCDDs/PCDFs	nd

**λ - calculation from measured O<sub>2</sub> content in exhaust**

$$\lambda = 1 + (V_{\text{min, tr}} \times O_{2\text{tr}}) / (21 - O_{2\text{tr}}) \times I_{\text{min}} \quad 1.77$$

V<sub>min, tr</sub>: minimum dry volume of exhaust

O<sub>2tr</sub>: measured dry content of O<sub>2</sub> in exhaust

I<sub>min, tr</sub>: minimum dry volume of air to burn 1 m<sup>3</sup> landfill gas

**Gas aggressiveness index** 2

Mild site	<input checked="" type="checkbox"/>	<30	mg/Nm <sup>3</sup>
Mildly aggressive	<input type="checkbox"/>	30 to 100	mg/Nm <sup>3</sup>
Aggressive	<input type="checkbox"/>	100 to 250	mg/Nm <sup>3</sup>
Very aggressive	<input type="checkbox"/>	>250	mg/Nm <sup>3</sup>
Average lube oil life		1400	hrs

**Figure A2.3 Gas supply and exhaust emissions summary for Lab C (17-18/09/02)**

**ANNEX 3**  
**ENGINE LOG EXTRACTS**  
**(04/12/01 – 07/12/01)**

**04/12/01 – 07/12/01 Engine Log Extract**

```

Last Trip 76 Emergency stop
CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<
Modulation: No modulation State 8 ON LOAD
Unit No: 673 Unit Type: 16C35TN1 Log No: 5
Time of Log 4/12 7:42: 6 Jacket Water pressure (bar) 2.7
Time of Sync 22/11 14:41:47 Manifold Press / bar 1.7
Fuel / kW / kWhr 0 0 Oil Press / bar 4.1
Elec / kW / kWhr 1009 61553 After Cooler Water Pressure/bar 2.3
Throttle / * 57 Gas pressure / (mbar) 150
Exh 1,2,3,4 / *C 608 608 602 602 Analog Calib 99
Exh 5,6,7,8 / *C 589 602 595 602
Exh 9,10,11,12 / *C 589 602 595 608 Switches 0-15 0000000000000000
Exh 13,14,15,16 / *C 608 602 614 608 Switches 16-23 00000000
RH Turbo In, Out / *C 0 525 Engine Speed / rpm 1500
LH Turbo In, Out / *C 0 525 Mains Freq / Hz 49.9
After Cooler Water In / *C 53 Power (R,Y,B) / kW 340.4 340.4 328.6
Jacket Water In, Out / *C 108 112 Power Calib 101
Manifold Air Temp / *C 67 Power (R,Y,B) / kVA 328.3 336.0 348.0
Oil / *C 102 Power Factors (R,Y,B) 1.00 1.00 0.94
Enclosure Ambient / *C 26 Volts (R,Y,B,Gen) / V 235 235 232 226
Gen Temps (R,Y,B) / *C 95 94 94 Current (R,Y,B) / A 1400 1432 1497
RMS Calib 100
    
```

```

Last Trip 76 Emergency stop
CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<
Modulation: No modulation State 8 ON LOAD
Unit No: 673 Unit Type: 16C35TN1 Log No: 6
Time of Log 4/12 8:42: 6 Jacket Water pressure (bar) 2.7
Time of Sync 22/11 14:41:47 Manifold Press / bar 1.6
Fuel / kW / kWhr 0 0 Oil Press / bar 4.1
Elec / kW / kWhr 1021 62548 After Cooler Water Pressure/bar 2.3
Throttle / * 57 Gas pressure / (mbar) 150
Exh 1,2,3,4 / *C 608 608 602 602 Analog Calib 99
Exh 5,6,7,8 / *C 589 602 595 602
Exh 9,10,11,12 / *C 589 602 595 608 Switches 0-15 0000000000000000
Exh 13,14,15,16 / *C 608 602 614 608 Switches 16-23 00000000
RH Turbo In, Out / *C 0 525 Engine Speed / rpm 1500
LH Turbo In, Out / *C 0 525 Mains Freq / Hz 49.9
After Cooler Water In / *C 53 Power (R,Y,B) / kW 340.4 340.4 340.4
Jacket Water In, Out / *C 108 112 Power Calib 101
Manifold Air Temp / *C 67 Power (R,Y,B) / kVA 323.7 342.9 351.2
Oil / *C 102 Power Factors (R,Y,B) 1.00 0.99 0.97
Enclosure Ambient / *C 26 Volts (R,Y,B,Gen) / V 237 237 235 228
Gen Temps (R,Y,B) / *C 94 94 94 Current (R,Y,B) / A 1367 1449 1497
RMS Calib 100
    
```

10

```

Last Trip 76 Emergency stop
CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<
Modulation: No modulation State 8 ON LOAD
Unit No: 673 Unit Type: 16C35TN1 Log No: 7
Time of Log 4/12 9:42: 6 Jacket Water pressure (bar) 2.7
Time of Sync 22/11 14:41:47 Manifold Press / bar 1.6
Fuel / kW / kWhr 0 0 Oil Press / bar 4.0
Elec / kW / kWhr 986 63545 After Cooler Water Pressure/bar 2.3
Throttle / * 59 Gas pressure / (mbar) 150
Exh 1,2,3,4 / *C 608 608 602 602 Analog Calib 99
    
```

Exh 5,6,7,8 / *C	589 602 595 602			
Exh 9,10,11,12 / *C	589 602 595 608	Switches 0-15	0000000000000000	
Exh 13,14,15,16 / *C	608 602 614 608	Switches 16-23	00000000	
RH Turbo In, Out / *C	0 525	Engine Speed / rpm	1500	
LH Turbo In, Out / *C	0 525	Mains Freq / Hz	50.0	
After Cooler Water In / *C	53	Power (R,Y,B) / kW	328.6 328.6 328.6	
Jacket Water In, Out / *C	108 112	Power Calib	101	
Manifold Air Temp / *C	67	Power (R,Y,B) / kVA	332.1 323.7 325.3	
Oil / *C	102	Power Factors (R,Y,B)	0.99 1.00 1.00	
Enclosure Ambient / *C	26	Volts (R,Y,B,Gen) / V	235 237 232 226	
Gen Temps (R,Y,B) / *C	94 94 94	Current (R,Y,B) / A	1416 1367 1400	
		RMS Calib	100	

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 8

Time of Log	4/12 10:42: 6	Jacket Water pressure (bar)	2.7
Time of Sync	22/11 14:41:47	Manifold Press / bar	1.6
Fuel / kW / kWhr	0 0	Oil Press / bar	4.1
Elec / kW / kWhr	986 64542	After Cooler Water Pressure/bar	2.3
Throttle / *	56	Gas pressure / (mbar)	150
Exh 1,2,3,4 / *C	608 608 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 602 595 602		
Exh 9,10,11,12 / *C	589 602 595 608	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	602 602 608 608	Switches 16-23	00000000
RH Turbo In, Out / *C	0 525	Engine Speed / rpm	1500
LH Turbo In, Out / *C	0 525	Mains Freq / Hz	50.0
After Cooler Water In / *C	53	Power (R,Y,B) / kW	328.6 328.6 328.6
Jacket Water In, Out / *C	108 112	Power Calib	101
Manifold Air Temp / *C	67	Power (R,Y,B) / kVA	330.5 338.3 342.9
Oil / *C	102	Power Factors (R,Y,B)	0.99 0.97 0.96
Enclosure Ambient / *C	26	Volts (R,Y,B,Gen) / V	239 239 237 230
Gen Temps (R,Y,B) / *C	94 94 94	Current (R,Y,B) / A	1383 1416 1449
		RMS Calib	100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 0

Time of Log	4/12 11:42: 4	Jacket Water pressure (bar)	2.7
Time of Sync	22/11 14:41:47	Manifold Press / bar	1.6
Fuel / kW / kWhr	0 0	Oil Press / bar	4.1
Elec / kW / kWhr	1009 65540	After Cooler Water Pressure/bar	2.3
Throttle / *	56	Gas pressure / (mbar)	150
Exh 1,2,3,4 / *C	608 602 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 602 595 602		
Exh 9,10,11,12 / *C	595 602 595 608	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	608 602 614 608	Switches 16-23	00000000
RH Turbo In, Out / *C	0 525	Engine Speed / rpm	1500
LH Turbo In, Out / *C	0 525	Mains Freq / Hz	50.0
After Cooler Water In / *C	54	Power (R,Y,B) / kW	328.6 340.4 340.4
Jacket Water In, Out / *C	109 112	Power Calib	101
Manifold Air Temp / *C	68	Power (R,Y,B) / kVA	323.7 330.5 347.4
Oil / *C	102	Power Factors (R,Y,B)	1.00 1.00 0.98
Enclosure Ambient / *C	26	Volts (R,Y,B,Gen) / V	237 239 235 228
Gen Temps (R,Y,B) / *C	94 95 94	Current (R,Y,B) / A	1367 1383 1481

				RMS Calib	100
Last Trip 76 Emergency stop					
CPU Status	136	>>>	CURRENT STATUS	255	Normal running <<<
Modulation:	No modulation		State	8 ON LOAD	
Unit No:	673	Unit Type:	16C35TN1		
			Log No:	1	
Time of Log	4/12	12:42:4	Jacket Water pressure (bar)	2.7	
Time of Sync	22/11	14:41:47	Manifold Press / bar	1.7	
Fuel / kW / kWhr	0	0	Oil Press / bar	4.1	
Elec / kW / kWhr	1021	66540	After Cooler Water Pressure/bar	2.3	
Throttle / *	57		Gas pressure / (mbar)	150	
Exh 1,2,3,4 / *C	608	608 602 602	Analog Calib	99	
Exh 5,6,7,8 / *C	589	602 595 602			
Exh 9,10,11,12 / *C	589	602 595 608	Switches 0-15	0000000000000000	
Exh 13,14,15,16 / *C	608	602 608 608	Switches 16-23	00000000	
RH Turbo In, Out / *C	0	525	Engine Speed / rpm	1500	
LH Turbo In, Out / *C	0	525	Mains Freq / Hz	50.0	
After Cooler Water In / *C	53		Power (R,Y,B) / kW	340.4	340.4 340.4
Jacket Water In, Out / *C	108	112	Power Calib	101	
Manifold Air Temp / *C	67		Power (R,Y,B) / kVA	342.2	338.3 342.9
Oil / *C	102		Power Factors (R,Y,B)	0.99	1.00 0.99
Enclosure Ambient / *C	25		Volts (R,Y,B,Gen) / V	239	239 237 230
Gen Temps (R,Y,B) / *C	94	94 94	Current (R,Y,B) / A	1432	1416 1449
			RMS Calib	100	

Last Trip 76 Emergency stop					
CPU Status	136	>>>	CURRENT STATUS	255	Normal running <<<
Modulation:	No modulation		State	8 ON LOAD	
Unit No:	673	Unit Type:	16C35TN1		
			Log No:	2	
Time of Log	4/12	13:42:4	Jacket Water pressure (bar)	2.7	
Time of Sync	22/11	14:41:47	Manifold Press / bar	1.6	
Fuel / kW / kWhr	0	0	Oil Press / bar	4.1	
Elec / kW / kWhr	1021	67538	After Cooler Water Pressure/bar	2.3	
Throttle / *	57		Gas pressure / (mbar)	150	
Exh 1,2,3,4 / *C	608	602 602 602	Analog Calib	99	
Exh 5,6,7,8 / *C	589	602 595 602			
Exh 9,10,11,12 / *C	589	602 595 608	Switches 0-15	0000000000000000	
Exh 13,14,15,16 / *C	602	602 614 608	Switches 16-23	00000000	
RH Turbo In, Out / *C	0	525	Engine Speed / rpm	1500	
LH Turbo In, Out / *C	0	525	Mains Freq / Hz	50.0	
After Cooler Water In / *C	53		Power (R,Y,B) / kW	340.4	340.4 340.4
Jacket Water In, Out / *C	109	112	Power Calib	101	
Manifold Air Temp / *C	67		Power (R,Y,B) / kVA	338.3	334.4 336.0
Oil / *C	102		Power Factors (R,Y,B)	1.00	1.00 1.00
Enclosure Ambient / *C	26		Volts (R,Y,B,Gen) / V	239	239 235 230
Gen Temps (R,Y,B) / *C	94	94 93	Current (R,Y,B) / A	1416	1400 1432
			RMS Calib	100	

Last Trip 76 Emergency stop					
CPU Status	136	>>>	CURRENT STATUS	255	Normal running <<<
Modulation:	No modulation		State	8 ON LOAD	
Unit No:	673	Unit Type:	16C35TN1		
			Log No:	3	
Time of Log	4/12	14:42:4	Jacket Water pressure (bar)	2.7	
Time of Sync	22/11	14:41:47	Manifold Press / bar	1.7	
Fuel / kW / kWhr	0	0	Oil Press / bar	4.1	
Elec / kW / kWhr	1021	68535	After Cooler Water Pressure/bar	2.3	
Throttle / *	58		Gas pressure / (mbar)	159	

Exh 1,2,3,4 / *C	608	608	602	602	Analog Calib					99
Exh 5,6,7,8 / *C	589	602	595	602						
Exh 9,10,11,12 / *C	589	602	595	608	Switches 0-15		0000000000000000			
Exh 13,14,15,16 / *C	602	602	608	608	Switches 16-23			00000000		
RH Turbo In, Out / *C			0	525	Engine Speed / rpm					1508
LH Turbo In, Out / *C			0	525	Mains Freq / Hz					50.0
After Cooler Water In / *C				54	Power (R,Y,B) / kW	328.6	340.4	352.1		
Jacket Water In, Out / *C		108	112		Power Calib					100
Manifold Air Temp / *C				67	Power (R,Y,B) / kVA	334.4	338.3	335.2		
Oil / *C				102	Power Factors (R,Y,B)		0.98	1.00	1.00	
Enclosure Ambient / *C				25	Volts (R,Y,B,Gen) / V	239	239	237	230	
Gen Temps (R,Y,B) / *C	94	94	93		Current (R,Y,B) / A	1400	1416	1416		
					RMS Calib					100

Last Trip 76 Emergency stop  
CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
Modulation: No modulation State 8 ON LOAD  
Unit No: 673 Unit Type: 16C35TN1 Log No: 4

Time of Log	4/12 15:42: 4	Jacket Water pressure (bar)	2.7
Time of Sync	22/11 14:41:47	Manifold Press / bar	1.6
Fuel / kW / kWhr	0 0	Oil Press / bar	4.1
Elec / kW / kWhr	1009 69535	After Cooler Water Pressure/bar	2.2
Throttle / *	54	Gas pressure / (mbar)	150
Exh 1,2,3,4 / *C	608 602 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 602 589 602		
Exh 9,10,11,12 / *C	589 602 595 608	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	608 595 608 602	Switches 16-23	00000000
RH Turbo In, Out / *C		Engine Speed / rpm	1500
LH Turbo In, Out / *C		Mains Freq / Hz	50.0
After Cooler Water In / *C		Power (R,Y,B) / kW	328.6 340.4 340.4
Jacket Water In, Out / *C	108 111	Power Calib	101
Manifold Air Temp / *C		Power (R,Y,B) / kVA	327.5 334.4 347.4
Oil / *C		Power Factors (R,Y,B)	1.00 1.00 0.98
Enclosure Ambient / *C		Volts (R,Y,B,Gen) / V	237 239 235 228
Gen Temps (R,Y,B) / *C	93 92 91	Current (R,Y,B) / A	1383 1400 1481
		RMS Calib	100

Last Trip 76 Emergency stop  
CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
Modulation: No modulation State 8 ON LOAD  
Unit No: 673 Unit Type: 16C35TN1 Log No: 5

Time of Log	4/12 16:42: 4	Jacket Water pressure (bar)	2.7
Time of Sync	22/11 14:41:47	Manifold Press / bar	1.6
Fuel / kW / kWhr	0 0	Oil Press / bar	4.1
Elec / kW / kWhr	998 70532	After Cooler Water Pressure/bar	2.3
Throttle / *	59	Gas pressure / (mbar)	159
Exh 1,2,3,4 / *C	608 602 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 602 589 602		
Exh 9,10,11,12 / *C	589 602 595 608	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	608 602 608 608	Switches 16-23	00000000
RH Turbo In, Out / *C		Engine Speed / rpm	1500
LH Turbo In, Out / *C		Mains Freq / Hz	50.0
After Cooler Water In / *C		Power (R,Y,B) / kW	328.6 328.6 340.4
Jacket Water In, Out / *C	108 112	Power Calib	101
Manifold Air Temp / *C		Power (R,Y,B) / kVA	336.0 332.1 325.3
Oil / *C		Power Factors (R,Y,B)	0.98 0.99 1.00
Enclosure Ambient / *C		Volts (R,Y,B,Gen) / V	235 235 232 226



Throttle / *		55	Gas pressure / (mbar)	159
Exh 1,2,3,4 / *C	608 602 602 602		Analog Calib	99
Exh 5,6,7,8 / *C	589 602 589 595			
Exh 9,10,11,12 / *C	589 595 595 608		Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	602 595 608 602		Switches 16-23	00000000
RH Turbo In, Out / *C	0 525		Engine Speed / rpm	1500
LH Turbo In, Out / *C	0 525		Mains Freq / Hz	50.0
After Cooler Water In / *C	53		Power (R,Y,B) / kW	328.6 328.6 328.6
Jacket Water In, Out / *C	108 112		Power Calib	101
Manifold Air Temp / *C	67		Power (R,Y,B) / kVA	329.1 332.1 333.5
Oil / *C	102		Power Factors (R,Y,B)	1.00 0.99 0.99
Enclosure Ambient / *C	26		Volts (R,Y,B,Gen) / V	232 235 230 224
Gen Temps (R,Y,B) / *C	91 92 91		Current (R,Y,B) / A	1416 1416 1449
			RMS Calib	100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 9

Time of Log	4/12 20:42: 4	Jacket Water pressure (bar)	2.8
Time of Sync	22/11 14:41:47	Manifold Press / bar	1.7
Fuel / kW / kWhr	0 0	Oil Press / bar	4.1
Elec / kW / kWhr	1033 74510	After Cooler Water Pressure/bar	2.3
Throttle / *	55	Gas pressure / (mbar)	150
Exh 1,2,3,4 / *C	608 602 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 602 595 602		
Exh 9,10,11,12 / *C	589 602 595 608	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	608 602 608 608	Switches 16-23	00000000
RH Turbo In, Out / *C	0 525	Engine Speed / rpm	1500
LH Turbo In, Out / *C	0 525	Mains Freq / Hz	49.9
After Cooler Water In / *C	53	Power (R,Y,B) / kW	340.4 340.4 352.1
Jacket Water In, Out / *C	108 112	Power Calib	101
Manifold Air Temp / *C	68	Power (R,Y,B) / kVA	339.8 339.8 348.0
Oil / *C	102	Power Factors (R,Y,B)	1.00 1.00 1.00
Enclosure Ambient / *C	21	Volts (R,Y,B,Gen) / V	235 235 232 226
Gen Temps (R,Y,B) / *C	90 90 90	Current (R,Y,B) / A	1449 1449 1497
		RMS Calib	100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 10

Time of Log	4/12 21:42: 4	Jacket Water pressure (bar)	2.8
Time of Sync	22/11 14:41:47	Manifold Press / bar	1.6
Fuel / kW / kWhr	0 0	Oil Press / bar	4.1
Elec / kW / kWhr	1021 75507	After Cooler Water Pressure/bar	2.3
Throttle / *	54	Gas pressure / (mbar)	159
Exh 1,2,3,4 / *C	608 602 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 595 589 602		
Exh 9,10,11,12 / *C	589 595 595 608	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	608 602 608 602	Switches 16-23	00000000
RH Turbo In, Out / *C	0 525	Engine Speed / rpm	1500
LH Turbo In, Out / *C	0 525	Mains Freq / Hz	50.0
After Cooler Water In / *C	53	Power (R,Y,B) / kW	340.4 340.4 340.4
Jacket Water In, Out / *C	108 112	Power Calib	101
Manifold Air Temp / *C	68	Power (R,Y,B) / kVA	343.6 339.8 340.4
Oil / *C	102	Power Factors (R,Y,B)	0.99 1.00 1.00

Enclosure Ambient / *C		23	Volts (R,Y,B,Gen) / V	235	235	232	226
Gen Temps (R,Y,B) / *C	88	89	88	Current (R,Y,B) / A	1465	1449	1465
				RMS Calib			100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 11  
 Time of Log 4/12 22:42: 4 Jacket Water pressure (bar) 2.8  
 Time of Sync 22/11 14:41:47 Manifold Press / bar 1.7  
 Fuel / kW / kWhr 0 0 Oil Press / bar 4.1  
 Elec / kW / kWhr 986 76502 After Cooler Water Pressure/bar 2.3  
 Throttle / \* 61 Gas pressure / (mbar) 159  
 Exh 1,2,3,4 / \*C 608 608 602 602 Analog Calib 99  
 Exh 5,6,7,8 / \*C 589 602 595 602  
 Exh 9,10,11,12 / \*C 589 602 595 608 Switches 0-15 0000000000000000  
 Exh 13,14,15,16 / \*C 608 602 608 608 Switches 16-23 00000000  
 RH Turbo In, Out / \*C 0 525 Engine Speed / rpm 1500  
 LH Turbo In, Out / \*C 0 525 Mains Freq / Hz 50.1  
 After Cooler Water In / \*C 53 Power (R,Y,B) / kW 328.6 328.6 328.6  
 Jacket Water In, Out / \*C 108 112 Power Calib 100  
 Manifold Air Temp / \*C 68 Power (R,Y,B) / kVA 336.0 336.0 343.6  
 Oil / \*C 102 Power Factors (R,Y,B) 0.98 0.98 0.96  
 Enclosure Ambient / \*C 25 Volts (R,Y,B,Gen) / V 235 235 235 226  
 Gen Temps (R,Y,B) / \*C 90 90 89 Current (R,Y,B) / A 1432 1432 1465  
 RMS Calib 100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 12  
 Time of Log 4/12 23:42: 4 Jacket Water pressure (bar) 2.8  
 Time of Sync 22/11 14:41:47 Manifold Press / bar 1.6  
 Fuel / kW / kWhr 0 0 Oil Press / bar 4.1  
 Elec / kW / kWhr 1009 77497 After Cooler Water Pressure/bar 2.3  
 Throttle / \* 55 Gas pressure / (mbar) 159  
 Exh 1,2,3,4 / \*C 608 602 602 602 Analog Calib 99  
 Exh 5,6,7,8 / \*C 589 595 595 602  
 Exh 9,10,11,12 / \*C 589 602 595 608 Switches 0-15 0000000000000000  
 Exh 13,14,15,16 / \*C 608 602 608 608 Switches 16-23 00000000  
 RH Turbo In, Out / \*C 0 525 Engine Speed / rpm 1500  
 LH Turbo In, Out / \*C 0 525 Mains Freq / Hz 50.0  
 After Cooler Water In / \*C 52 Power (R,Y,B) / kW 328.6 340.4 340.4  
 Jacket Water In, Out / \*C 108 111 Power Calib 100  
 Manifold Air Temp / \*C 67 Power (R,Y,B) / kVA 330.5 330.5 339.1  
 Oil / \*C 102 Power Factors (R,Y,B) 0.99 1.00 1.00  
 Enclosure Ambient / \*C 22 Volts (R,Y,B,Gen) / V 239 239 237 230  
 Gen Temps (R,Y,B) / \*C 88 88 88 Current (R,Y,B) / A 1383 1383 1432  
 RMS Calib 100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 13  
 Time of Log 5/12 0:42: 4 Jacket Water pressure (bar) 2.9  
 Time of Sync 22/11 14:41:47 Manifold Press / bar 1.7  
 Fuel / kW / kWhr 0 0 Oil Press / bar 4.1

Elec / kW / kWhr	1009	78492	After Cooler Water Pressure/bar	2.3
Throttle / *		59	Gas pressure / (mbar)	159
Exh 1,2,3,4 / *C	608	602 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589	602 595 602		
Exh 9,10,11,12 / *C	589	602 595 608	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	602	602 608 608	Switches 16-23	00000000
RH Turbo In, Out / *C		0 525	Engine Speed / rpm	1500
LH Turbo In, Out / *C		0 525	Mains Freq / Hz	50.1
After Cooler Water In / *C		52	Power (R,Y,B) / kW	328.6 340.4 340.4
Jacket Water In, Out / *C	107	111	Power Calib	100
Manifold Air Temp / *C		67	Power (R,Y,B) / kVA	331.4 346.1 346.8
Oil / *C		102	Power Factors (R,Y,B)	0.99 0.98 0.98
Enclosure Ambient / *C		22	Volts (R,Y,B,Gen) / V	237 239 237 228
Gen Temps (R,Y,B) / *C	88	88 87	Current (R,Y,B) / A	1400 1449 1465
			RMS Calib	100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 14

Time of Log	5/12	1:42: 4	Jacket Water pressure (bar)	2.9
Time of Sync	22/11	14:41:47	Manifold Press / bar	1.6
Fuel / kW / kWhr	0	0	Oil Press / bar	4.1
Elec / kW / kWhr	998	79488	After Cooler Water Pressure/bar	2.3
Throttle / *		57	Gas pressure / (mbar)	159
Exh 1,2,3,4 / *C	608	602 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589	602 595 602		
Exh 9,10,11,12 / *C	589	602 595 608	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	608	602 608 608	Switches 16-23	00000000
RH Turbo In, Out / *C		0 525	Engine Speed / rpm	1508
LH Turbo In, Out / *C		0 525	Mains Freq / Hz	50.1
After Cooler Water In / *C		52	Power (R,Y,B) / kW	328.6 340.4 328.6
Jacket Water In, Out / *C	107	111	Power Calib	100
Manifold Air Temp / *C		67	Power (R,Y,B) / kVA	337.4 338.3 339.1
Oil / *C		102	Power Factors (R,Y,B)	0.97 1.00 0.97
Enclosure Ambient / *C		22	Volts (R,Y,B,Gen) / V	241 239 237 230
Gen Temps (R,Y,B) / *C	86	86 86	Current (R,Y,B) / A	1400 1416 1432
			RMS Calib	100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 0

Time of Log	5/12	2:42: 2	Jacket Water pressure (bar)	2.9
Time of Sync	22/11	14:41:47	Manifold Press / bar	1.6
Fuel / kW / kWhr	0	0	Oil Press / bar	4.1
Elec / kW / kWhr	1009	80485	After Cooler Water Pressure/bar	2.3
Throttle / *		56	Gas pressure / (mbar)	159
Exh 1,2,3,4 / *C	608	602 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589	602 589 595		
Exh 9,10,11,12 / *C	589	595 595 608	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	608	595 608 608	Switches 16-23	00000000
RH Turbo In, Out / *C		0 525	Engine Speed / rpm	1500
LH Turbo In, Out / *C		0 525	Mains Freq / Hz	50.1
After Cooler Water In / *C		52	Power (R,Y,B) / kW	328.6 340.4 340.4
Jacket Water In, Out / *C	108	111	Power Calib	101
Manifold Air Temp / *C		67	Power (R,Y,B) / kVA	345.3 334.4 326.6

Oil / *C		102	Power Factors (R,Y,B)	0.95	1.00	1.00
Enclosure Ambient / *C		22	Volts (R,Y,B,Gen) / V	241	239	239
Gen Temps (R,Y,B) / *C	86	86	86	Current (R,Y,B) / A	1432	1400
				RMS Calib		1367
						100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 1  
 Time of Log 5/12 3:42: 2 Jacket Water pressure (bar) 2.8  
 Time of Sync 22/11 14:41:47 Manifold Press / bar 1.6  
 Fuel / kW / kWhr 0 0 Oil Press / bar 4.1  
 Elec / kW / kWhr 1009 81480 After Cooler Water Pressure/bar 2.3  
 Throttle / \* 54 Gas pressure / (mbar) 159  
 Exh 1,2,3,4 / \*C 608 602 602 602 Analog Calib 99  
 Exh 5,6,7,8 / \*C 589 602 589 602  
 Exh 9,10,11,12 / \*C 589 602 595 608 Switches 0-15 0000000000000000  
 Exh 13,14,15,16 / \*C 608 595 608 602 Switches 16-23 00000000  
 RH Turbo In, Out / \*C 0 525 Engine Speed / rpm 1500  
 LH Turbo In, Out / \*C 0 525 Mains Freq / Hz 49.9  
 After Cooler Water In / \*C 52 Power (R,Y,B) / kW 340.4 340.4 328.6  
 Jacket Water In, Out / \*C 108 111 Power Calib 100  
 Manifold Air Temp / \*C 67 Power (R,Y,B) / kVA 337.4 330.5 338.3  
 Oil / \*C 102 Power Factors (R,Y,B) 1.00 1.00 0.97  
 Enclosure Ambient / \*C 22 Volts (R,Y,B,Gen) / V 241 239 239 232  
 Gen Temps (R,Y,B) / \*C 86 86 86 Current (R,Y,B) / A 1400 1383 1416  
 RMS Calib 100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 2  
 Time of Log 5/12 4:42: 2 Jacket Water pressure (bar) 2.9  
 Time of Sync 22/11 14:41:47 Manifold Press / bar 1.7  
 Fuel / kW / kWhr 0 0 Oil Press / bar 4.1  
 Elec / kW / kWhr 1021 82475 After Cooler Water Pressure/bar 2.4  
 Throttle / \* 57 Gas pressure / (mbar) 159  
 Exh 1,2,3,4 / \*C 608 602 602 602 Analog Calib 99  
 Exh 5,6,7,8 / \*C 589 595 589 602  
 Exh 9,10,11,12 / \*C 589 602 595 608 Switches 0-15 0000000000000000  
 Exh 13,14,15,16 / \*C 608 602 608 608 Switches 16-23 00000000  
 RH Turbo In, Out / \*C 0 525 Engine Speed / rpm 1500  
 LH Turbo In, Out / \*C 0 525 Mains Freq / Hz 50.0  
 After Cooler Water In / \*C 52 Power (R,Y,B) / kW 340.4 340.4 340.4  
 Jacket Water In, Out / \*C 108 112 Power Calib 100  
 Manifold Air Temp / \*C 68 Power (R,Y,B) / kVA 337.4 341.4 346.1  
 Oil / \*C 102 Power Factors (R,Y,B) 1.00 1.00 0.98  
 Enclosure Ambient / \*C 22 Volts (R,Y,B,Gen) / V 241 241 239 232  
 Gen Temps (R,Y,B) / \*C 87 87 86 Current (R,Y,B) / A 1400 1416 1449  
 RMS Calib 100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 3  
 Time of Log 5/12 5:42: 2 Jacket Water pressure (bar) 2.9  
 Time of Sync 22/11 14:41:47 Manifold Press / bar 1.7

Fuel / kW / kWhr	0	0	Oil Press / bar	4.0
Elec / kW / kWhr	998	83473	After Cooler Water Pressure/bar	2.4
Throttle / *		58	Gas pressure / (mbar)	159
Exh 1,2,3,4 / *C	608	602 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589	595 589 602		
Exh 9,10,11,12 / *C	589	602 595 608	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	608	602 608 608	Switches 16-23	00000000
RH Turbo In, Out / *C		0 525	Engine Speed / rpm	1500
LH Turbo In, Out / *C		0 525	Mains Freq / Hz	50.0
After Cooler Water In / *C		52	Power (R,Y,B) / kW	340.4 328.6 328.6
Jacket Water In, Out / *C	108	112	Power Calib	101
Manifold Air Temp / *C		68	Power (R,Y,B) / kVA	349.2 342.2 334.4
Oil / *C		102	Power Factors (R,Y,B)	0.97 0.96 0.98
Enclosure Ambient / *C		22	Volts (R,Y,B,Gen) / V	241 239 239 232
Gen Temps (R,Y,B) / *C	87	87 86	Current (R,Y,B) / A	1449 1432 1400
			RMS Calib	100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 4

Time of Log	5/12 6:42: 2	Jacket Water pressure (bar)	2.9
Time of Sync	22/11 14:41:47	Manifold Press / bar	1.6
Fuel / kW / kWhr	0 0	Oil Press / bar	4.1
Elec / kW / kWhr	986 84470	After Cooler Water Pressure/bar	2.4
Throttle / *	55	Gas pressure / (mbar)	159
Exh 1,2,3,4 / *C	608 602 595 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 595 589 595		
Exh 9,10,11,12 / *C	589 595 595 608	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	602 595 608 602	Switches 16-23	00000000
RH Turbo In, Out / *C	0 525	Engine Speed / rpm	1500
LH Turbo In, Out / *C	0 525	Mains Freq / Hz	49.9
After Cooler Water In / *C	52	Power (R,Y,B) / kW	328.6 328.6 328.6
Jacket Water In, Out / *C	108 112	Power Calib	100
Manifold Air Temp / *C	68	Power (R,Y,B) / kVA	326.6 341.4 346.1
Oil / *C	102	Power Factors (R,Y,B)	1.00 0.96 0.95
Enclosure Ambient / *C	23	Volts (R,Y,B,Gen) / V	239 241 239 232
Gen Temps (R,Y,B) / *C	88 88 88	Current (R,Y,B) / A	1367 1416 1449
		RMS Calib	100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 5

Time of Log	5/12 7:42: 2	Jacket Water pressure (bar)	2.9
Time of Sync	22/11 14:41:47	Manifold Press / bar	1.7
Fuel / kW / kWhr	0 0	Oil Press / bar	4.1
Elec / kW / kWhr	1021 85467	After Cooler Water Pressure/bar	2.4
Throttle / *	56	Gas pressure / (mbar)	159
Exh 1,2,3,4 / *C	608 602 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 602 595 602		
Exh 9,10,11,12 / *C	589 602 595 608	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	608 602 608 608	Switches 16-23	00000000
RH Turbo In, Out / *C	0 525	Engine Speed / rpm	1500
LH Turbo In, Out / *C	0 525	Mains Freq / Hz	50.0
After Cooler Water In / *C	53	Power (R,Y,B) / kW	340.4 340.4 340.4
Jacket Water In, Out / *C	108 112	Power Calib	100

Manifold Air Temp / *C	68	Power (R,Y,B) / kVA	342.2	334.4	339.1		
Oil / *C	102	Power Factors (R,Y,B)	0.99	1.00	1.00		
Enclosure Ambient / *C	21	Volts (R,Y,B,Gen) / V	239	239	237	230	
Gen Temps (R,Y,B) / *C	89	89	88	Current (R,Y,B) / A	1432	1400	1432
				RMS Calib			100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 6  
 Time of Log 5/12 8:42: 2 Jacket Water pressure (bar) 2.8  
 Time of Sync 22/11 14:41:47 Manifold Press / bar 1.6  
 Fuel / kW / kWhr 0 0 Oil Press / bar 4.1  
 Elec / kW / kWhr 998 86463 After Cooler Water Pressure/bar 2.3  
 Throttle / \* 56 Gas pressure / (mbar) 159  
 Exh 1,2,3,4 / \*C 608 602 602 602 Analog Calib 99  
 Exh 5,6,7,8 / \*C 589 595 589 595  
 Exh 9,10,11,12 / \*C 589 595 595 602 Switches 0-15 0000000000000000  
 Exh 13,14,15,16 / \*C 602 595 608 602 Switches 16-23 00000000  
 RH Turbo In, Out / \*C 0 525 Engine Speed / rpm 1500  
 LH Turbo In, Out / \*C 0 525 Mains Freq / Hz 50.0  
 After Cooler Water In / \*C 52 Power (R,Y,B) / kW 328.6 340.4 328.6  
 Jacket Water In, Out / \*C 108 111 Power Calib 100  
 Manifold Air Temp / \*C 68 Power (R,Y,B) / kVA 327.5 326.6 331.4  
 Oil / \*C 102 Power Factors (R,Y,B) 1.00 1.00 0.99  
 Enclosure Ambient / \*C 25 Volts (R,Y,B,Gen) / V 237 239 237 228  
 Gen Temps (R,Y,B) / \*C 89 90 88 Current (R,Y,B) / A 1383 1367 1400  
 RMS Calib 100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 7  
 Time of Log 5/12 9:42: 2 Jacket Water pressure (bar) 2.8  
 Time of Sync 22/11 14:41:47 Manifold Press / bar 1.7  
 Fuel / kW / kWhr 0 0 Oil Press / bar 4.1  
 Elec / kW / kWhr 1009 87460 After Cooler Water Pressure/bar 2.3  
 Throttle / \* 56 Gas pressure / (mbar) 159  
 Exh 1,2,3,4 / \*C 608 602 602 602 Analog Calib 99  
 Exh 5,6,7,8 / \*C 589 602 595 602  
 Exh 9,10,11,12 / \*C 589 602 595 608 Switches 0-15 0000000000000000  
 Exh 13,14,15,16 / \*C 602 595 608 608 Switches 16-23 00000000  
 RH Turbo In, Out / \*C 0 525 Engine Speed / rpm 1500  
 LH Turbo In, Out / \*C 0 525 Mains Freq / Hz 50.0  
 After Cooler Water In / \*C 53 Power (R,Y,B) / kW 328.6 340.4 340.4  
 Jacket Water In, Out / \*C 109 112 Power Calib 101  
 Manifold Air Temp / \*C 66 Power (R,Y,B) / kVA 331.4 342.9 351.2  
 Oil / \*C 102 Power Factors (R,Y,B) 0.99 0.99 0.97  
 Enclosure Ambient / \*C 22 Volts (R,Y,B,Gen) / V 237 237 235 228  
 Gen Temps (R,Y,B) / \*C 90 90 90 Current (R,Y,B) / A 1400 1449 1497  
 RMS Calib 100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 8  
 Time of Log 5/12 10:42: 2 Jacket Water pressure (bar) 2.7

Time of Sync	22/11 14:41:47	Manifold Press / bar	1.6
Fuel / kW / kWhr	0 0	Oil Press / bar	4.1
Elec / kW / kWhr	998 88457	After Cooler Water Pressure/bar	2.3
Throttle / *	57	Gas pressure / (mbar)	159
Exh 1,2,3,4 / *C	608 602 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 602 589 602	Switches 0-15	0000000000000000
Exh 9,10,11,12 / *C	589 602 595 608	Switches 16-23	00000000
Exh 13,14,15,16 / *C	602 595 614 608	Engine Speed / rpm	1500
RH Turbo In, Out / *C	0 525	Mains Freq / Hz	50.0
LH Turbo In, Out / *C	0 525	Power (R,Y,B) / kW	328.6 340.4 328.6
After Cooler Water In / *C	53	Power Calib	101
Jacket Water In, Out / *C	109 112	Power (R,Y,B) / kVA	335.2 327.5 336.0
Manifold Air Temp / *C	67	Power Factors (R,Y,B)	0.98 1.00 0.98
Oil / *C	102	Volts (R,Y,B,Gen) / V	237 237 235 228
Enclosure Ambient / *C	23	Current (R,Y,B) / A	1416 1383 1432
Gen Temps (R,Y,B) / *C	92 92 91	RMS Calib	100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 0

Time of Log	5/12 11:42: 1	Jacket Water pressure (bar)	2.7
Time of Sync	22/11 14:41:47	Manifold Press / bar	1.7
Fuel / kW / kWhr	0 0	Oil Press / bar	4.0
Elec / kW / kWhr	1021 89452	After Cooler Water Pressure/bar	2.3
Throttle / *	63	Gas pressure / (mbar)	159
Exh 1,2,3,4 / *C	608 608 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 602 595 602	Switches 0-15	0000000000000000
Exh 9,10,11,12 / *C	589 602 602 608	Switches 16-23	00000000
Exh 13,14,15,16 / *C	608 602 614 608	Engine Speed / rpm	1500
RH Turbo In, Out / *C	0 525	Mains Freq / Hz	50.1
LH Turbo In, Out / *C	0 525	Power (R,Y,B) / kW	340.4 340.4 340.4
After Cooler Water In / *C	53	Power Calib	100
Jacket Water In, Out / *C	109 112	Power (R,Y,B) / kVA	342.9 339.1 350.6
Manifold Air Temp / *C	67	Power Factors (R,Y,B)	0.99 1.00 0.97
Oil / *C	102	Volts (R,Y,B,Gen) / V	237 237 237 226
Enclosure Ambient / *C	24	Current (R,Y,B) / A	1449 1432 1481
Gen Temps (R,Y,B) / *C	94 94 93	RMS Calib	100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 0

Time of Log	5/12 12:42: 0	Jacket Water pressure (bar)	2.8
Time of Sync	22/11 14:41:47	Manifold Press / bar	1.6
Fuel / kW / kWhr	0 0	Oil Press / bar	4.1
Elec / kW / kWhr	998 90448	After Cooler Water Pressure/bar	2.3
Throttle / *	59	Gas pressure / (mbar)	159
Exh 1,2,3,4 / *C	608 608 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 602 595 602	Switches 0-15	0000000000000000
Exh 9,10,11,12 / *C	589 602 595 608	Switches 16-23	00000000
Exh 13,14,15,16 / *C	608 602 614 608	Engine Speed / rpm	1500
RH Turbo In, Out / *C	0 525	Mains Freq / Hz	50.0
LH Turbo In, Out / *C	0 525	Power (R,Y,B) / kW	328.6 328.6 340.4
After Cooler Water In / *C	54		

Jacket Water In, Out / *C	109	112	Power Calib	101
Manifold Air Temp / *C		67	Power (R,Y,B) / kVA	330.5 326.6 331.4
Oil / *C		102	Power Factors (R,Y,B)	0.99 1.00 1.00
Enclosure Ambient / *C		26	Volts (R,Y,B,Gen) / V	239 239 237 230
Gen Temps (R,Y,B) / *C	94	94 94	Current (R,Y,B) / A	1383 1367 1400
			RMS Calib	100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 1  
 Time of Log 5/12 13:42: 0 Jacket Water pressure (bar) 2.8  
 Time of Sync 22/11 14:41:47 Manifold Press / bar 1.7  
 Fuel / kW / kWhr 0 0 Oil Press / bar 4.0  
 Elec / kW / kWhr 1009 91447 After Cooler Water Pressure/bar 2.4  
 Throttle / \* 60 Gas pressure / (mbar) 150  
 Exh 1,2,3,4 / \*C 608 608 602 608 Analog Calib 99  
 Exh 5,6,7,8 / \*C 595 602 595 602  
 Exh 9,10,11,12 / \*C 595 602 602 608 Switches 0-15 0000000000000000  
 Exh 13,14,15,16 / \*C 608 602 614 608 Switches 16-23 00000000  
 RH Turbo In, Out / \*C 0 525 Engine Speed / rpm 1500  
 LH Turbo In, Out / \*C 0 525 Mains Freq / Hz 50.0  
 After Cooler Water In / \*C 54 Power (R,Y,B) / kW 328.6 340.4 340.4  
 Jacket Water In, Out / \*C 109 113 Power Calib 101  
 Manifold Air Temp / \*C 69 Power (R,Y,B) / kVA 338.3 342.2 346.8  
 Oil / \*C 103 Power Factors (R,Y,B) 0.97 0.99 0.98  
 Enclosure Ambient / \*C 29 Volts (R,Y,B,Gen) / V 239 239 237 230  
 Gen Temps (R,Y,B) / \*C 96 97 96 Current (R,Y,B) / A 1416 1432 1465  
 RMS Calib 100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 2  
 Time of Log 5/12 14:42: 0 Jacket Water pressure (bar) 2.7  
 Time of Sync 22/11 14:41:47 Manifold Press / bar 1.6  
 Fuel / kW / kWhr 0 0 Oil Press / bar 4.0  
 Elec / kW / kWhr 1021 92443 After Cooler Water Pressure/bar 2.4  
 Throttle / \* 57 Gas pressure / (mbar) 150  
 Exh 1,2,3,4 / \*C 608 608 602 608 Analog Calib 99  
 Exh 5,6,7,8 / \*C 589 602 595 602  
 Exh 9,10,11,12 / \*C 589 602 602 608 Switches 0-15 0000000000000000  
 Exh 13,14,15,16 / \*C 608 602 614 608 Switches 16-23 00000000  
 RH Turbo In, Out / \*C 0 525 Engine Speed / rpm 1500  
 LH Turbo In, Out / \*C 0 525 Mains Freq / Hz 49.9  
 After Cooler Water In / \*C 54 Power (R,Y,B) / kW 340.4 340.4 340.4  
 Jacket Water In, Out / \*C 109 113 Power Calib 101  
 Manifold Air Temp / \*C 68 Power (R,Y,B) / kVA 330.5 342.2 354.5  
 Oil / \*C 103 Power Factors (R,Y,B) 1.00 0.99 0.96  
 Enclosure Ambient / \*C 28 Volts (R,Y,B,Gen) / V 239 239 237 230  
 Gen Temps (R,Y,B) / \*C 97 98 97 Current (R,Y,B) / A 1383 1432 1497  
 RMS Calib 100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 3

Time of Log	5/12 15:42: 0	Jacket Water pressure (bar)	2.7
Time of Sync	22/11 14:41:47	Manifold Press / bar	1.7
Fuel / kW / kWhr	0 0	Oil Press / bar	4.1
Elec / kW / kWhr	1009 93442	After Cooler Water Pressure/bar	2.3
Throttle / *	56	Gas pressure / (mbar)	150
Exh 1,2,3,4 / *C	608 608 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 602 595 602		
Exh 9,10,11,12 / *C	589 602 595 608	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	608 595 614 608	Switches 16-23	00000000
RH Turbo In, Out / *C	0 525	Engine Speed / rpm	1500
LH Turbo In, Out / *C	0 525	Mains Freq / Hz	49.9
After Cooler Water In / *C	53	Power (R,Y,B) / kW	328.6 340.4 340.4
Jacket Water In, Out / *C	108 112	Power Calib	101
Manifold Air Temp / *C	67	Power (R,Y,B) / kVA	339.1 342.9 339.8
Oil / *C	102	Power Factors (R,Y,B)	0.97 0.99 1.00
Enclosure Ambient / *C	24	Volts (R,Y,B,Gen) / V	237 237 235 228
Gen Temps (R,Y,B) / *C	94 94 94	Current (R,Y,B) / A	1432 1449 1449
		RMS Calib	100

Last Trip 76 Emergency stop

CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<

Modulation: No modulation State 8 ON LOAD

Unit No: 673 Unit Type: 16C35TN1 Log No: 4

Time of Log	5/12 16:42: 0	Jacket Water pressure (bar)	2.8
Time of Sync	22/11 14:41:47	Manifold Press / bar	1.7
Fuel / kW / kWhr	0 0	Oil Press / bar	4.1
Elec / kW / kWhr	1009 94440	After Cooler Water Pressure/bar	2.3
Throttle / *	55	Gas pressure / (mbar)	150
Exh 1,2,3,4 / *C	608 608 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 602 595 602		
Exh 9,10,11,12 / *C	589 602 595 608	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	608 602 608 608	Switches 16-23	00000000
RH Turbo In, Out / *C	0 525	Engine Speed / rpm	1500
LH Turbo In, Out / *C	0 525	Mains Freq / Hz	49.9
After Cooler Water In / *C	53	Power (R,Y,B) / kW	328.6 340.4 340.4
Jacket Water In, Out / *C	108 112	Power Calib	101
Manifold Air Temp / *C	69	Power (R,Y,B) / kVA	328.3 332.1 344.2
Oil / *C	102	Power Factors (R,Y,B)	1.00 1.00 0.99
Enclosure Ambient / *C	22	Volts (R,Y,B,Gen) / V	235 235 232 226
Gen Temps (R,Y,B) / *C	92 92 91	Current (R,Y,B) / A	1400 1416 1481
		RMS Calib	100

Last Trip 76 Emergency stop

CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<

Modulation: No modulation State 8 ON LOAD

Unit No: 673 Unit Type: 16C35TN1 Log No: 5

Time of Log	5/12 17:42: 0	Jacket Water pressure (bar)	2.8
Time of Sync	22/11 14:41:47	Manifold Press / bar	1.7
Fuel / kW / kWhr	0 0	Oil Press / bar	4.1
Elec / kW / kWhr	998 95438	After Cooler Water Pressure/bar	2.3
Throttle / *	57	Gas pressure / (mbar)	150
Exh 1,2,3,4 / *C	608 608 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 602 595 602		
Exh 9,10,11,12 / *C	589 602 595 608	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	608 602 608 608	Switches 16-23	00000000
RH Turbo In, Out / *C	0 525	Engine Speed / rpm	1500
LH Turbo In, Out / *C	0 525	Mains Freq / Hz	50.0

After Cooler Water In / *C	53	Power (R,Y,B) / kW	328.6	328.6	340.4
Jacket Water In, Out / *C	108 112	Power Calib			101
Manifold Air Temp / *C	68	Power (R,Y,B) / kVA	335.2	326.6	335.2
Oil / *C	103	Power Factors (R,Y,B)	0.98	1.00	1.00
Enclosure Ambient / *C	24	Volts (R,Y,B,Gen) / V	237	239	237 230
Gen Temps (R,Y,B) / *C	90 90 90	Current (R,Y,B) / A	1416	1367	1416
		RMS Calib			100

Last Trip 76 Emergency stop

CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<

Modulation: No modulation State 8 ON LOAD

Unit No: 673 Unit Type: 16C35TN1	Log No: 6
Time of Log 5/12 18:42: 0	Jacket Water pressure (bar) 2.8
Time of Sync 22/11 14:41:47	Manifold Press / bar 1.6
Fuel / kW / kWhr 0 0	Oil Press / bar 4.0
Elec / kW / kWhr 998 96433	After Cooler Water Pressure/bar 2.3
Throttle / * 55	Gas pressure / (mbar) 150
Exh 1,2,3,4 / *C 608 602 602 602	Analog Calib 99
Exh 5,6,7,8 / *C 589 602 595 602	
Exh 9,10,11,12 / *C 589 602 595 608	Switches 0-15 0000000000000000
Exh 13,14,15,16 / *C 608 602 608 608	Switches 16-23 00000000
RH Turbo In, Out / *C 0 525	Engine Speed / rpm 1500
LH Turbo In, Out / *C 0 525	Mains Freq / Hz 50.0
After Cooler Water In / *C 53	Power (R,Y,B) / kW 328.6 328.6 340.4
Jacket Water In, Out / *C 108 112	Power Calib 101
Manifold Air Temp / *C 68	Power (R,Y,B) / kVA 335.2 323.7 324.5
Oil / *C 102	Power Factors (R,Y,B) 0.98 1.00 1.00
Enclosure Ambient / *C 24	Volts (R,Y,B,Gen) / V 237 237 235 228
Gen Temps (R,Y,B) / *C 89 90 89	Current (R,Y,B) / A 1416 1367 1383
	RMS Calib 100

Last Trip 76 Emergency stop

CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<

Modulation: No modulation State 8 ON LOAD

Unit No: 673 Unit Type: 16C35TN1	Log No: 7
Time of Log 5/12 19:42: 0	Jacket Water pressure (bar) 2.8
Time of Sync 22/11 14:41:47	Manifold Press / bar 1.7
Fuel / kW / kWhr 0 0	Oil Press / bar 4.0
Elec / kW / kWhr 1009 97428	After Cooler Water Pressure/bar 2.3
Throttle / * 55	Gas pressure / (mbar) 150
Exh 1,2,3,4 / *C 608 602 602 602	Analog Calib 99
Exh 5,6,7,8 / *C 589 602 595 602	
Exh 9,10,11,12 / *C 589 602 595 608	Switches 0-15 0000000000000000
Exh 13,14,15,16 / *C 608 602 608 608	Switches 16-23 00000000
RH Turbo In, Out / *C 0 525	Engine Speed / rpm 1500
LH Turbo In, Out / *C 0 525	Mains Freq / Hz 49.9
After Cooler Water In / *C 53	Power (R,Y,B) / kW 328.6 340.4 340.4
Jacket Water In, Out / *C 108 112	Power Calib 101
Manifold Air Temp / *C 68	Power (R,Y,B) / kVA 335.2 327.5 339.8
Oil / *C 102	Power Factors (R,Y,B) 0.98 1.00 1.00
Enclosure Ambient / *C 24	Volts (R,Y,B,Gen) / V 237 237 235 228
Gen Temps (R,Y,B) / *C 89 90 89	Current (R,Y,B) / A 1416 1383 1449
	RMS Calib 100

Last Trip 76 Emergency stop

CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<

Modulation: No modulation State 8 ON LOAD

Unit No: 673	Unit Type: 16C35TN1	Log No: 8	
Time of Log	5/12 20:42: 0	Jacket Water pressure (bar)	2.8
Time of Sync	22/11 14:41:47	Manifold Press / bar	1.7
Fuel / kW / kWhr	0 0	Oil Press / bar	4.1
Elec / kW / kWhr	1009 98425	After Cooler Water Pressure/bar	2.3
Throttle / *	61	Gas pressure / (mbar)	150
Exh 1,2,3,4 / *C	608 608 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 602 595 602		
Exh 9,10,11,12 / *C	589 602 602 608	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	608 602 608 608	Switches 16-23	00000000
RH Turbo In, Out / *C	0 525	Engine Speed / rpm	1500
LH Turbo In, Out / *C	0 525	Mains Freq / Hz	50.1
After Cooler Water In / *C	53	Power (R,Y,B) / kW	328.6 340.4 340.4
Jacket Water In, Out / *C	108 112	Power Calib	100
Manifold Air Temp / *C	68	Power (R,Y,B) / kVA	335.2 342.2 355.5
Oil / *C	102	Power Factors (R,Y,B)	0.98 0.99 0.96
Enclosure Ambient / *C	23	Volts (R,Y,B,Gen) / V	237 239 232 230
Gen Temps (R,Y,B) / *C	89 90 88	Current (R,Y,B) / A	1416 1432 1530
		RMS Calib	99

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD

Unit No: 673	Unit Type: 16C35TN1	Log No: 9	
Time of Log	5/12 21:42: 0	Jacket Water pressure (bar)	2.8
Time of Sync	22/11 14:41:47	Manifold Press / bar	1.6
Fuel / kW / kWhr	0 0	Oil Press / bar	4.1
Elec / kW / kWhr	1009 99422	After Cooler Water Pressure/bar	2.3
Throttle / *	55	Gas pressure / (mbar)	150
Exh 1,2,3,4 / *C	608 608 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 602 595 602		
Exh 9,10,11,12 / *C	589 602 595 608	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	608 595 608 608	Switches 16-23	00000000
RH Turbo In, Out / *C	0 525	Engine Speed / rpm	1500
LH Turbo In, Out / *C	0 525	Mains Freq / Hz	50.0
After Cooler Water In / *C	53	Power (R,Y,B) / kW	328.6 340.4 340.4
Jacket Water In, Out / *C	108 112	Power Calib	101
Manifold Air Temp / *C	68	Power (R,Y,B) / kVA	331.4 335.2 347.4
Oil / *C	102	Power Factors (R,Y,B)	0.99 1.00 0.98
Enclosure Ambient / *C	23	Volts (R,Y,B,Gen) / V	237 237 235 228
Gen Temps (R,Y,B) / *C	88 89 87	Current (R,Y,B) / A	1400 1416 1481
		RMS Calib	100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD

Unit No: 673	Unit Type: 16C35TN1	Log No: 10	
Time of Log	5/12 22:42: 0	Jacket Water pressure (bar)	2.9
Time of Sync	22/11 14:41:47	Manifold Press / bar	1.6
Fuel / kW / kWhr	0 0	Oil Press / bar	4.1
Elec / kW / kWhr	1021 100420	After Cooler Water Pressure/bar	2.3
Throttle / *	57	Gas pressure / (mbar)	159
Exh 1,2,3,4 / *C	608 602 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 602 595 602		
Exh 9,10,11,12 / *C	589 602 595 608	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	608 595 608 608	Switches 16-23	00000000
RH Turbo In, Out / *C	0 525	Engine Speed / rpm	1500

LH Turbo In, Out / *C	0	525	Mains Freq / Hz	50.1
After Cooler Water In / *C	52		Power (R,Y,B) / kW	340.4 340.4 340.4
Jacket Water In, Out / *C	107	111	Power Calib	100
Manifold Air Temp / *C	68		Power (R,Y,B) / kVA	345.3 330.5 331.4
Oil / *C	102		Power Factors (R,Y,B)	0.99 1.00 1.00
Enclosure Ambient / *C	23		Volts (R,Y,B,Gen) / V	241 239 237 230
Gen Temps (R,Y,B) / *C	88	88 87	Current (R,Y,B) / A	1432 1383 1400
			RMS Calib	101

Last Trip 76 Emergency stop

CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<

Modulation: No modulation State 8 ON LOAD

Unit No: 673 Unit Type: 16C35TN1 Log No: 11

Time of Log	5/12 23:42: 0	Jacket Water pressure (bar)	2.9
Time of Sync	22/11 14:41:47	Manifold Press / bar	1.6
Fuel / kW / kWhr	0 0	Oil Press / bar	4.1
Elec / kW / kWhr	1021 101415	After Cooler Water Pressure/bar	2.3
Throttle / *	56	Gas pressure / (mbar)	159
Exh 1,2,3,4 / *C	608 602 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 602 589 602	Switches 0-15	0000000000000000
Exh 9,10,11,12 / *C	589 602 595 608	Switches 16-23	00000000
Exh 13,14,15,16 / *C	608 595 608 602	Engine Speed / rpm	1500
RH Turbo In, Out / *C	0 525	Mains Freq / Hz	50.0
LH Turbo In, Out / *C	0 525	Power (R,Y,B) / kW	340.4 340.4 340.4
After Cooler Water In / *C	52	Power Calib	100
Jacket Water In, Out / *C	107 111	Power (R,Y,B) / kVA	344.4 325.7 329.6
Manifold Air Temp / *C	67	Power Factors (R,Y,B)	0.99 1.00 1.00
Oil / *C	102	Volts (R,Y,B,Gen) / V	243 241 241 230
Enclosure Ambient / *C	22	Current (R,Y,B) / A	1416 1351 1367
Gen Temps (R,Y,B) / *C	87 86 86	RMS Calib	100

Last Trip 76 Emergency stop

CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<

Modulation: No modulation State 8 ON LOAD

Unit No: 673 Unit Type: 16C35TN1 Log No: 12

Time of Log	6/12 0:42: 0	Jacket Water pressure (bar)	2.8
Time of Sync	22/11 14:41:47	Manifold Press / bar	1.6
Fuel / kW / kWhr	0 0	Oil Press / bar	4.1
Elec / kW / kWhr	1021 102410	After Cooler Water Pressure/bar	2.3
Throttle / *	54	Gas pressure / (mbar)	159
Exh 1,2,3,4 / *C	608 602 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 602 595 595	Switches 0-15	0000000000000000
Exh 9,10,11,12 / *C	589 595 595 608	Switches 16-23	00000000
Exh 13,14,15,16 / *C	608 595 608 608	Engine Speed / rpm	1500
RH Turbo In, Out / *C	0 525	Mains Freq / Hz	50.0
LH Turbo In, Out / *C	0 525	Power (R,Y,B) / kW	340.4 340.4 340.4
After Cooler Water In / *C	52	Power Calib	100
Jacket Water In, Out / *C	107 111	Power (R,Y,B) / kVA	342.9 327.5 332.1
Manifold Air Temp / *C	66	Power Factors (R,Y,B)	0.99 1.00 1.00
Oil / *C	102	Volts (R,Y,B,Gen) / V	237 237 235 228
Enclosure Ambient / *C	22	Current (R,Y,B) / A	1449 1383 1416
Gen Temps (R,Y,B) / *C	86 86 86	RMS Calib	100

Last Trip 76 Emergency stop

CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<

Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 13  
 Time of Log 6/12 1:42:0 Jacket Water pressure (bar) 2.8  
 Time of Sync 22/11 14:41:47 Manifold Press / bar 1.6  
 Fuel / kW / kWhr 0 0 Oil Press / bar 4.1  
 Elec / kW / kWhr 986 103407 After Cooler Water Pressure/bar 2.3  
 Throttle / \* 52 Gas pressure / (mbar) 159  
 Exh 1,2,3,4 / \*C 608 602 602 602 Analog Calib 99  
 Exh 5,6,7,8 / \*C 589 595 589 595  
 Exh 9,10,11,12 / \*C 589 595 595 608 Switches 0-15 0000000000000000  
 Exh 13,14,15,16 / \*C 608 595 608 608 Switches 16-23 00000000  
 RH Turbo In, Out / \*C 0 525 Engine Speed / rpm 1500  
 LH Turbo In, Out / \*C 0 525 Mains Freq / Hz 49.9  
 After Cooler Water In / \*C 52 Power (R,Y,B) / kW 328.6 328.6 328.6  
 Jacket Water In, Out / \*C 108 111 Power Calib 101  
 Manifold Air Temp / \*C 66 Power (R,Y,B) / kVA 327.5 338.3 342.9  
 Oil / \*C 102 Power Factors (R,Y,B) 1.00 0.97 0.96  
 Enclosure Ambient / \*C 21 Volts (R,Y,B,Gen) / V 237 239 237 230  
 Gen Temps (R,Y,B) / \*C 85 85 85 Current (R,Y,B) / A 1383 1416 1449  
 RMS Calib 100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 0  
 Time of Log 6/12 2:41:58 Jacket Water pressure (bar) 2.8  
 Time of Sync 22/11 14:41:47 Manifold Press / bar 1.7  
 Fuel / kW / kWhr 0 0 Oil Press / bar 4.1  
 Elec / kW / kWhr 1009 104403 After Cooler Water Pressure/bar 2.3  
 Throttle / \* 51 Gas pressure / (mbar) 159  
 Exh 1,2,3,4 / \*C 608 602 602 602 Analog Calib 99  
 Exh 5,6,7,8 / \*C 589 602 589 595  
 Exh 9,10,11,12 / \*C 589 595 595 602 Switches 0-15 0000000000000000  
 Exh 13,14,15,16 / \*C 608 595 608 602 Switches 16-23 00000000  
 RH Turbo In, Out / \*C 0 525 Engine Speed / rpm 1500  
 LH Turbo In, Out / \*C 0 525 Mains Freq / Hz 49.9  
 After Cooler Water In / \*C 51 Power (R,Y,B) / kW 328.6 340.4 340.4  
 Jacket Water In, Out / \*C 107 111 Power Calib 100  
 Manifold Air Temp / \*C 66 Power (R,Y,B) / kVA 334.4 330.5 339.1  
 Oil / \*C 102 Power Factors (R,Y,B) 0.98 1.00 1.00  
 Enclosure Ambient / \*C 20 Volts (R,Y,B,Gen) / V 239 239 237 230  
 Gen Temps (R,Y,B) / \*C 84 84 84 Current (R,Y,B) / A 1400 1383 1432  
 RMS Calib 100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 1  
 Time of Log 6/12 3:41:58 Jacket Water pressure (bar) 2.8  
 Time of Sync 22/11 14:41:47 Manifold Press / bar 1.6  
 Fuel / kW / kWhr 0 0 Oil Press / bar 4.1  
 Elec / kW / kWhr 1009 105402 After Cooler Water Pressure/bar 2.3  
 Throttle / \* 51 Gas pressure / (mbar) 159  
 Exh 1,2,3,4 / \*C 608 602 602 602 Analog Calib 99  
 Exh 5,6,7,8 / \*C 589 595 589 595  
 Exh 9,10,11,12 / \*C 589 595 595 602 Switches 0-15 0000000000000000  
 Exh 13,14,15,16 / \*C 608 595 608 602 Switches 16-23 00000000

RH Turbo In, Out / *C	0	525	Engine Speed / rpm	1493
LH Turbo In, Out / *C	0	525	Mains Freq / Hz	50.0
After Cooler Water In / *C		52	Power (R,Y,B) / kW	340.4 340.4 328.6
Jacket Water In, Out / *C	108	111	Power Calib	100
Manifold Air Temp / *C		66	Power (R,Y,B) / kVA	334.4 338.3 339.1
Oil / *C		102	Power Factors (R,Y,B)	1.00 1.00 0.97
Enclosure Ambient / *C		20	Volts (R,Y,B,Gen) / V	239 239 237 230
Gen Temps (R,Y,B) / *C	84	84 84	Current (R,Y,B) / A	1400 1416 1432
			RMS Calib	100

Last Trip 76 Emergency stop

CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<

Modulation: No modulation

State 8 ON LOAD

Unit No: 673 Unit Type: 16C35TN1

Log No: 2

Time of Log	6/12	4:41:58	Jacket Water pressure (bar)	2.8
Time of Sync	22/11	14:41:47	Manifold Press / bar	1.6
Fuel / kW / kWhr	0	0	Oil Press / bar	4.1
Elec / kW / kWhr	1009	106395	After Cooler Water Pressure/bar	2.3
Throttle / *		51	Gas pressure / (mbar)	159
Exh 1,2,3,4 / *C	608	602 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589	595 589 595	Switches 0-15	0000000000000000
Exh 9,10,11,12 / *C	589	595 595 602	Switches 16-23	00000000
Exh 13,14,15,16 / *C	602	595 608 602	Engine Speed / rpm	1500
RH Turbo In, Out / *C	0	525	Mains Freq / Hz	49.9
LH Turbo In, Out / *C	0	525	Power (R,Y,B) / kW	340.4 328.6 340.4
After Cooler Water In / *C		52	Power Calib	100
Jacket Water In, Out / *C	107	111	Power (R,Y,B) / kVA	338.3 330.5 331.4
Manifold Air Temp / *C		66	Power Factors (R,Y,B)	1.00 0.99 1.00
Oil / *C		102	Volts (R,Y,B,Gen) / V	239 239 237 230
Enclosure Ambient / *C		19	Current (R,Y,B) / A	1416 1383 1400
Gen Temps (R,Y,B) / *C	83	83 82	RMS Calib	100

Last Trip 76 Emergency stop

CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<

Modulation: No modulation

State 8 ON LOAD

Unit No: 673 Unit Type: 16C35TN1

Log No: 3

Time of Log	6/12	5:41:58	Jacket Water pressure (bar)	2.8
Time of Sync	22/11	14:41:47	Manifold Press / bar	1.6
Fuel / kW / kWhr	0	0	Oil Press / bar	4.1
Elec / kW / kWhr	1009	107388	After Cooler Water Pressure/bar	2.3
Throttle / *		52	Gas pressure / (mbar)	159
Exh 1,2,3,4 / *C	608	602 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589	602 589 595	Switches 0-15	0000000000000000
Exh 9,10,11,12 / *C	589	595 595 602	Switches 16-23	00000000
Exh 13,14,15,16 / *C	608	595 608 608	Engine Speed / rpm	1500
RH Turbo In, Out / *C	0	525	Mains Freq / Hz	50.0
LH Turbo In, Out / *C	0	525	Power (R,Y,B) / kW	328.6 340.4 340.4
After Cooler Water In / *C		51	Power Calib	100
Jacket Water In, Out / *C	107	111	Power (R,Y,B) / kVA	338.3 342.2 346.8
Manifold Air Temp / *C		66	Power Factors (R,Y,B)	0.97 0.99 0.98
Oil / *C		102	Volts (R,Y,B,Gen) / V	239 239 237 230
Enclosure Ambient / *C		18	Current (R,Y,B) / A	1416 1432 1465
Gen Temps (R,Y,B) / *C	82	82 82	RMS Calib	100

Last Trip 76 Emergency stop

CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 4  
 Time of Log 6/12 6:41:58 Jacket Water pressure (bar) 2.8  
 Time of Sync 22/11 14:41:47 Manifold Press / bar 1.6  
 Fuel / kW / kWhr 0 0 Oil Press / bar 4.1  
 Elec / kW / kWhr 998 108383 After Cooler Water Pressure/bar 2.3  
 Throttle / \* 54 Gas pressure / (mbar) 159  
 Exh 1,2,3,4 / \*C 608 602 602 602 Analog Calib 99  
 Exh 5,6,7,8 / \*C 589 595 589 602  
 Exh 9,10,11,12 / \*C 589 602 595 608 Switches 0-15 0000000000000000  
 Exh 13,14,15,16 / \*C 608 602 608 608 Switches 16-23 00000000  
 RH Turbo In, Out / \*C 0 525 Engine Speed / rpm 1500  
 LH Turbo In, Out / \*C 0 525 Mains Freq / Hz 50.0  
 After Cooler Water In / \*C 51 Power (R,Y,B) / kW 328.6 328.6 340.4  
 Jacket Water In, Out / \*C 108 111 Power Calib 101  
 Manifold Air Temp / \*C 66 Power (R,Y,B) / kVA 342.9 331.4 347.4  
 Oil / \*C 102 Power Factors (R,Y,B) 0.96 0.99 0.98  
 Enclosure Ambient / \*C 18 Volts (R,Y,B,Gen) / V 237 237 235 228  
 Gen Temps (R,Y,B) / \*C 82 82 82 Current (R,Y,B) / A 1449 1400 1481  
 RMS Calib 100

Last Trip 76 Emergency stop

CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 5  
 Time of Log 6/12 7:41:58 Jacket Water pressure (bar) 2.8  
 Time of Sync 22/11 14:41:47 Manifold Press / bar 1.6  
 Fuel / kW / kWhr 0 0 Oil Press / bar 4.1  
 Elec / kW / kWhr 986 153 After Cooler Water Pressure/bar 2.3  
 Throttle / \* 51 Gas pressure / (mbar) 159  
 Exh 1,2,3,4 / \*C 608 602 602 602 Analog Calib 99  
 Exh 5,6,7,8 / \*C 589 595 589 595  
 Exh 9,10,11,12 / \*C 589 595 595 602 Switches 0-15 0000000000000000  
 Exh 13,14,15,16 / \*C 602 595 608 602 Switches 16-23 00000000  
 RH Turbo In, Out / \*C 0 525 Engine Speed / rpm 1500  
 LH Turbo In, Out / \*C 0 525 Mains Freq / Hz 50.0  
 After Cooler Water In / \*C 52 Power (R,Y,B) / kW 328.6 328.6 328.6  
 Jacket Water In, Out / \*C 107 111 Power Calib 100  
 Manifold Air Temp / \*C 66 Power (R,Y,B) / kVA 339.8 336.0 329.1  
 Oil / \*C 102 Power Factors (R,Y,B) 0.97 0.98 1.00  
 Enclosure Ambient / \*C 17 Volts (R,Y,B,Gen) / V 235 235 232 226  
 Gen Temps (R,Y,B) / \*C 82 82 81 Current (R,Y,B) / A 1449 1432 1416  
 RMS Calib 100

Last Trip 76 Emergency stop

CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 6  
 Time of Log 6/12 8:41:58 Jacket Water pressure (bar) 2.8  
 Time of Sync 22/11 14:41:47 Manifold Press / bar 1.7  
 Fuel / kW / kWhr 0 0 Oil Press / bar 4.1  
 Elec / kW / kWhr 1009 1150 After Cooler Water Pressure/bar 2.3  
 Throttle / \* 57 Gas pressure / (mbar) 159  
 Exh 1,2,3,4 / \*C 608 602 602 602 Analog Calib 99  
 Exh 5,6,7,8 / \*C 589 602 595 602  
 Exh 9,10,11,12 / \*C 589 602 595 608 Switches 0-15 0000000000000000

Exh 13,14,15,16 / *C	608	602	608	608	Switches 16-23	00000000
RH Turbo In, Out / *C			0	525	Engine Speed / rpm	1508
LH Turbo In, Out / *C			0	525	Mains Freq / Hz	50.1
After Cooler Water In / *C				52	Power (R,Y,B) / kW	328.6 340.4 340.4
Jacket Water In, Out / *C	108	111			Power Calib	99
Manifold Air Temp / *C				66	Power (R,Y,B) / kVA	344.2 336.0 334.1
Oil / *C				102	Power Factors (R,Y,B)	0.95 1.00 1.00
Enclosure Ambient / *C				18	Volts (R,Y,B,Gen) / V	232 235 228 226
Gen Temps (R,Y,B) / *C	82	82	82		Current (R,Y,B) / A	1481 1432 1465
					RMS Calib	101

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 7

Time of Log	6/12	9:41:58	Jacket Water pressure (bar)	2.8		
Time of Sync	22/11	14:41:47	Manifold Press / bar	1.6		
Fuel / kW / kWhr	0	0	Oil Press / bar	4.1		
Elec / kW / kWhr	986	2148	After Cooler Water Pressure/bar	2.3		
Throttle / *		51	Gas pressure / (mbar)	159		
Exh 1,2,3,4 / *C	621	589	602	602	Analog Calib	99
Exh 5,6,7,8 / *C	589	595	589	595	Switches 0-15	0000000000000000
Exh 9,10,11,12 / *C	589	595	595	602	Switches 16-23	00000000
Exh 13,14,15,16 / *C	602	595	608	602	Engine Speed / rpm	1500
RH Turbo In, Out / *C			0	525	Mains Freq / Hz	49.9
LH Turbo In, Out / *C			0	525	Power (R,Y,B) / kW	328.6 328.6 328.6
After Cooler Water In / *C				51	Power Calib	100
Jacket Water In, Out / *C	108	111			Power (R,Y,B) / kVA	321.5 328.3 337.2
Manifold Air Temp / *C				66	Power Factors (R,Y,B)	1.00 1.00 0.97
Oil / *C				102	Volts (R,Y,B,Gen) / V	232 235 230 226
Enclosure Ambient / *C				19	Current (R,Y,B) / A	1383 1400 1465
Gen Temps (R,Y,B) / *C	84	83	83		RMS Calib	100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 8

Time of Log	6/12	10:41:58	Jacket Water pressure (bar)	2.8		
Time of Sync	22/11	14:41:47	Manifold Press / bar	1.7		
Fuel / kW / kWhr	0	0	Oil Press / bar	4.1		
Elec / kW / kWhr	1021	3145	After Cooler Water Pressure/bar	2.3		
Throttle / *		52	Gas pressure / (mbar)	159		
Exh 1,2,3,4 / *C	608	602	602	602	Analog Calib	99
Exh 5,6,7,8 / *C	589	602	589	595	Switches 0-15	0000000000000000
Exh 9,10,11,12 / *C	589	595	595	602	Switches 16-23	00000000
Exh 13,14,15,16 / *C	602	595	608	602	Engine Speed / rpm	1500
RH Turbo In, Out / *C			0	525	Mains Freq / Hz	50.0
LH Turbo In, Out / *C			0	525	Power (R,Y,B) / kW	340.4 340.4 340.4
After Cooler Water In / *C				52	Power Calib	100
Jacket Water In, Out / *C	108	111			Power (R,Y,B) / kVA	329.1 339.8 337.2
Manifold Air Temp / *C				66	Power Factors (R,Y,B)	1.00 1.00 1.00
Oil / *C				102	Volts (R,Y,B,Gen) / V	232 235 230 224
Enclosure Ambient / *C				19	Current (R,Y,B) / A	1416 1449 1465
Gen Temps (R,Y,B) / *C	84	84	82		RMS Calib	100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 0  
 Time of Log 6/12 11:41:57 Jacket Water pressure (bar) 2.8  
 Time of Sync 22/11 14:41:47 Manifold Press / bar 1.6  
 Fuel / kW / kWhr 0 0 Oil Press / bar 4.1  
 Elec / kW / kWhr 986 4140 After Cooler Water Pressure/bar 2.3  
 Throttle / \* 53 Gas pressure / (mbar) 159  
 Exh 1,2,3,4 / \*C 608 602 602 602 Analog Calib 99  
 Exh 5,6,7,8 / \*C 589 602 589 602  
 Exh 9,10,11,12 / \*C 589 602 595 602 Switches 0-15 0000000000000000  
 Exh 13,14,15,16 / \*C 608 595 608 602 Switches 16-23 00000000  
 RH Turbo In, Out / \*C 0 525 Engine Speed / rpm 1500  
 LH Turbo In, Out / \*C 0 525 Mains Freq / Hz 49.9  
 After Cooler Water In / \*C 52 Power (R,Y,B) / kW 328.6 328.6 328.6  
 Jacket Water In, Out / \*C 108 112 Power Calib 100  
 Manifold Air Temp / \*C 66 Power (R,Y,B) / kVA 332.9 332.9 329.7  
 Oil / \*C 102 Power Factors (R,Y,B) 0.99 0.99 1.00  
 Enclosure Ambient / \*C 22 Volts (R,Y,B,Gen) / V 232 232 230 224  
 Gen Temps (R,Y,B) / \*C 85 86 85 Current (R,Y,B) / A 1432 1432 1432  
 RMS Calib 100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 1  
 Time of Log 6/12 12:41:57 Jacket Water pressure (bar) 2.9  
 Time of Sync 22/11 14:41:47 Manifold Press / bar 1.7  
 Fuel / kW / kWhr 0 0 Oil Press / bar 4.0  
 Elec / kW / kWhr 998 5137 After Cooler Water Pressure/bar 2.3  
 Throttle / \* 59 Gas pressure / (mbar) 159  
 Exh 1,2,3,4 / \*C 608 608 602 602 Analog Calib 99  
 Exh 5,6,7,8 / \*C 589 602 595 602  
 Exh 9,10,11,12 / \*C 589 602 595 608 Switches 0-15 0000000000000000  
 Exh 13,14,15,16 / \*C 608 602 608 608 Switches 16-23 00000000  
 RH Turbo In, Out / \*C 0 525 Engine Speed / rpm 1500  
 LH Turbo In, Out / \*C 0 525 Mains Freq / Hz 50.1  
 After Cooler Water In / \*C 52 Power (R,Y,B) / kW 328.6 340.4 328.6  
 Jacket Water In, Out / \*C 108 112 Power Calib 100  
 Manifold Air Temp / \*C 67 Power (R,Y,B) / kVA 325.3 329.1 352.2  
 Oil / \*C 102 Power Factors (R,Y,B) 1.00 1.00 0.93  
 Enclosure Ambient / \*C 23 Volts (R,Y,B,Gen) / V 232 232 230 226  
 Gen Temps (R,Y,B) / \*C 87 87 86 Current (R,Y,B) / A 1400 1416 1530  
 RMS Calib 100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 2  
 Time of Log 6/12 13:41:57 Jacket Water pressure (bar) 2.8  
 Time of Sync 22/11 14:41:47 Manifold Press / bar 1.6  
 Fuel / kW / kWhr 0 0 Oil Press / bar 4.1  
 Elec / kW / kWhr 986 6133 After Cooler Water Pressure/bar 2.3  
 Throttle / \* 52 Gas pressure / (mbar) 159  
 Exh 1,2,3,4 / \*C 608 602 602 602 Analog Calib 99  
 Exh 5,6,7,8 / \*C 589 602 595 602

Exh 9,10,11,12 / *C	589 602 595 608	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	608 602 608 608	Switches 16-23	00000000
RH Turbo In, Out / *C	0 525	Engine Speed / rpm	1500
LH Turbo In, Out / *C	0 525	Mains Freq / Hz	49.9
After Cooler Water In / *C	52	Power (R,Y,B) / kW	328.6 328.6 328.6
Jacket Water In, Out / *C	108 112	Power Calib	100
Manifold Air Temp / *C	67	Power (R,Y,B) / kVA	340.4 344.2 341.0
Oil / *C	102	Power Factors (R,Y,B)	0.97 0.95 0.96
Enclosure Ambient / *C	22	Volts (R,Y,B,Gen) / V	232 232 230 226
Gen Temps (R,Y,B) / *C	87 88 87	Current (R,Y,B) / A	1465 1481 1481
		RMS Calib	100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 3

Time of Log	6/12 14:41:57	Jacket Water pressure (bar)	2.8
Time of Sync	22/11 14:41:47	Manifold Press / bar	1.6
Fuel / kW / kWhr	0 0	Oil Press / bar	4.1
Elec / kW / kWhr	998 7127	After Cooler Water Pressure/bar	2.3
Throttle / *	53	Gas pressure / (mbar)	159
Exh 1,2,3,4 / *C	608 602 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 602 595 595		
Exh 9,10,11,12 / *C	589 595 595 608	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	608 595 608 602	Switches 16-23	00000000
RH Turbo In, Out / *C	0 525	Engine Speed / rpm	1500
LH Turbo In, Out / *C	0 525	Mains Freq / Hz	50.0
After Cooler Water In / *C	52	Power (R,Y,B) / kW	328.6 328.6 340.4
Jacket Water In, Out / *C	108 111	Power Calib	100
Manifold Air Temp / *C	66	Power (R,Y,B) / kVA	332.1 335.2 339.8
Oil / *C	102	Power Factors (R,Y,B)	0.99 0.98 1.00
Enclosure Ambient / *C	22	Volts (R,Y,B,Gen) / V	235 237 235 228
Gen Temps (R,Y,B) / *C	87 86 86	Current (R,Y,B) / A	1416 1416 1449
		RMS Calib	100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 4

Time of Log	6/12 15:41:57	Jacket Water pressure (bar)	2.8
Time of Sync	22/11 14:41:47	Manifold Press / bar	1.6
Fuel / kW / kWhr	0 0	Oil Press / bar	4.1
Elec / kW / kWhr	1009 8122	After Cooler Water Pressure/bar	2.3
Throttle / *	53	Gas pressure / (mbar)	159
Exh 1,2,3,4 / *C	608 602 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 595 595 602		
Exh 9,10,11,12 / *C	589 602 595 608	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	608 602 608 602	Switches 16-23	00000000
RH Turbo In, Out / *C	0 525	Engine Speed / rpm	1500
LH Turbo In, Out / *C	0 525	Mains Freq / Hz	50.0
After Cooler Water In / *C	52	Power (R,Y,B) / kW	340.4 328.6 340.4
Jacket Water In, Out / *C	108 112	Power Calib	100
Manifold Air Temp / *C	67	Power (R,Y,B) / kVA	336.0 339.8 336.6
Oil / *C	102	Power Factors (R,Y,B)	1.00 0.97 1.00
Enclosure Ambient / *C	22	Volts (R,Y,B,Gen) / V	235 235 232 226
Gen Temps (R,Y,B) / *C	87 86 86	Current (R,Y,B) / A	1432 1449 1449
		RMS Calib	100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 5  
 Time of Log 6/12 16:41:57 Jacket Water pressure (bar) 2.9  
 Time of Sync 22/11 14:41:47 Manifold Press / bar 1.7  
 Fuel / kW / kWhr 0 0 Oil Press / bar 4.1  
 Elec / kW / kWhr 986 9120 After Cooler Water Pressure/bar 2.3  
 Throttle / \* 56 Gas pressure / (mbar) 159  
 Exh 1,2,3,4 / \*C 608 608 602 602 Analog Calib 99  
 Exh 5,6,7,8 / \*C 589 602 595 602  
 Exh 9,10,11,12 / \*C 589 602 595 608 Switches 0-15 0000000000000000  
 Exh 13,14,15,16 / \*C 608 602 608 608 Switches 16-23 00000000  
 RH Turbo In, Out / \*C 0 525 Engine Speed / rpm 1500  
 LH Turbo In, Out / \*C 0 525 Mains Freq / Hz 50.0  
 After Cooler Water In / \*C 52 Power (R,Y,B) / kW 328.6 328.6 328.6  
 Jacket Water In, Out / \*C 108 112 Power Calib 99  
 Manifold Air Temp / \*C 66 Power (R,Y,B) / kVA 331.4 331.4 340.4  
 Oil / \*C 102 Power Factors (R,Y,B) 0.99 0.99 0.97  
 Enclosure Ambient / \*C 22 Volts (R,Y,B,Gen) / V 237 237 232 226  
 Gen Temps (R,Y,B) / \*C 86 86 86 Current (R,Y,B) / A 1400 1400 1465  
 RMS Calib 99

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 6  
 Time of Log 6/12 17:41:57 Jacket Water pressure (bar) 2.8  
 Time of Sync 22/11 14:41:47 Manifold Press / bar 1.6  
 Fuel / kW / kWhr 0 0 Oil Press / bar 4.1  
 Elec / kW / kWhr 998 10118 After Cooler Water Pressure/bar 2.3  
 Throttle / \* 53 Gas pressure / (mbar) 168  
 Exh 1,2,3,4 / \*C 608 602 602 602 Analog Calib 99  
 Exh 5,6,7,8 / \*C 589 602 595 602  
 Exh 9,10,11,12 / \*C 589 595 595 608 Switches 0-15 0000000000000000  
 Exh 13,14,15,16 / \*C 602 602 608 602 Switches 16-23 00000000  
 RH Turbo In, Out / \*C 0 525 Engine Speed / rpm 1500  
 LH Turbo In, Out / \*C 0 525 Mains Freq / Hz 50.0  
 After Cooler Water In / \*C 52 Power (R,Y,B) / kW 328.6 328.6 340.4  
 Jacket Water In, Out / \*C 108 112 Power Calib 100  
 Manifold Air Temp / \*C 67 Power (R,Y,B) / kVA 342.9 335.2 339.8  
 Oil / \*C 102 Power Factors (R,Y,B) 0.96 0.98 1.00  
 Enclosure Ambient / \*C 22 Volts (R,Y,B,Gen) / V 237 237 235 228  
 Gen Temps (R,Y,B) / \*C 86 86 86 Current (R,Y,B) / A 1449 1416 1449  
 RMS Calib 100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 7  
 Time of Log 6/12 18:41:57 Jacket Water pressure (bar) 2.9  
 Time of Sync 22/11 14:41:47 Manifold Press / bar 1.6  
 Fuel / kW / kWhr 0 0 Oil Press / bar 4.0  
 Elec / kW / kWhr 986 11113 After Cooler Water Pressure/bar 2.3  
 Throttle / \* 53 Gas pressure / (mbar) 159  
 Exh 1,2,3,4 / \*C 608 602 602 602 Analog Calib 99



RMS Calib 100

Last Trip 76 Emergency stop  
CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
Modulation: No modulation State 8 ON LOAD  
Unit No: 673 Unit Type: 16C35TN1 Log No: 10  
Time of Log 6/12 21:41:57 Jacket Water pressure (bar) 2.9  
Time of Sync 22/11 14:41:47 Manifold Press / bar 1.6  
Fuel / kW / kWhr 0 0 Oil Press / bar 4.1  
Elec / kW / kWhr 1009 14102 After Cooler Water Pressure/bar 2.4  
Throttle / \* 52 Gas pressure / (mbar) 168  
Exh 1,2,3,4 / \*C 608 602 602 602 Analog Calib 99  
Exh 5,6,7,8 / \*C 589 595 595 595  
Exh 9,10,11,12 / \*C 589 595 595 608 Switches 0-15 0000000000000000  
Exh 13,14,15,16 / \*C 608 602 608 602 Switches 16-23 00000000  
RH Turbo In, Out / \*C 0 525 Engine Speed / rpm 1493  
LH Turbo In, Out / \*C 0 525 Mains Freq / Hz 49.9  
After Cooler Water In / \*C 52 Power (R,Y,B) / kW 340.4 328.6 340.4  
Jacket Water In, Out / \*C 108 112 Power Calib 100  
Manifold Air Temp / \*C 68 Power (R,Y,B) / kVA 339.1 335.2 336.0  
Oil / \*C 102 Power Factors (R,Y,B) 1.00 0.98 1.00  
Enclosure Ambient / \*C 23 Volts (R,Y,B,Gen) / V 237 237 235 230  
Gen Temps (R,Y,B) / \*C 88 87 87 Current (R,Y,B) / A 1432 1416 1432  
RMS Calib 100

Last Trip 76 Emergency stop  
CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
Modulation: No modulation State 8 ON LOAD  
Unit No: 673 Unit Type: 16C35TN1 Log No: 11  
Time of Log 6/12 22:41:57 Jacket Water pressure (bar) 2.9  
Time of Sync 22/11 14:41:47 Manifold Press / bar 1.7  
Fuel / kW / kWhr 0 0 Oil Press / bar 4.0  
Elec / kW / kWhr 1021 15098 After Cooler Water Pressure/bar 2.4  
Throttle / \* 54 Gas pressure / (mbar) 159  
Exh 1,2,3,4 / \*C 608 602 602 602 Analog Calib 99  
Exh 5,6,7,8 / \*C 589 595 589 602  
Exh 9,10,11,12 / \*C 589 602 595 608 Switches 0-15 0000000000000000  
Exh 13,14,15,16 / \*C 608 602 608 608 Switches 16-23 00000000  
RH Turbo In, Out / \*C 0 525 Engine Speed / rpm 1500  
LH Turbo In, Out / \*C 0 525 Mains Freq / Hz 49.9  
After Cooler Water In / \*C 53 Power (R,Y,B) / kW 340.4 340.4 340.4  
Jacket Water In, Out / \*C 108 112 Power Calib 100  
Manifold Air Temp / \*C 68 Power (R,Y,B) / kVA 350.0 342.2 342.9  
Oil / \*C 102 Power Factors (R,Y,B) 0.97 0.99 0.99  
Enclosure Ambient / \*C 24 Volts (R,Y,B,Gen) / V 239 239 237 230  
Gen Temps (R,Y,B) / \*C 88 88 86 Current (R,Y,B) / A 1465 1432 1449  
RMS Calib 100

Last Trip 76 Emergency stop  
CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
Modulation: No modulation State 8 ON LOAD  
Unit No: 673 Unit Type: 16C35TN1 Log No: 12  
Time of Log 6/12 23:41:57 Jacket Water pressure (bar) 2.8  
Time of Sync 22/11 14:41:47 Manifold Press / bar 1.7  
Fuel / kW / kWhr 0 0 Oil Press / bar 4.0  
Elec / kW / kWhr 1009 16095 After Cooler Water Pressure/bar 2.4  
Throttle / \* 55 Gas pressure / (mbar) 168

Exh 1,2,3,4 / *C	614 602 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 595 595 602		
Exh 9,10,11,12 / *C	589 602 595 608	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	608 602 614 602	Switches 16-23	00000000
RH Turbo In, Out / *C	0 525	Engine Speed / rpm	1500
LH Turbo In, Out / *C	0 525	Mains Freq / Hz	50.0
After Cooler Water In / *C	53	Power (R,Y,B) / kW	328.6 340.4 340.4
Jacket Water In, Out / *C	108 112	Power Calib	100
Manifold Air Temp / *C	68	Power (R,Y,B) / kVA	341.4 337.4 342.2
Oil / *C	102	Power Factors (R,Y,B)	0.96 1.00 0.99
Enclosure Ambient / *C	25	Volts (R,Y,B,Gen) / V	241 241 239 232
Gen Temps (R,Y,B) / *C	89 89 88	Current (R,Y,B) / A	1416 1400 1432
		RMS Calib	100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 13

Time of Log	7/12 0:41:57	Jacket Water pressure (bar)	2.8
Time of Sync	22/11 14:41:47	Manifold Press / bar	1.6
Fuel / kW / kWhr	0 0	Oil Press / bar	4.0
Elec / kW / kWhr	986 17090	After Cooler Water Pressure/bar	2.3
Throttle / *	52	Gas pressure / (mbar)	168
Exh 1,2,3,4 / *C	608 602 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 595 589 595		
Exh 9,10,11,12 / *C	589 595 595 602	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	602 602 608 602	Switches 16-23	00000000
RH Turbo In, Out / *C	0 525	Engine Speed / rpm	1500
LH Turbo In, Out / *C	0 525	Mains Freq / Hz	49.9
After Cooler Water In / *C	53	Power (R,Y,B) / kW	328.6 328.6 328.6
Jacket Water In, Out / *C	108 112	Power Calib	100
Manifold Air Temp / *C	68	Power (R,Y,B) / kVA	334.4 333.5 342.2
Oil / *C	102	Power Factors (R,Y,B)	0.98 0.99 0.96
Enclosure Ambient / *C	26	Volts (R,Y,B,Gen) / V	239 241 239 232
Gen Temps (R,Y,B) / *C	88 89 88	Current (R,Y,B) / A	1400 1383 1432
		RMS Calib	100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 14

Time of Log	7/12 1:41:57	Jacket Water pressure (bar)	2.8
Time of Sync	22/11 14:41:47	Manifold Press / bar	1.6
Fuel / kW / kWhr	0 0	Oil Press / bar	4.1
Elec / kW / kWhr	998 18087	After Cooler Water Pressure/bar	2.4
Throttle / *	55	Gas pressure / (mbar)	159
Exh 1,2,3,4 / *C	608 608 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 595 595 602		
Exh 9,10,11,12 / *C	589 602 595 608	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	602 602 614 608	Switches 16-23	00000000
RH Turbo In, Out / *C	0 525	Engine Speed / rpm	1500
LH Turbo In, Out / *C	0 525	Mains Freq / Hz	50.1
After Cooler Water In / *C	53	Power (R,Y,B) / kW	328.6 340.4 328.6
Jacket Water In, Out / *C	108 112	Power Calib	100
Manifold Air Temp / *C	69	Power (R,Y,B) / kVA	340.5 329.6 334.4
Oil / *C	102	Power Factors (R,Y,B)	0.97 1.00 0.98
Enclosure Ambient / *C	22	Volts (R,Y,B,Gen) / V	243 241 239 232

Gen Temps (R,Y,B) / \*C      88    89    88      Current (R,Y,B) / A      1400 1367 1400  
 RMS Calib      100

Last Trip    76 Emergency stop  
 CPU Status 136      >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation      State    8 ON LOAD  
     Unit No: 673    Unit Type: 16C35TN1      Log No: 0  
 Time of Log      7/12  2:41:54      Jacket Water pressure (bar)      2.8  
 Time of Sync      22/11 14:41:47      Manifold Press / bar      1.6  
 Fuel / kW / kWhr      0      0      Oil Press / bar      4.1  
 Elec / kW / kWhr      986    19085      After Cooler Water Pressure/bar      2.4  
 Throttle / \*      54      Gas pressure / (mbar)      159  
 Exh 1,2,3,4 / \*C      608 608 602 602      Analog Calib      99  
 Exh 5,6,7,8 / \*C      589 595 589 602  
 Exh 9,10,11,12 / \*C      589 602 595 602      Switches 0-15      0000000000000000  
 Exh 13,14,15,16 / \*C      602 602 608 602      Switches 16-23      00000000  
 RH Turbo In, Out / \*C      0 525      Engine Speed / rpm      1493  
 LH Turbo In, Out / \*C      0 525      Mains Freq / Hz      50.0  
 After Cooler Water In / \*C      53      Power (R,Y,B) / kW      328.6 328.6 328.6  
 Jacket Water In, Out / \*C      108 112      Power Calib      101  
 Manifold Air Temp / \*C      68      Power (R,Y,B) / kVA      338.3 334.4 342.9  
 Oil / \*C      102      Power Factors (R,Y,B)      0.97 0.98 0.96  
 Enclosure Ambient / \*C      24      Volts (R,Y,B,Gen) / V      239 239 237 230  
 Gen Temps (R,Y,B) / \*C      89    89    88      Current (R,Y,B) / A      1416 1400 1449  
     RMS Calib      100

Last Trip    76 Emergency stop  
 CPU Status 136      >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation      State    8 ON LOAD  
     Unit No: 673    Unit Type: 16C35TN1      Log No: 1  
 Time of Log      7/12  3:41:54      Jacket Water pressure (bar)      2.9  
 Time of Sync      22/11 14:41:47      Manifold Press / bar      1.6  
 Fuel / kW / kWhr      0      0      Oil Press / bar      4.1  
 Elec / kW / kWhr      1009    20080      After Cooler Water Pressure/bar      2.4  
 Throttle / \*      55      Gas pressure / (mbar)      159  
 Exh 1,2,3,4 / \*C      608 602 602 602      Analog Calib      99  
 Exh 5,6,7,8 / \*C      589 595 589 602  
 Exh 9,10,11,12 / \*C      589 602 595 602      Switches 0-15      0000000000000000  
 Exh 13,14,15,16 / \*C      608 602 608 602      Switches 16-23      00000000  
 RH Turbo In, Out / \*C      0 525      Engine Speed / rpm      1508  
 LH Turbo In, Out / \*C      0 525      Mains Freq / Hz      50.1  
 After Cooler Water In / \*C      53      Power (R,Y,B) / kW      340.4 340.4 328.6  
 Jacket Water In, Out / \*C      108 112      Power Calib      100  
 Manifold Air Temp / \*C      68      Power (R,Y,B) / kVA      337.4 337.4 335.2  
 Oil / \*C      102      Power Factors (R,Y,B)      1.00 1.00 0.98  
 Enclosure Ambient / \*C      26      Volts (R,Y,B,Gen) / V      241 241 237 232  
 Gen Temps (R,Y,B) / \*C      89    89    88      Current (R,Y,B) / A      1400 1400 1416  
     RMS Calib      100

Last Trip    76 Emergency stop  
 CPU Status 136      >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation      State    8 ON LOAD  
     Unit No: 673    Unit Type: 16C35TN1      Log No: 2  
 Time of Log      7/12  4:41:54      Jacket Water pressure (bar)      2.8  
 Time of Sync      22/11 14:41:47      Manifold Press / bar      1.6  
 Fuel / kW / kWhr      0      0      Oil Press / bar      4.0  
 Elec / kW / kWhr      986    21077      After Cooler Water Pressure/bar      2.4

Throttle / *		53	Gas pressure / (mbar)	168
Exh 1,2,3,4 / *C	608 602 602 602		Analog Calib	99
Exh 5,6,7,8 / *C	589 595 589 602			
Exh 9,10,11,12 / *C	589 602 595 608		Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	602 602 608 608		Switches 16-23	00000000
RH Turbo In, Out / *C	0 525		Engine Speed / rpm	1500
LH Turbo In, Out / *C	0 525		Mains Freq / Hz	49.9
After Cooler Water In / *C	53		Power (R,Y,B) / kW	328.6 328.6 328.6
Jacket Water In, Out / *C	108 112		Power Calib	101
Manifold Air Temp / *C	68		Power (R,Y,B) / kVA	317.8 329.6 334.4
Oil / *C	102		Power Factors (R,Y,B)	1.00 1.00 0.98
Enclosure Ambient / *C	26		Volts (R,Y,B,Gen) / V	241 241 239 232
Gen Temps (R,Y,B) / *C	89 89 89		Current (R,Y,B) / A	1318 1367 1400
			RMS Calib	100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 3

Time of Log	7/12 5:41:54	Jacket Water pressure (bar)	2.8
Time of Sync	22/11 14:41:47	Manifold Press / bar	1.7
Fuel / kW / kWhr	0 0	Oil Press / bar	4.1
Elec / kW / kWhr	1009 22072	After Cooler Water Pressure/bar	2.4
Throttle / *	56	Gas pressure / (mbar)	159
Exh 1,2,3,4 / *C	608 602 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 602 595 595		
Exh 9,10,11,12 / *C	589 595 595 608	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	608 602 608 608	Switches 16-23	00000000
RH Turbo In, Out / *C	0 525	Engine Speed / rpm	1500
LH Turbo In, Out / *C	0 525	Mains Freq / Hz	50.1
After Cooler Water In / *C	53	Power (R,Y,B) / kW	328.6 352.1 328.6
Jacket Water In, Out / *C	109 112	Power Calib	100
Manifold Air Temp / *C	69	Power (R,Y,B) / kVA	333.5 337.4 350.6
Oil / *C	102	Power Factors (R,Y,B)	0.99 1.00 0.94
Enclosure Ambient / *C	22	Volts (R,Y,B,Gen) / V	241 241 237 230
Gen Temps (R,Y,B) / *C	89 89 88	Current (R,Y,B) / A	1383 1400 1481
		RMS Calib	100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 4

Time of Log	7/12 6:41:54	Jacket Water pressure (bar)	2.8
Time of Sync	22/11 14:41:47	Manifold Press / bar	1.7
Fuel / kW / kWhr	0 0	Oil Press / bar	4.1
Elec / kW / kWhr	1009 23068	After Cooler Water Pressure/bar	2.3
Throttle / *	51	Gas pressure / (mbar)	159
Exh 1,2,3,4 / *C	608 602 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 595 595 602		
Exh 9,10,11,12 / *C	589 602 595 608	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	608 602 608 608	Switches 16-23	00000000
RH Turbo In, Out / *C	0 525	Engine Speed / rpm	1500
LH Turbo In, Out / *C	0 525	Mains Freq / Hz	50.0
After Cooler Water In / *C	53	Power (R,Y,B) / kW	328.6 340.4 340.4
Jacket Water In, Out / *C	108 112	Power Calib	101
Manifold Air Temp / *C	68	Power (R,Y,B) / kVA	319.8 334.4 339.8
Oil / *C	102	Power Factors (R,Y,B)	1.00 1.00 1.00

Enclosure Ambient / *C	22	Volts (R,Y,B,Gen) / V	237	239	235	228	
Gen Temps (R,Y,B) / *C	89	90	89	Current (R,Y,B) / A	1351	1400	1449
				RMS Calib			100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 5  
 Time of Log 7/12 7:41:54 Jacket Water pressure (bar) 2.9  
 Time of Sync 22/11 14:41:47 Manifold Press / bar 1.6  
 Fuel / kW / kWhr 0 0 Oil Press / bar 4.1  
 Elec / kW / kWhr 998 24063 After Cooler Water Pressure/bar 2.4  
 Throttle / \* 56 Gas pressure / (mbar) 159  
 Exh 1,2,3,4 / \*C 608 602 602 602 Analog Calib 99  
 Exh 5,6,7,8 / \*C 589 595 595 602  
 Exh 9,10,11,12 / \*C 589 602 595 608 Switches 0-15 0000000000000000  
 Exh 13,14,15,16 / \*C 608 602 608 608 Switches 16-23 00000000  
 RH Turbo In, Out / \*C 0 525 Engine Speed / rpm 1500  
 LH Turbo In, Out / \*C 0 525 Mains Freq / Hz 50.0  
 After Cooler Water In / \*C 53 Power (R,Y,B) / kW 328.6 328.6 340.4  
 Jacket Water In, Out / \*C 108 112 Power Calib 100  
 Manifold Air Temp / \*C 69 Power (R,Y,B) / kVA 342.9 342.9 336.0  
 Oil / \*C 102 Power Factors (R,Y,B) 0.96 0.96 1.00  
 Enclosure Ambient / \*C 24 Volts (R,Y,B,Gen) / V 237 237 235 226  
 Gen Temps (R,Y,B) / \*C 90 89 89 Current (R,Y,B) / A 1449 1449 1432  
 RMS Calib 100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 6  
 Time of Log 7/12 8:41:54 Jacket Water pressure (bar) 2.8  
 Time of Sync 22/11 14:41:47 Manifold Press / bar 1.6  
 Fuel / kW / kWhr 0 0 Oil Press / bar 4.1  
 Elec / kW / kWhr 986 25060 After Cooler Water Pressure/bar 2.3  
 Throttle / \* 55 Gas pressure / (mbar) 159  
 Exh 1,2,3,4 / \*C 608 608 602 608 Analog Calib 99  
 Exh 5,6,7,8 / \*C 589 595 595 602  
 Exh 9,10,11,12 / \*C 589 602 595 608 Switches 0-15 0000000000000000  
 Exh 13,14,15,16 / \*C 608 602 608 608 Switches 16-23 00000000  
 RH Turbo In, Out / \*C 0 525 Engine Speed / rpm 1500  
 LH Turbo In, Out / \*C 0 525 Mains Freq / Hz 50.0  
 After Cooler Water In / \*C 53 Power (R,Y,B) / kW 328.6 328.6 328.6  
 Jacket Water In, Out / \*C 108 112 Power Calib 100  
 Manifold Air Temp / \*C 67 Power (R,Y,B) / kVA 336.0 339.8 337.2  
 Oil / \*C 102 Power Factors (R,Y,B) 0.98 0.97 0.97  
 Enclosure Ambient / \*C 22 Volts (R,Y,B,Gen) / V 235 235 230 226  
 Gen Temps (R,Y,B) / \*C 90 90 89 Current (R,Y,B) / A 1432 1449 1465  
 RMS Calib 100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 7  
 Time of Log 7/12 9:41:54 Jacket Water pressure (bar) 2.7  
 Time of Sync 22/11 14:41:47 Manifold Press / bar 1.6  
 Fuel / kW / kWhr 0 0 Oil Press / bar 4.1

Elec / kW / kWhr	986	26055	After Cooler Water Pressure/bar	2.3
Throttle / *		54	Gas pressure / (mbar)	159
Exh 1,2,3,4 / *C	608	602 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589	595 595 602		
Exh 9,10,11,12 / *C	589	602 595 602	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	602	595 614 602	Switches 16-23	00000000
RH Turbo In, Out / *C		0 525	Engine Speed / rpm	1500
LH Turbo In, Out / *C		0 525	Mains Freq / Hz	50.0
After Cooler Water In / *C		53	Power (R,Y,B) / kW	328.6 328.6 328.6
Jacket Water In, Out / *C	108	112	Power Calib	101
Manifold Air Temp / *C		66	Power (R,Y,B) / kVA	319.8 323.7 339.8
Oil / *C		102	Power Factors (R,Y,B)	1.00 1.00 0.97
Enclosure Ambient / *C		23	Volts (R,Y,B,Gen) / V	237 237 235 228
Gen Temps (R,Y,B) / *C	92	92 90	Current (R,Y,B) / A	1351 1367 1449
			RMS Calib	100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 8

Time of Log	7/12 10:41:54	Jacket Water pressure (bar)	2.7
Time of Sync	22/11 14:41:47	Manifold Press / bar	1.6
Fuel / kW / kWhr	0 0	Oil Press / bar	4.0
Elec / kW / kWhr	1009 27052	After Cooler Water Pressure/bar	2.2
Throttle / *	53	Gas pressure / (mbar)	159
Exh 1,2,3,4 / *C	608 602 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 595 595 602		
Exh 9,10,11,12 / *C	589 602 595 608	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	608 595 614 608	Switches 16-23	00000000
RH Turbo In, Out / *C		Engine Speed / rpm	1500
LH Turbo In, Out / *C		Mains Freq / Hz	49.9
After Cooler Water In / *C		Power (R,Y,B) / kW	328.6 340.4 340.4
Jacket Water In, Out / *C	109 112	Power Calib	101
Manifold Air Temp / *C		Power (R,Y,B) / kVA	335.2 335.2 339.8
Oil / *C		Power Factors (R,Y,B)	0.98 1.00 1.00
Enclosure Ambient / *C		Volts (R,Y,B,Gen) / V	237 237 235 228
Gen Temps (R,Y,B) / *C	92 92 92	Current (R,Y,B) / A	1416 1416 1449
		RMS Calib	100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 9

Time of Log	7/12 11:41:54	Jacket Water pressure (bar)	2.7
Time of Sync	22/11 14:41:47	Manifold Press / bar	1.6
Fuel / kW / kWhr	0 0	Oil Press / bar	4.1
Elec / kW / kWhr	1009 28045	After Cooler Water Pressure/bar	2.2
Throttle / *	54	Gas pressure / (mbar)	159
Exh 1,2,3,4 / *C	608 608 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 595 595 602		
Exh 9,10,11,12 / *C	589 602 595 608	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	608 602 614 608	Switches 16-23	00000000
RH Turbo In, Out / *C		Engine Speed / rpm	1500
LH Turbo In, Out / *C		Mains Freq / Hz	50.0
After Cooler Water In / *C		Power (R,Y,B) / kW	328.6 340.4 340.4
Jacket Water In, Out / *C	109 112	Power Calib	101
Manifold Air Temp / *C		Power (R,Y,B) / kVA	336.0 342.9 347.4

Oil / *C		102	Power Factors (R,Y,B)	0.98 0.99 0.98
Enclosure Ambient / *C		23	Volts (R,Y,B,Gen) / V	235 237 235 228
Gen Temps (R,Y,B) / *C	92 92 91		Current (R,Y,B) / A	1432 1449 1481
			RMS Calib	100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 10  
 Time of Log 7/12 12:41:54 Jacket Water pressure (bar) 2.7  
 Time of Sync 22/11 14:41:47 Manifold Press / bar 1.7  
 Fuel / kW / kWhr 0 0 Oil Press / bar 4.1  
 Elec / kW / kWhr 1009 29042 After Cooler Water Pressure/bar 2.3  
 Throttle / \* 55 Gas pressure / (mbar) 159  
 Exh 1,2,3,4 / \*C 608 608 602 602 Analog Calib 99  
 Exh 5,6,7,8 / \*C 589 595 595 602  
 Exh 9,10,11,12 / \*C 589 602 595 608 Switches 0-15 0000000000000000  
 Exh 13,14,15,16 / \*C 608 595 614 608 Switches 16-23 00000000  
 RH Turbo In, Out / \*C 0 525 Engine Speed / rpm 1500  
 LH Turbo In, Out / \*C 0 525 Mains Freq / Hz 50.0  
 After Cooler Water In / \*C 54 Power (R,Y,B) / kW 328.6 340.4 340.4  
 Jacket Water In, Out / \*C 109 112 Power Calib 101  
 Manifold Air Temp / \*C 67 Power (R,Y,B) / kVA 346.1 338.3 339.1  
 Oil / \*C 102 Power Factors (R,Y,B) 0.95 1.00 1.00  
 Enclosure Ambient / \*C 25 Volts (R,Y,B,Gen) / V 239 239 237 230  
 Gen Temps (R,Y,B) / \*C 93 93 93 Current (R,Y,B) / A 1449 1416 1432  
 RMS Calib 100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 11  
 Time of Log 7/12 13:41:54 Jacket Water pressure (bar) 2.7  
 Time of Sync 22/11 14:41:47 Manifold Press / bar 1.6  
 Fuel / kW / kWhr 0 0 Oil Press / bar 4.1  
 Elec / kW / kWhr 998 30040 After Cooler Water Pressure/bar 2.3  
 Throttle / \* 56 Gas pressure / (mbar) 168  
 Exh 1,2,3,4 / \*C 608 608 602 602 Analog Calib 99  
 Exh 5,6,7,8 / \*C 589 602 595 602  
 Exh 9,10,11,12 / \*C 589 602 602 608 Switches 0-15 0000000000000000  
 Exh 13,14,15,16 / \*C 608 602 614 608 Switches 16-23 00000000  
 RH Turbo In, Out / \*C 0 525 Engine Speed / rpm 1508  
 LH Turbo In, Out / \*C 0 525 Mains Freq / Hz 50.1  
 After Cooler Water In / \*C 53 Power (R,Y,B) / kW 340.4 328.6 328.6  
 Jacket Water In, Out / \*C 109 112 Power Calib 99  
 Manifold Air Temp / \*C 67 Power (R,Y,B) / kVA 335.2 342.2 331.4  
 Oil / \*C 102 Power Factors (R,Y,B) 1.00 0.96 0.99  
 Enclosure Ambient / \*C 26 Volts (R,Y,B,Gen) / V 237 239 237 228  
 Gen Temps (R,Y,B) / \*C 94 94 94 Current (R,Y,B) / A 1416 1432 1400  
 RMS Calib 100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 12  
 Time of Log 7/12 14:41:54 Jacket Water pressure (bar) 2.7  
 Time of Sync 22/11 14:41:47 Manifold Press / bar 1.6

Fuel / kW / kWhr	0	0	Oil Press / bar	4.1
Elec / kW / kWhr	986	31035	After Cooler Water Pressure/bar	2.2
Throttle / *		53	Gas pressure / (mbar)	159
Exh 1,2,3,4 / *C	608	608 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589	602 595 602		
Exh 9,10,11,12 / *C	589	602 595 608	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	608	595 614 608	Switches 16-23	00000000
RH Turbo In, Out / *C		0 525	Engine Speed / rpm	1500
LH Turbo In, Out / *C		0 525	Mains Freq / Hz	50.0
After Cooler Water In / *C		53	Power (R,Y,B) / kW	328.6 328.6 328.6
Jacket Water In, Out / *C	108	112	Power Calib	101
Manifold Air Temp / *C		67	Power (R,Y,B) / kVA	336.0 332.1 332.9
Oil / *C		102	Power Factors (R,Y,B)	0.98 0.99 0.99
Enclosure Ambient / *C		24	Volts (R,Y,B,Gen) / V	235 235 232 226
Gen Temps (R,Y,B) / *C	94	94 94	Current (R,Y,B) / A	1432 1416 1432
			RMS Calib	100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 13

Time of Log	7/12 15:41:54	Jacket Water pressure (bar)	2.7
Time of Sync	22/11 14:41:47	Manifold Press / bar	1.7
Fuel / kW / kWhr	0 0	Oil Press / bar	4.1
Elec / kW / kWhr	1009 32033	After Cooler Water Pressure/bar	2.2
Throttle / *	56	Gas pressure / (mbar)	159
Exh 1,2,3,4 / *C	608 608 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 602 595 602		
Exh 9,10,11,12 / *C	589 602 602 608	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	608 602 614 608	Switches 16-23	00000000
RH Turbo In, Out / *C		Engine Speed / rpm	1500
LH Turbo In, Out / *C		Mains Freq / Hz	50.0
After Cooler Water In / *C		Power (R,Y,B) / kW	328.6 340.4 340.4
Jacket Water In, Out / *C	108 112	Power Calib	101
Manifold Air Temp / *C		Power (R,Y,B) / kVA	340.4 339.8 337.2
Oil / *C		Power Factors (R,Y,B)	0.97 1.00 1.00
Enclosure Ambient / *C		Volts (R,Y,B,Gen) / V	232 235 230 226
Gen Temps (R,Y,B) / *C	93 94 93	Current (R,Y,B) / A	1465 1449 1465
		RMS Calib	100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 14

Time of Log	7/12 16:41:54	Jacket Water pressure (bar)	2.7
Time of Sync	22/11 14:41:47	Manifold Press / bar	1.7
Fuel / kW / kWhr	0 0	Oil Press / bar	4.1
Elec / kW / kWhr	1009 33030	After Cooler Water Pressure/bar	2.2
Throttle / *	55	Gas pressure / (mbar)	168
Exh 1,2,3,4 / *C	608 608 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 602 595 602		
Exh 9,10,11,12 / *C	589 602 595 608	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	608 602 614 608	Switches 16-23	00000000
RH Turbo In, Out / *C		Engine Speed / rpm	1500
LH Turbo In, Out / *C		Mains Freq / Hz	50.0
After Cooler Water In / *C		Power (R,Y,B) / kW	340.4 328.6 340.4
Jacket Water In, Out / *C	109 112	Power Calib	100

Manifold Air Temp / *C	66	Power (R,Y,B) / kVA	332.1	336.0	342.9		
Oil / *C	102	Power Factors (R,Y,B)	1.00	0.98	0.99		
Enclosure Ambient / *C	24	Volts (R,Y,B,Gen) / V	235	235	237	230	
Gen Temps (R,Y,B) / *C	93	93	92	Current (R,Y,B) / A	1416	1432	1449
				RMS Calib			100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 15  
 Time of Log 7/12 17:41:54 Jacket Water pressure (bar) 2.6  
 Time of Sync 22/11 14:41:47 Manifold Press / bar 1.6  
 Fuel / kW / kWhr 0 0 Oil Press / bar 4.1  
 Elec / kW / kWhr 1009 34025 After Cooler Water Pressure/bar 2.2  
 Throttle / \* 54 Gas pressure / (mbar) 159  
 Exh 1,2,3,4 / \*C 608 608 602 602 Analog Calib 99  
 Exh 5,6,7,8 / \*C 589 602 595 602  
 Exh 9,10,11,12 / \*C 589 602 595 608 Switches 0-15 0000000000000000  
 Exh 13,14,15,16 / \*C 608 595 614 608 Switches 16-23 00000000  
 RH Turbo In, Out / \*C 0 525 Engine Speed / rpm 1500  
 LH Turbo In, Out / \*C 0 525 Mains Freq / Hz 50.0  
 After Cooler Water In / \*C 53 Power (R,Y,B) / kW 340.4 328.6 340.4  
 Jacket Water In, Out / \*C 109 112 Power Calib 100  
 Manifold Air Temp / \*C 67 Power (R,Y,B) / kVA 338.3 334.4 339.1  
 Oil / \*C 102 Power Factors (R,Y,B) 1.00 0.98 1.00  
 Enclosure Ambient / \*C 25 Volts (R,Y,B,Gen) / V 239 239 237 230  
 Gen Temps (R,Y,B) / \*C 92 93 92 Current (R,Y,B) / A 1416 1400 1432  
 RMS Calib 100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 16  
 Time of Log 7/12 18:41:54 Jacket Water pressure (bar) 2.7  
 Time of Sync 22/11 14:41:47 Manifold Press / bar 1.7  
 Fuel / kW / kWhr 0 0 Oil Press / bar 4.1  
 Elec / kW / kWhr 1021 35020 After Cooler Water Pressure/bar 2.2  
 Throttle / \* 59 Gas pressure / (mbar) 168  
 Exh 1,2,3,4 / \*C 614 608 602 608 Analog Calib 99  
 Exh 5,6,7,8 / \*C 595 602 595 602  
 Exh 9,10,11,12 / \*C 589 602 602 608 Switches 0-15 0000000000000000  
 Exh 13,14,15,16 / \*C 608 602 614 608 Switches 16-23 00000000  
 RH Turbo In, Out / \*C 0 525 Engine Speed / rpm 1508  
 LH Turbo In, Out / \*C 0 525 Mains Freq / Hz 50.1  
 After Cooler Water In / \*C 53 Power (R,Y,B) / kW 340.4 340.4 340.4  
 Jacket Water In, Out / \*C 109 112 Power Calib 100  
 Manifold Air Temp / \*C 67 Power (R,Y,B) / kVA 336.0 342.9 358.3  
 Oil / \*C 102 Power Factors (R,Y,B) 1.00 0.99 0.95  
 Enclosure Ambient / \*C 23 Volts (R,Y,B,Gen) / V 235 237 237 226  
 Gen Temps (R,Y,B) / \*C 93 93 93 Current (R,Y,B) / A 1432 1449 1514  
 RMS Calib 100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 17  
 Time of Log 7/12 19:41:54 Jacket Water pressure (bar) 2.6

Time of Sync	22/11 14:41:47	Manifold Press / bar	1.7
Fuel / kW / kWhr	0 0	Oil Press / bar	4.1
Elec / kW / kWhr	1009 36017	After Cooler Water Pressure/bar	2.2
Throttle / *	56	Gas pressure / (mbar)	159
Exh 1,2,3,4 / *C	608 608 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 602 595 602		
Exh 9,10,11,12 / *C	589 602 595 608	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	608 595 614 608	Switches 16-23	00000000
RH Turbo In, Out / *C	0 525	Engine Speed / rpm	1508
LH Turbo In, Out / *C	0 525	Mains Freq / Hz	50.1
After Cooler Water In / *C	53	Power (R,Y,B) / kW	328.6 340.4 340.4
Jacket Water In, Out / *C	108 112	Power Calib	99
Manifold Air Temp / *C	67	Power (R,Y,B) / kVA	322.7 335.2 358.3
Oil / *C	102	Power Factors (R,Y,B)	1.00 1.00 0.95
Enclosure Ambient / *C	22	Volts (R,Y,B,Gen) / V	239 237 237 232
Gen Temps (R,Y,B) / *C	91 92 91	Current (R,Y,B) / A	1351 1416 1514
		RMS Calib	101

Last Trip 76 Emergency stop

CPU Status 136	>>> CURRENT STATUS 255	Normal running <<<	
Modulation: No modulation	State 8 ON LOAD		
Unit No: 673 Unit Type: 16C35TN1	Log No: 18		
Time of Log	7/12 20:41:54	Jacket Water pressure (bar)	2.8
Time of Sync	22/11 14:41:47	Manifold Press / bar	1.6
Fuel / kW / kWhr	0 0	Oil Press / bar	4.1
Elec / kW / kWhr	998 37013	After Cooler Water Pressure/bar	2.3
Throttle / *	54	Gas pressure / (mbar)	168
Exh 1,2,3,4 / *C	608 602 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 602 595 602		
Exh 9,10,11,12 / *C	589 602 595 608	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	608 602 608 608	Switches 16-23	00000000
RH Turbo In, Out / *C	0 525	Engine Speed / rpm	1500
LH Turbo In, Out / *C	0 525	Mains Freq / Hz	50.0
After Cooler Water In / *C	52	Power (R,Y,B) / kW	328.6 340.4 328.6
Jacket Water In, Out / *C	108 112	Power Calib	101
Manifold Air Temp / *C	68	Power (R,Y,B) / kVA	323.7 326.6 342.9
Oil / *C	102	Power Factors (R,Y,B)	1.00 1.00 0.96
Enclosure Ambient / *C	24	Volts (R,Y,B,Gen) / V	237 239 237 230
Gen Temps (R,Y,B) / *C	90 90 90	Current (R,Y,B) / A	1367 1367 1449
		RMS Calib	100

Last Trip 76 Emergency stop

CPU Status 136	>>> CURRENT STATUS 255	Normal running <<<	
Modulation: No modulation	State 8 ON LOAD		
Unit No: 673 Unit Type: 16C35TN1	Log No: 19		
Time of Log	7/12 21:41:54	Jacket Water pressure (bar)	2.8
Time of Sync	22/11 14:41:47	Manifold Press / bar	1.6
Fuel / kW / kWhr	0 0	Oil Press / bar	4.1
Elec / kW / kWhr	974 38010	After Cooler Water Pressure/bar	2.3
Throttle / *	51	Gas pressure / (mbar)	168
Exh 1,2,3,4 / *C	608 602 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 602 589 595		
Exh 9,10,11,12 / *C	589 595 595 608	Switches 0-15	0000000000000000
Exh 13,14,15,16 / *C	602 595 608 602	Switches 16-23	00000000
RH Turbo In, Out / *C	0 525	Engine Speed / rpm	1500
LH Turbo In, Out / *C	0 525	Mains Freq / Hz	50.0
After Cooler Water In / *C	53	Power (R,Y,B) / kW	316.9 328.6 328.6

Jacket Water In, Out / *C	108	112	Power Calib	101
Manifold Air Temp / *C		68	Power (R,Y,B) / kVA	326.6 318.9 319.8
Oil / *C		102	Power Factors (R,Y,B)	0.97 1.00 1.00
Enclosure Ambient / *C		25	Volts (R,Y,B,Gen) / V	239 239 237 230
Gen Temps (R,Y,B) / *C	89	89 89	Current (R,Y,B) / A	1367 1335 1351
			RMS Calib	100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 20

Time of Log	7/12 22:41:54	Jacket Water pressure (bar)	2.8
Time of Sync	22/11 14:41:47	Manifold Press / bar	1.7
Fuel / kW / kWhr	0 0	Oil Press / bar	4.1
Elec / kW / kWhr	1009 39007	After Cooler Water Pressure/bar	2.3
Throttle / *	52	Gas pressure / (mbar)	159
Exh 1,2,3,4 / *C	608 602 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 602 595 595	Switches 0-15	0000000000000000
Exh 9,10,11,12 / *C	589 595 595 608	Switches 16-23	00000000
Exh 13,14,15,16 / *C	608 602 614 608	Engine Speed / rpm	1493
RH Turbo In, Out / *C	0 525	Mains Freq / Hz	50.0
LH Turbo In, Out / *C	0 525	Power (R,Y,B) / kW	340.4 328.6 340.4
After Cooler Water In / *C	53	Power Calib	101
Jacket Water In, Out / *C	108 112	Power (R,Y,B) / kVA	337.4 318.9 323.7
Manifold Air Temp / *C	68	Power Factors (R,Y,B)	1.00 1.00 1.00
Oil / *C	102	Volts (R,Y,B,Gen) / V	241 239 237 232
Enclosure Ambient / *C	24	Current (R,Y,B) / A	1400 1335 1367
Gen Temps (R,Y,B) / *C	89 88 88	RMS Calib	100

Last Trip 76 Emergency stop  
 CPU Status 136 >>> CURRENT STATUS 255 Normal running <<<  
 Modulation: No modulation State 8 ON LOAD  
 Unit No: 673 Unit Type: 16C35TN1 Log No: 21

Time of Log	7/12 23:41:54	Jacket Water pressure (bar)	2.8
Time of Sync	22/11 14:41:47	Manifold Press / bar	1.7
Fuel / kW / kWhr	0 0	Oil Press / bar	4.0
Elec / kW / kWhr	1021 40003	After Cooler Water Pressure/bar	2.3
Throttle / *	52	Gas pressure / (mbar)	159
Exh 1,2,3,4 / *C	614 602 602 602	Analog Calib	99
Exh 5,6,7,8 / *C	589 602 595 602	Switches 0-15	0000000000000000
Exh 9,10,11,12 / *C	589 602 595 608	Switches 16-23	00000000
Exh 13,14,15,16 / *C	608 602 608 608	Engine Speed / rpm	1500
RH Turbo In, Out / *C	0 525	Mains Freq / Hz	50.0
LH Turbo In, Out / *C	0 525	Power (R,Y,B) / kW	340.4 340.4 340.4
After Cooler Water In / *C	52	Power Calib	101
Jacket Water In, Out / *C	108 112	Power (R,Y,B) / kVA	333.5 341.4 339.1
Manifold Air Temp / *C	68	Power Factors (R,Y,B)	1.00 1.00 1.00
Oil / *C	102	Volts (R,Y,B,Gen) / V	241 241 237 232
Enclosure Ambient / *C	24	Current (R,Y,B) / A	1383 1416 1432
Gen Temps (R,Y,B) / *C	88 88 88	RMS Calib	100

