Cimbria Manufacturing A/S

SHSD - Super Heated Steam Drier

Verification Report

Energy efficient pre-treatment of biomass

Date: 12. May 2010

Project Manager: Marianne Kyed Ørbæk

Task no: 110-22627

0. Table of contents

1. Abbreviations and definitions

The abbreviations and definitions used in the verification report are summarized below.

Word	DANETV
AMS	Automated Monitoring System
Analytical laboratory	Independent analytical laboratory used to analyze reference samples
Application	The use of a product specified with respect to matrix, target, effect and limitations
CEN	European Committee for Standardization
DS	Danish Standardisation
Effect	The way the target is affected
EN	European standard
Environmental product	Ready to market or prototype stage product, process, system or service based upon an environmental technology
Environmental Technology	The practical application of knowledge in the environmental area
ETV	Environmental technology verification (ETV) is an independent (third party) assessment of the performance of a technology or a product for a specified application, under defined conditions and adequate quality assurance.
Evaluation	Evaluation of test data for a technology product for performance and data quality
Expert	Independent person qualified on a technology in verification or on verification as a process
ISO	International Standardization Organization
Matrix	The type of material that the product is intended for
Method	Generic document that provides rules, guidelines or characteristics for tests or analysis
Performance claim	The effects foreseen by the vendor on the target(s) in the matrix of intended use
Performance parameters	Parameters that can be documented quantitatively in tests and that provide the relevant information on the performance
QA	Quality assurance
Reference analyses	Analysis after a reference method in an accredited (ISO 17025) laboratory.

Reference samples	Samples taken for and analyzed after a reference method in an accredited (ISO 17025) laboratory.
RSD	Relative standard deviation in %.
Standard	Generic document established by consensus and approved by a recognized standardization body that provides rules, guidelines or characteristics for tests or analysis
Target	The property that is affected by the product
Test/testing	Determination of the performance of a product for parameters defined for the application
VDI	Verein Deutscher Ingenieure
Verification	Evaluation of product performance parameters for a specified application under defined conditions and adequate quality assurance
VTC	Verification and Test Centre

2. Introduction

Environmental technology verification (ETV) is an independent (third party) assessment of the performance of a technology or a product for a specified application, under defined conditions and quality assurance.

2.1. Name of product

The product is Super Heated Steam Drier - hereafter called SHSD.

2.2. Name and contact of vendor

Cimbria Manufacturing A/S
Faartoftvej 22
7700 Thisted
Denmark
Phone +45 9617 9000
Contact Bent Bjerregaard
E-mail: bbj@cimbria.com
Phone +45 9617 9149

2.3. Name of centre / verification responsible

Test centre:
FORCE Technology
Park Allé 345
DK - 2605 Brøndby
Denmark

Verification responsible:
William Hansen
E-mail: wha@force.dk
Phone +45 4326 7174
Cell phone +45 2218 1138

2.4. Verification documentation

The documentation of the verification process is described in four main documents in the order indicated below following the template of DANETV FORCE Technology verification centre quality manual /1/. The verification protocol and test plan result in a test and verification report, respectively. The verification report is the final completing document.

1. Verification Protocol
2. Test plan
3. Test Report
4. Verification Report

The verification process is summarized in the verification statement.

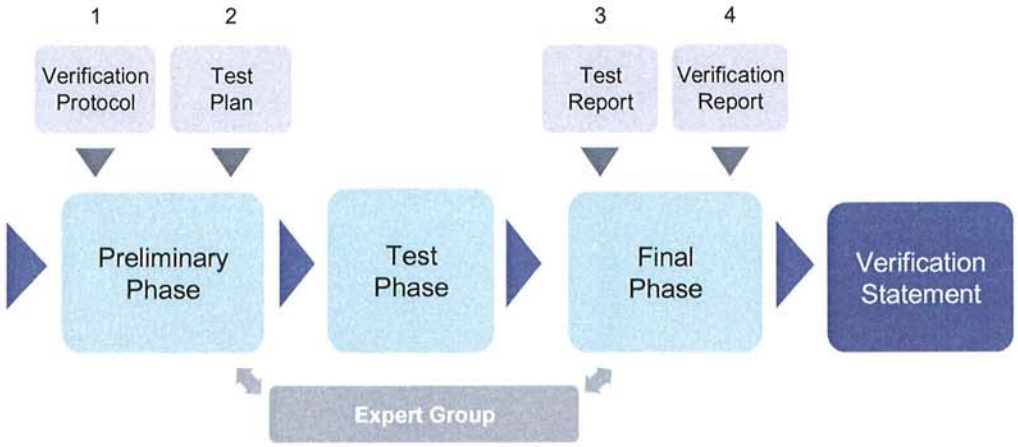
2.4.1. Verification document status

This Verification Report is a result of the Verification Protocol, November 2009 /7/ and is referring to the Test Report (Appendix 2).

2.5. *Verification process*

Verification and tests will be conducted in two separate steps, as required by DANETV. The steps in the verification are shown in Figure 1.

Figure 1. Verification steps.



References for the verification process are the Quality Management Plan for DANETV /1/.

2.6. *Verification and test organization*

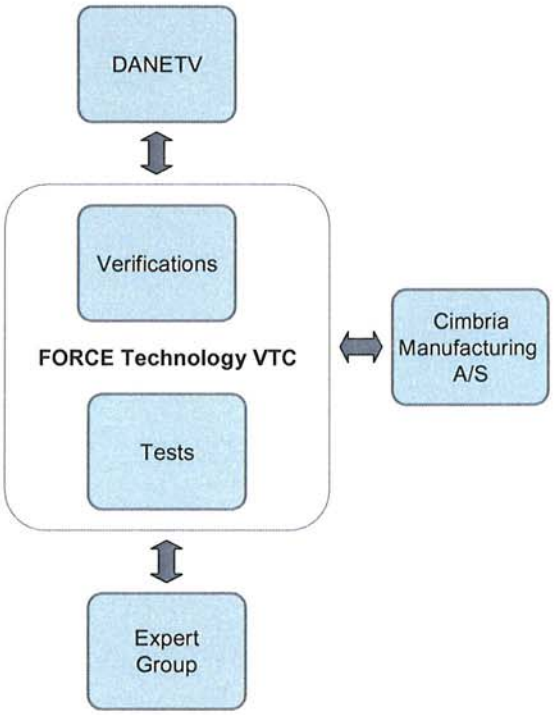
The verification was conducted by the Danish test centre DANETV. The verification was planned and conducted to satisfy the requirements of the ETV scheme currently being established by the European Union (EU ETV). The verification and test was performed by FORCE Technology as the Air Emission and Energy Efficient Technology Verification Center (VTC) under DANETV.

The day to day operations of the verification and test was coordinated and supervised by FORCE Technology, with participation of the vendor, Cimbria Manufacturing A/S. The testing was conducted at Fangel Bioenergi (Bigadan), Østermarksvej 70, 5260 Odense S., Denmark, and coordinated by FORCE Technology. Cimbria Manufacturing A/S was providing FORCE Technology with the necessary documentation and operation instructions. In addition Cimbria Manufacturing A/S was also participating in the development of the verification protocol and test plan together with FORCE Technology.

A part of the verification organization is the expert group who supports FORCE Technology in planning, conducting and reporting the verification and tests. The expert group makes the review of the test plan and test report.

The organization chart in Figure 2 identifies the relationships of the organization associated with this verification and tests.

Figure 2. Organization of the verification and tests.



2.7. *Expert group*

The expert group assigned to this test and responsible for review of test plan and test report includes:

Stig Lind Schmidt (SLS)
Head of Department
Carlo Lorentzen Smed A/S
Håndværkervej 76
4000 Roskilde
E-mail: sls@cl-smed.dk
Phone +45 7222 8270

Qualification:

Several years of practical experience with energy processes in the environmental industry

Orla Munk Jensen (OMJ)
Department: "Energy & Building"
FORCE Technology
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2800 Kgs. Lyngby
E-mail: omj@force.dk
Phone +45 7215 7808

Qualification:

Several years of practical and theoretical experience with energy processes (biomass and incineration) as specialist.

3. Description of the technology

The technology is "superheated steam drying" where the dewatering process takes place under positive pressure approximately 1 bar relative, with a material temperature above 100°C.

4. Description of the product

The set-up for the verification test consists of the SHSD and hot exhaust gas from a biogas engine producing district heating and electricity.

The dewatering process takes place in an enclosed cabinet without any emissions to the surrounding area.

The process is a continuous evaporation process, using overheated steam as a mean to evaporate the water from the fibrous material. The temperature of the manure is increased under pressure (1 bar abs) to above 100°C, where the water content in the media is evaporated. The evaporated water, now as steam, is withdrawn from the cabinet and condensed. The energy in the condensate is recovered and reused as district heating.

The wet manure is introduced to the SHSD through a preheated screw conveyer, which equally distributes the material on a slat conveyor belt and leads it horizontally through four sections of dryers. Finally the fibrous material leaves the cabinet in dry form for storage or further treatments.

Inside the cabinet, diagonally with the slat conveyor belt is a number of fans and heating coils. The fan in each section generates a closed circulated flow (fan – heating coil – manure material – fan etc.).

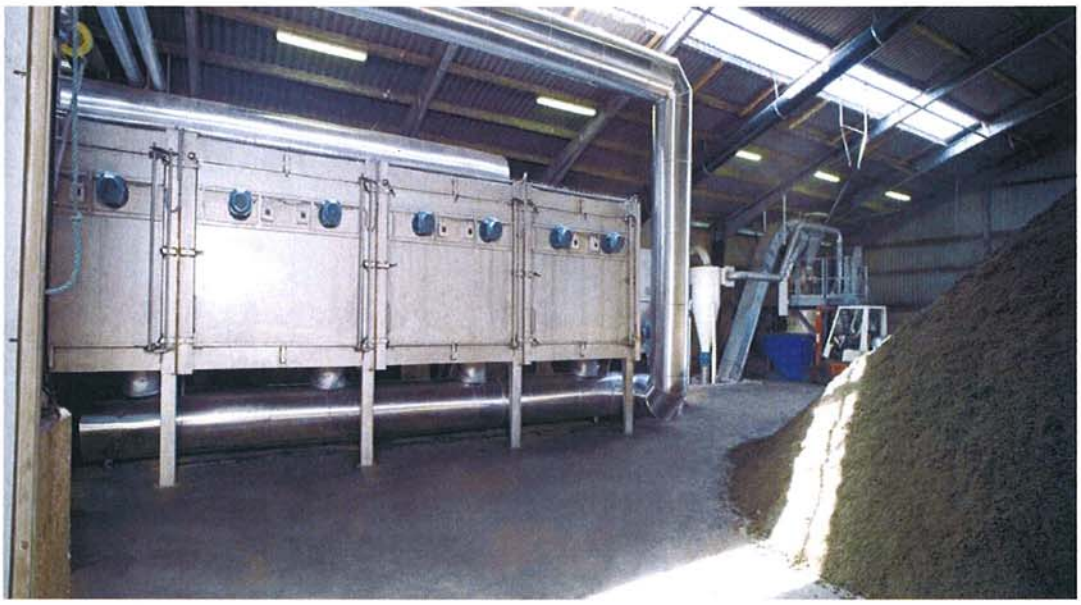
The heating coil is fed with energy from an external source.

The dewatering process accelerates when the temperature inside the cabinet increases to above 100 °C. The circulated media inside the cabinet is water vapour. Each time the water vapour passes the heating coil the temperature will increase up to the set-point – operation value. The superheated steam passes through the fibrous material and will generate an evaporation equal to the heated value of the circulated water vapour (superheated steam).

The generated superheated steam is continuous diverted from the cabinet and its energy content is reused in the district heating system.

The following figure 3 shows the SHSD. A schematic diagram of the energy and manure flow is illustrated in section 8.2.2.

Figure 3. SHSD - Super Heated Steam Drier.



5. Application and performance parameter definitions

This section defines the application and the relevant performance parameters application as input for verification and test of an environmental technology following the DANETV method.

The application is described in detail in Appendix 1, in terms of matrix for use, targets and effects.

5.1. Matrix

The matrix of the application is biomass and for this verification it is manure fibre fractions, with high water content.

5.2. Target

The target of the application is the dry weight of the manure fibres.

5.3. Effects

The performance parameters (effect) for the application are the steam drier's capability to dry manure fibres and it is reported in terms of dry matter in % of the manure fibres and the related energy consumption.

5.4. Additional parameters

No additional parameters.

Besides the performance parameters to be obtained by testing, compilation of parameters describing user manual, product costs and occupational health & safety issues of the product are required as a part of the verification.

6. Existing data

No existing data are available.

7. Test plan requirements

Based upon the application and performance parameter identification, Section 5, the requirements for test design is set - see section 7.1 "Test design". The detailed test report is in a separate document see Appendix 2.

The test plan for this application was based upon the identified performance parameters, see section 5.

7.1. Test design

The test design outlined in the test plan is summarized in the following table 1.

Table 1. Test design.

Performance parameters	Scope of measurement	Measurements methods and readings
Energy supply Flue gas	Volume Temperature Humidity O_2	Manuel measurement in accordance with DANAK accreditation no. 51 held by FORCE Technology /7/
Condensate	Quantity Temperature	Quantity: Manuel measurements, measured by weight and volume. Temperature: In Accordance with DANAK accreditation no. 51 held by FORCE Technology
Fibrous material inlet and outlet	Quantity Dry matter content Temperature	Quantity: Manual measurements, measured by weight. Temperature: Manuel measurement in accordance with DANAK accreditation no. 51 held by FORCE Technology Dry matter contents: Laboratory analysis in accordance with CEN/TS 14774-3 and CEN/TS 14774-1
Power Consumption	Quantity	Scanning and reading the data from the operation panel.

7.2. Data management

Data storage, transfer and control was carried out in accordance with the requirements of ISO 9001 /2/ enabling full control and retrieval of documents and records.

7.3. Quality assurance

The quality assurance of the tests includes all handwritten data sheets and data dumps from the online registrations, control of the test system and control of the data quality and integrity.

The test report was reviewed by the expert group in accordance to the Quality Management Plan see Figure 1.

7.4. Test report

The test report is a result of the test plan as described in section 2.4 and follows the template of DANETV FORCE Technology verification centre quality manual /1/ with data and records from the tests presented.

8. Evaluation

The evaluation includes calculation of the performance parameters, see Section 5.4 for definition.

Evaluation of the data quality is based upon the test quality assurance; see Section 7.3 for requirements, and compilation of the parameters as specified in Section 5.4.

8.1. Calculation of performance parameters

Calculations are done according to generally accepted mathematical and statistical principles such as those described in /2/ and as described in the Test Report (Appendix 2)

8.2. Performance parameter summary

According to the Test Report (Appendix 2) the Cimbria Manufacturing, SHSD was tested for its ability to dry manure fibres. To determine the steam driers capability to dry manure fibres, measurements of the dry matter content in the manure fibres and the related energy parameters were carried out. Results of measurements, full data printout and the original analysis report from the laboratory is available in the Test Report (Appendix 2).

8.2.1. Dry matter content in manure fibres

In table 2 the dry matter content in the manure fibres is shown. Additional the production capacity of the SHSD drier is given. All values are average values from the entire sampling period starting on September 28th and ending on October 1st 2009.

Table 2. Dry matter content in manure fibres (28.9 – 1.10. 2009)[1].

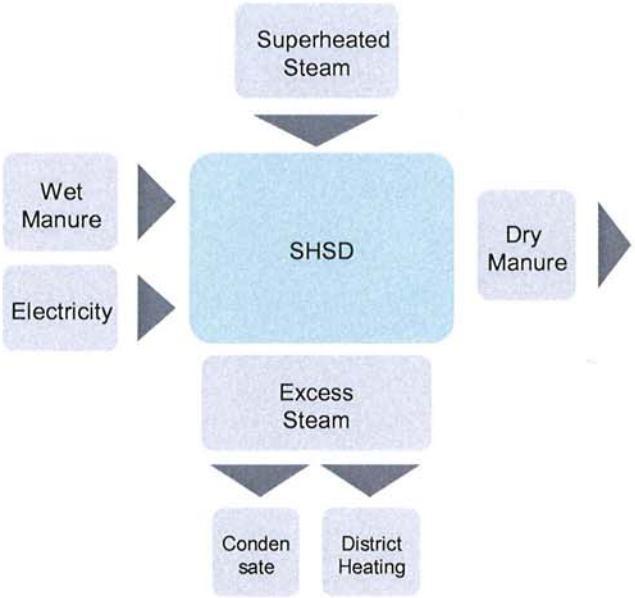
Dry matter content in manure fibres (% ± RSD[2])	
Inlet	**Outlet**
32,4 ±3,1	**90,2 ± 6,9**
Wet manure production capacity	**858 kg/h**

[1] *Refers to Test Report Appendix 2*
[2] *Relative standard deviation in %*

8.2.2. Energy Balance

The drying process of the manure is based on supply of energy in the form of heat. The sources of this energy are the flue gas from the biogas engine and the electricity to the fans circulating the drying steam inside the SHSD (see figure 1a). The energy from the flue gas is captured in the heat exchanger which overheats the steam inside the SHSD and the circulating fans ensure that superheated steam evaporates the water in the wet manure. The excess steam energy (Q_s) from the drying process is later utilized into district heating. The remaining energy after the district heating is derived as condensate. Figures 3 to 5 are schematic diagrams of the flow of energy and manure to and from the SHSD.

Figure 3. SHSD flow d**iagram of Energy and Manure.**



The energy used to dry the manure is provided by the sources mentioned above, i.e. flue gas (Q_{FG}) and electricity (Pe) assuming that the manure does not contribute to the energy input (or output). Regarding the energy provided by the fans it is assumed, that 85 % of the electricity input to the fans is used to move the fans or used to equipment outside the SHSD and the remaining 15 % is transferred to heat inside the SHSD.

The SHSD energy demand is given in table 3 and table 4 reflect the available energy from the process and how it is recovered.

Table 3. Energy demand to dry manure (28.9 – 1.10. 2009)[1]

Energy flow	Parameter		Amount MJ/h
Input	Energy contribution from the flue gas to the heat exchanger	Q_{FG}	1.407
	Electricity to fans	P_e [2]	27
		Total Input	**1.434**
Gross energy needed to evaporate 1 kg of water is 3 MJ			

[1] *Refers to the Test Report Appendix 2.*

[2] *Calculated as 15 % of electricity input to fans (27 MJ = 176,8 MJ x 15%)*

Table 4. Energy recovery in the plant (28.9 – 1.10. 2009)[1]

Energy flow	Parameter		Amount MJ/h
Output	Energy contribution from the excess steam	Q_S	1.288
	Energy loss	Q_L	146
		Total Output	**1.434**
Net energy needed to evaporate 1 kg of water is 0,6 MJ			
2,4 MJ/kg is utilized energy for district heating			

[1] *Refers to the Test Report Appendix 2.*

The calculation of energy used to dry the manure is associated with uncertainty due to the measurements included. This uncertainty is estimated to approximately 10 % and it is to some extend included in the figure of the energy loss (Q_L).

Figure 4. SHSD flow diagram including the energy loss

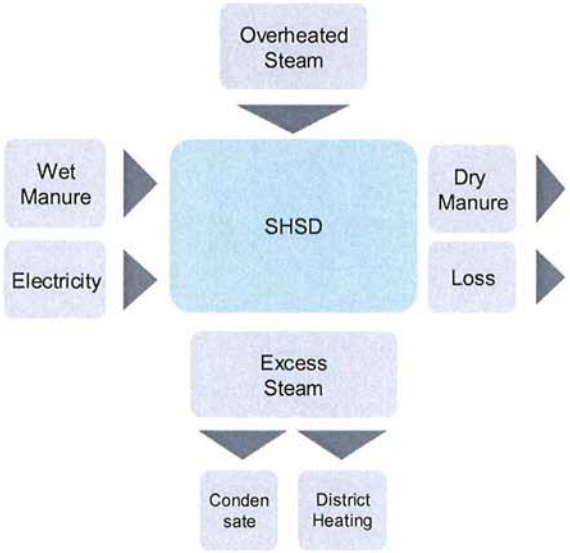
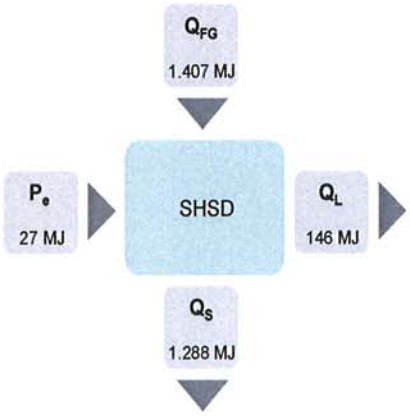


Figure 5. SHSD flow diagram with energy values (MJ)



8.3. *Evaluation of test quality*

All measuring, handling of data and calculation of results have been carried out according to the FORCE Technology DANAK accreditation No. 51 (also for parameters not covered by the accreditation).

Transfer of data from handwritten form to computer, has been subjected to 100 % control by another person.

The evaluation of the test and the results has proven that the quality and the accuracy fulfil the requirements or guidelines stated in the DANAK accreditation No. 51 and 65 /2/ and /8/

In connection with data processing and evaluation of the test results it is concluded that the specifications and guidelines complies with the test plan /6/.

8.4. *Control data*

Approved spread sheets for calculations of results has been subjected to an intensive control, to assure correct calculations, and consequently no further control is necessary.

8.5. *Deviations*

The test was performed according to the test plan. In general there were no deviations from the test plan regarding measurements, data logging and sampling.

However it is of importance to mention that a minor problem occurred during the test due to a blockage in the decanter. The blockage gave high water content in the inlet to the SHSD

system. The SHSD system was on stand-by for approximately 30 – 45 minutes. The break is considered as neglect able.

A blockage will result in a poor drying effectiveness of the system due to high water content in the fibrous material.

8.6. Additional parameter summary

No additional parameters.

8.7. User manual

The product is a prototype and there is no user manual available.

8.8. Product costs

The product is a prototype and there are no information regarding products costs available at present.

8.9. Occupational health and environment

It is confirmed that the use of the product does not imply special health, safety and waste issues during the test.

The work during testing was carried out according to the FORCE Technology Safety Rules, which complies with the extensive Danish rules for safe occupational health and the European regulations of work with chemicals.

8.10. Recommendations for verification statement

The verification of the Super Heated Steam Drying technology is completed. All documents (cf. /1/) are available.

On the basis of the verification process, relevant documents and the evaluation (see section 8) it is recommendable to issue a verification statement to the vendor.

Signed by	12/5 -10	Signed by	12/5–10
Annemette Geertinger Technical Vice President DANETV Steering Committee member	Date	William Hansen Verification Responsible DANETV Verification Centre	Date

9. References

1. DANETV at FORCE Technology. Verification Test Centre Quality Manual. 27-2-2009.
2. DANAK accreditation number 51
3. Method for the determination of moisture content. CEN/TS 14774-1
4. Method for the determination of moisture content. CEN/TS 14774-3
5. The heavy current regulation. 01-06-2001 (In Danish)
6. Cimbria Manufacturing A/S SHSD, Energy efficient pre-treatment of biomass, Test Plan, September 2009
7. Cimbria Manufacturing A/S SHSD, Energy efficient pre-treatment of biomass, Verification Protocol, November 2009
8. DANAK accreditation number 65

10. Appendix

Appendix 1	Application and performance parameter definitions
Appendix 2	Test Report
Appendix 3	Review reports

Appendix 1

Application and performance parameter definitions

This appendix defines the application and the relevant performance parameters application as input for verification and test of an environmental technology following the DANETV method.

1. Application

The intended application of the product for verification is defined in terms of the matrix, the targets and the effects of the product.

1.1. Matrix

The matrix of the application is biomass. An investigation of different types of biomasses shows that the water content varies considerably. For this verification it is manure fibre fractions, with a high water content that are suitable as biomass product. Furthermore the biomasses should be penetrable, and tolerate temperatures above 100°C.

1.2. Target(s)

The target of the application is the dry weight of the manure fibres.

The dry weight verified shall accordingly reflect both calculated energy balance, and measured temperature/humidity changes.

1.3. Effects

The effect for the application is generally reported in terms of dry matter in (%) of the manure fibres. Additional the following parameters are observed as side effect parameters: The energy efficiency and the energy balance of the drying process is measured and evaluated together with any emissions air-born or held back in the product or condensate from kk the process.

During operation, the following operation conditions are recorded and sampled:

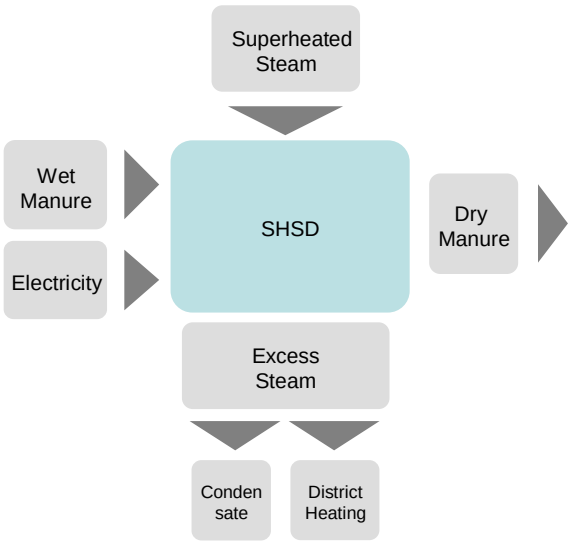
- District heating flow
- Temperature (inlet)
- Temperature (outlet)
- Power Consumption (in generally, all related systems)
- Excess steam (temperature)
- Fibrous material collected before and after the SHSD unit

In figure 1 is a schematic diagram of the flow of energy and manure to and from the SHSD.

Appendix 1

Application and performance parameter definitions

Figure 1. **Diagram of Energy and Manure flow in the SHSD.**



1.4. Exclusion

The energy source deriving from the decanter is excluded from the calculated energy balance, due to the fact that the decanter together with the boiler was a part of the established system.

The technology product to be verified is an add-on system which reuses the generated energy from the existing process, as mentioned above.

2. General performance requirements

No formal performance requirements for the application have been identified in the European Union or the US.

2.1. Regulatory requirements

There are no general requirements for the application.

2.2. Application based needs

Not relevant.

3. State of the art performance

Not relevant.

4. Performance parameter definitions

No elaborating comments.

Appendix 2

Test Report

Cimbria Manufacturing A/S

SHSD - Super Heated Steam Drier

Energy efficient pre-treatment of biomass

0. Table of contents

1. Abbreviations and definitions

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Evaluation	Evaluation of test data for a technology product for performance and data quality
Expert	Independent person qualified on a technology in verification or on verification as a process
ISO	International Standardization Organization
Matrix	The type of material that the product is intended for
Method	Generic document that provides rules, guidelines or characteristics for tests or analysis
Performance claim	The effects foreseen by the vendor on the target(s) in the matrix of intended use
Performance parameters	Parameters that can be documented quantitatively in tests and that provide the relevant information on the performance
QA	Quality assurance

Reference analyses	Analysis after a reference method in an accredited (ISO 17025) laboratory.
Reference samples	Samples taken for and analyzed after a reference method in an accredited (ISO 17025) laboratory.
RSD	Relative standard deviation in %.
Standard	Generic document established by consensus and approved by a recognized standardization body that provides rules, guidelines or characteristics for tests or analysis
Target	The property that is affected by the product
Test/testing	Determination of the performance of a product for parameters defined for the application
VDI	Verein Deutscher Ingenieure
Verification	Evaluation of product performance parameters for a specified application under defined conditions and adequate quality assurance
VTC	Verification and Test Centre

2. Introduction

This test report is the implementation of a test design developed for verification of the performance of an environmental technology following the DANETV guideline. See the verification protocol /1/ for details on organization and implications.

2.1. Verification protocol reference

Cimbria Manufacturing, SHSD - Super Heated Steam Drier, November 2009.

2.2. Name and contact of vendor

Cimbria Manufacturing A/S
Faartoftvej 22
7700 Thisted
Denmark
Phone +45 9617 9000
Contact Bent Bjerregaard
E-mail: bbj@cimbria.com
Phone: +45 9617 9149

2.3. Name of centre/test responsible

Test centre:
FORCE Technology
Test centre
Park Allé 345
DK - 2605 Brøndby
Denmark.

Test responsible:

Ole Tvede Larsen
E-mail otl@force.dk
Phone +45 4326 7168
Cell phone +45 4082 9873

2.4. Expert group

The expert group assigned to this test and responsible for review of test plan and test report includes:

Stig Lind Schmidt (SLS)
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Orla Munk Jensen (OMJ)
Department: "Energy & Building"
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2800 Kgs. Lyngby
E-mail: omj@force.dk,
Phone +45 7215 7808

3. Test design

The test design outlined in the verification protocol /1/ is summarized in the following Table 1.

Table 1. Test Design.

Performance parameters	Scope of measurement	Measurements methods and readings
Energy supply Flue gas	Volume Temperature Humidity O2	Manuel measurement in accordance with DANAK accreditation no. 51 held by FORCE Technology /7/
Condensate	Quantity Temperature	Quantity: Manuel measurements, measured by weight and volume. Temperature: In Accordance with DANAK accreditation no. 51 held by FORCE Technology
Fibrous material inlet and outlet	Quantity Dry matter content Temperature	Quantity: Manual measurements, measured by weight. Temperature: Manuel measurement in accordance with DANAK accreditation no. 51 held by FORCE Technology Dry matter contents: Laboratory analysis in accordance with CEN/TS 14774-3 and CEN/TS 14774-1
Power Consumption	Quantity	Scanning and reading the data from the operation panel.

3.1. Test site

The test is conducted at Fangel Bioenergi (Bigadan), Østermarksvej 70, 5260 Odense S on behalf of Cimbria Manufacturing and coordinated by FORCE Technology.

3.2. Tests

Cimbria Manufacturing, Super Heated Steam Drier - hereafter called SHSD - is tested for its ability to dry manure fibres.

3.2.1. Test methods

The test methods are divided into two types of measurements: Continuous and manual measurements. The detections levels of the test methods, references and uncertainty are shown in Table 2.

Table 2. Test methods.

Test methods	Type of measurement
Volume of flue gas	Manuel measurement in accordance with DANAK accreditation no. 51 held by FORCE Technology, and acknowledged international standards. Reference: DS/ISO 10780 / US EPA Method 1-3 /4/ Detection Level: 2,3 m/s Uncertainty: 10 % of the measured value (95 % confidence interval)
Temperature	Continuously measurement in accordance with DANAK accreditation no. 51 held by FORCE Technology, and acknowledged international standards. Reference/standard: VDI 3511 bl.1-5, DS/IEC 584-2 /5/ Measurement range: 40 – 600°C Uncertainty: 4°C (absolute)
Humidity / water content of fibrous material	Manuel measurement in accordance with DANAK accreditation no. 51 held by FORCE Technology, and acknowledged international standards. Reference: DS/EN 14790 US EPA M. 4. US EPA M. 4 /6/ Measurement range: 0 – 75 Vol % Uncertainty: 14 % Detection Level: 2 Vol % of the measured value (95 % confidence interval)
Fibrous material inlet and outlet, humidity	Manuel collecting of samples. *Analysis:* Reference/standard: CEN/TS 14774 – 1 /9/ Solid bio fuels. Methods for the determination of moisture content. Uncertainty: +/- 0,2 % V/V Reference/standard: CEN/TS 14774 – 3 /10/ Solid bio fuels. Methods for the determination of moisture content. Uncertainty: +/- 0,5 % V/V
Fibrous material inlet and outlet, amount	Logging of data from the operation panel.
District heating production	Continuously reading and logging data from the operation panel.
Energy consumption	Continuously reading data from the operation panel.
Energy efficiency	Calculations based on the results of the measurements and analysis.

Detection and uncertainty limits:

Continuous measurements

The detection levels used in this verification are the normally achievable under a normal performance control.

The detection levels are defined as the average value plus 3 times the scattering of the equipments deviation in the span calibration range.

The uncertainty levels are calculated as the normally achievable uncertainty at the measuring point, which full fills the guidelines in the chapter 8. in the "Luftvejledningen", from the Danish EPA\2\. By any deviation from the guidelines stated in the "Luftvejledningen" the uncertainty may increase.

Manuel measurements

The detection levels are defined as the normally achievable under a normal performance control, equal 60 minutes measurements. The detection level is defined as the average value of repeated "blind samples" plus three times the deviation of the samples.

The uncertainty level is calculated as the normally achievable uncertainty at the measuring point, which full fills the guidelines in the chapter 8. in the "Luftvejledningen", from the Danish EPA By any deviation from the guidelines stated in the "Luftvejledningen" the uncertainty may increase.

The uncertainty of the measurement is defined in % of the measured value (95 % confidence interval) equal 2 times RSD. Measured values between 5 and 1 times the detection level, will increase the uncertainty from the stated %-value to 50 – 100 % by the detection level.

3.2.2. Test staff

Test responsible: Ole Tvede Larsen (OTL)

Field responsible: Steen Meldorf (SME)

3.2.3. Test schedule including types and number of samples

The test schedule is shown in the following Table 3a and 3b.

Table 3a. Test schedule.

Component	Id/position no[1]	Plant equipment	Method
Fibrous material inlet Quantity	SRO – no. CF03	Plant AMS	Manuel measurement by weight.
Fibrous material outlet, Quantity	None	Plant AMS	Manuel measurement by weight.
Fibrous material inlet, water content	None	FORCE manual sample	Collecting of 5 samples a day for analysis at the laboratory. Quantity: 250 ml. Storage: Glass container with cap
Fibrous material outlet, water content	None	FORCE manual sample	Collecting of 5 samples a day for analysis at the laboratory. Quantity: 250 ml. Storage: Glass container with cap
District heating production	SRO – no. 450	Plant AMS	Continuous logging of data from the operation panel.
District heating temperature given	SRO – no. 451	Plant AMS	Continuous logging of data from the operation panel.
District heating temperature return	SRO – no. 452	Plant AMS	Continuous logging of data from the operation panel.
Condensate Quantity	None	FORCE manual sample	Manuel measurement by volume.
Condensate temperature	None	Plant AMS	Continuous logging of data from the outlet of the convey belt.
Energy inlet heat exchanger Temperature	None	FORCE manual sample	Manuel measurement in accordance with DANAK accreditation no. 51 held by FORCE Technology, and acknowledged international standards. Reference/standard: VDI 3511 bl.1-5, DS/IEC 584-2 Measure range -40 – 600°C
Energy inlet heat exchanger pressure drop	None	FORCE manual sample	
Energy inlet heat exchanger volumetric flow	None	FORCE manual sample	Manuel measurement in accordance with DANAK accreditation no. 51 held by FORCE Technology, and acknowledged international standards. Standard: DS/ISO 10780,
Screw Conveyer Bottom	None	Plant AMS	Manual measurement of consumptions - Amp

[1] *Identity numbers used at Fangel Bioenergi electric documentation*

Table 3a. Test schedule (*continued*).

Component	Id/position no[1]	Plant equipment	Method
Energy outlet heat exchanger Temperature	None	FORCE manual sample	Manuel measurement in accordance with DANAK accreditation no. 51 held by FORCE Technology, and acknowledged international standards. Reference/standard: VDI 3211 bl.2-5, DS/IEC 584-2 Measure range -40 – 600°C /5/
Electricity infuse Horizontal screw conveyer	None	Plant AMS	Manual measurement of consumptions - Amp
Screw conveyer	M10 – 025U2	FORCE continuous sampling	Continuous logging of data from the operation panel.
Feeder bowl	M30 – 027U2		
Fan 31	M31 – 028U2		
Fan 32	M32 – 029U2		
Fan 33	M33 – 030U2		
Fan 34	M34 – 031U2		
Fan 35	M35 – 032U2		
Fan 36	M36 – 033U2		
Fan 37	M37 – 034U2		
Fan 38	M38 – 035U2		
Conveyer Drier	M39 – 036U2		
Rotating Brush[2]		Plant AMS	Manual measurement of consumptions - Amp
Camber Sluice	None	Plant AMS	Manual measurement of consumptions - Amp

[1] *Identity numbers used at Fangel Bioenergi electric documentation*

[2] *Rotating brush for cleaning the slate conveyer belt, placed at the outlet of the cabinet.*

Table3b. Test schedule.

Task	Week number 2009								
	35	36	37	38	39	40	48	49	50
Test plan	x								
Measuring point layout		x							
Test plan QA					x				
Pre-test measuring device					x				
Sampling equipment					x				
Test						x			
Test Report draft							x		
Test Report QA								x	
Test report									x

3.2.4. Test equipment

Flue gas flow:

The gas velocity is measured by a pitot tube determining the dynamic pressure in connection with an inclined tube manometer. Based on the velocity and the area of the measuring cross section the flue gas flow is calculated.

Reference: US EPA Method 1-3 /4/

Flue gas temperature:

A type K temperature sensor (NiCr/NiAl) connected to a digital thermometer (accuracy 1°C) is applied. The indicated values are read with short intervals or recorded on a data logger.

Reference: VDI 3511 bl. 1-5. /5/

Moisture:

A well-determined partial quantity of flue gas is cleaned for particles and aspirated through a column containing silica gel to adsorb the water. The collected Quantity of water is determined by differential weighing. Alternatively the weight gain of impinger trains, condensation units etc. can be applied for moisture determination.

Reference: US EPA M. 4. /6/

3.2.5. Operational measurements

During operation, the following operational conditions are recorded and sampled, see table 2 and 3:

- District heating flow
- Temperature (inlet)
- Temperature (outlet)
- Power Consumption (in generally, all related systems)
- Excess steam (temperature)
- Fibrous material collected before and after the SHSD unit

3.2.6. Health, safety and wastes

The use of the product does not imply special health, safety and waste issues.

The work during testing is done according to the FORCE Safety Rules that are compliant with the extensive Danish rules for safe occupational health and the European regulations of work with chemicals.

Regarding waste:

The Cimbria Manufacturing, SHSD is build in an enclosed cabinet, which ensure that the emission or environmental impact is limited if any. There are no air-born emissions from the system. The condensate can be reused as fertilizers and the final by-product of the drying process can also be used as fertilizers or bio-fuel.

4. Reference analysis

4.1. Analytical laboratory

Reference analyses are done by:

FORCE Technology
Park Alle 345
2605 Brøndby
Denmark
Phone +45 4326 7000
Contact: Susanne Westborg
E-mail swe@force.dk

Reference analysis

All analysis, measurements and calculations are performed in accordance to the FORCE Technology DANAK accreditation No. 65 /8/. For parameters not covered by the accreditation the analysis is carried out according to well known and accepted standards.

4.2. Analytical parameters

Dry matter content of the fibrous material from manure, before and after drying with Cimbria Manufacturing, SHSD.

4.3. Analytical methods

Sampling and analysis of dry matter is performed according to Reference analysis: Reference/standard: CEN/TS 14774 – 1 /9/, Solid bio fuels.

Methods for the determination of moisture cont, uncertainty: +/- 0,2 % V/V, and reference/standard: CEN/TS 14774 – 3 /10/, Solid bio fuels.

4.4. Preservation and storage of samples

The samples are stored in a sealed glass bottle, and analyzed within 14 days from sampling, according to the requirements in the mentioned standard.

5. Data management

Handling of data and calculation of results is performed according to the FORCE Technology DANAK accreditation no. 51. For parameters not covered by the accreditation the analysis is carried out according to well known and accepted standards.

Calculations are performed by approved and controlled spread sheet.

5.1. Data storage, transfer and control

All reading data is stored in handwritten form on paper and schemes.

All the data stored in data loggers is transferred to the FORCE computer system, which is regularly backed up for data safety.

Analytical raw data is filed and archived according to the specifications of the DANAK accreditation no. 51 /7/

6. Quality assurance

All measuring, handling of data and calculation of results is performed according to the FORCE Technology DANAK accreditation no. 51 (also for parameters not covered by the accreditation).

All measuring data is available in handwritten form.

Transfer of data from handwritten form to computer, is subjected to 100 % control.

Approved spread sheets for calculations of results is subject to an intensive control, to assure correct calculations, and consequently no further control is necessary.

6.1. Test report review

The test report is subject to internal review by the verification responsible from FORCE Technology VTC:

William Hansen
E-mail: wha@force.dk
Phone +45 4326 7174
Cell phone: +45 2218 1138

External review of the test report is done by the expert group assigned to this verification (see paragraph 2.4). The re-view of the verification report will include the full test report as an Appendix.

6.2. Data integrity check procedures

All transfer of data from handwritten form to computer, is subject to 100 % control by another person.

Approved spread sheets for calculations of results has been subject to an intensive control, to assure correct calculations, and consequently no further control is necessary.

New calculations in spread sheets are subject to 100 % check of all formulas and spot check of at least 20 % of all copies of the formulas.

7. Test results

7.1. Test summary

The test was conducted at Fangel Bioenergi (Bigadan), Østermarksvej 70, 5260 Odense S on behalf of Cimbria Manufacturing and coordinated by FORCE Technology. Cimbria Manufacturing, SHSD was tested for its ability to dry manure fibres.

During operation, the operation conditions were recorded and sampled as mentioned in section 3.2.5

The test was carried out over 4 day's continuous running process. Representatives from Cimbria Manufacturing and FORCE Technology were at site under the whole period in order to observe and secure samples and recorded data from the test.

In total 18 samples were collected. Due to decanter default 1 sample was discarded from the data base.

7.2. Test results

In order to determine the steam driers capability to dry manure fibres, measurements of the dry matter content in the manure fibres and the related energy parameters are carried out.

7.2.1. Dry matter content in manure fibres

Based on the measurements and analysis from the verification test the dry matter content in the manure fibres is concluded in table 4. Additionally the production capacity of the SHSD is given. All values are average values from the entire sampling period starting on September 28th and ending on October 1st 2009.

Table 4. Dry matter content in manure fibres (28.9 – 1.10.2009)[1].

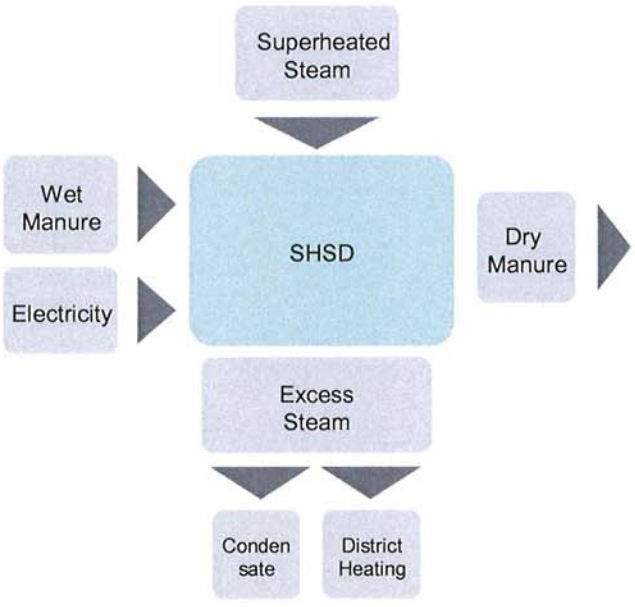
Dry matter content in manure fibres[2] (% ± RSD[3])	
Inlet	**Outlet**
32,4 ±3,1	**90,2 ± 6,9**
Wet manure production capacity	**858 kg/h[4]**

[1] *Refers to Appendix 6A (table 1-3): Results of all measurements - Manure*
[2] *Refers to Appendix 6A – Table 1*
[3] *Relative standard deviation in %*
[4] *Refers to Appendix 6A – Table 3*

7.2.2. Energy balance

The drying process of the manure is based on supply of energy in the form of heat. The sources of this energy are the flue gas from the biogas engine and the electricity to the fans circulating the drying steam inside the SHSD (see figure 1a). The energy from the flue gas is captured in the heat exchanger which overheat the steam inside the SHSD and the circulating fans ensure that superheated steam evaporates the water in the wet manure. The excess steam energy (Q_s) from the drying process is later utilized into district heating. The remaining energy after the district heating is derived as condensate. Figures 1a – 1c are schematic diagrams of the flow of energy and manure to and from the SHSD.

Figure 1a. SHSD flow d**iagram of Energy and Manure.**



The energy used to dry the manure is provided by the sources mentioned above, i.e. flue gas (Q_{FG}) and electricity (Pe) assuming that the manure does not contribute to the energy input (or output). Regarding the energy provided by the fans it is assumed, that 85 % of the electricity input to the fans is used to move the fans or used to equipment outside the SHSD and the remaining 15 % is transferred to heat inside the SHSD.

The SHSD energy demand is given in table 5 and table 6 reflect the available energy from the process and how it is recovered.

In Appendix 6 all test results from the measurements are given (App 6A: Manure, App 6B: Flue Gas, App 6C: Condensate and App 6D: Electricity) and appendix 4 shows the calculation formulas used.

Table 5. Energy demand to dry manure (28.9 – 1.10. 2009)[1, 2]

Energy flow	Parameter		Parameter	MJ/h	Amount MJ/h
Input	Energy contribution from the flue gas to the heat exchanger	Q_{FG}	Q_{FG} (inlet)	2.457	1.407
			Q_{FG} (outlet)	1.050	
	Electricity to fans	P_e [3]			27
				Total Input	**1.434**
Gross energy needed to evaporate 1 kg of water is 3 MJ[4]					

[1] *Refers to Appendix 6A – 6D: Results of all measurements*

[2] *Refers to Appendix 4: Calculations formulas*

[3] *Calculated as 15 % of electricity input to fans (27 MJ = 176,8 MJ x 15%) – see appendix 6D*

[4] *Calculated as 3 MJ=1.434 MJ/h (input)/489 kg/h (evaporated water ~ mass of condensate(see Appendix 6C))*

Table 6. Energy recovery in the plant (28.9 – 1.10. 2009)[1, 2]

Energy flow	Parameter		Parameter	MJ/h	Amount MJ/h
Output	Energy contribution from the excess steam	Q_S	Q_{S1}	21	1.288
			Q_{S2}	1.104	
			Q_{S3}	164	
	Energy loss	Q_L			146
				Total Output	**1.434**
Net energy needed to evaporate 1 kg of water is 0,6 MJ[4]					
2,4 MJ/kg is utilized energy for district heating					

[1] *Refers to Appendix 6A – 6D: Results of all measurements*

[2] *Refers to Appendix 4: Calculations formulas*

[3] *Calculated as 15 % of electricity input to fans (27 MJ = 176,8 MJ x 15%) – see appendix 6D*

[4] *Calculated as 0,6 MJ=(1.434 - 21-1.104 MJ/h (output))/489 kg/h (evaporated water ~ mass of condensate(see Appendix 6C))*

The calculation of energy used to dry the manure is associated with uncertainty due to the measurements included. This uncertainty is estimated to approximately 10 % and it is to some extend included in the figure of the energy loss (Q_L). Figure 1b including the energy loss and figure 1c including energy values (MJ).

Figure 1b. SHSD flow diagram including the energy loss

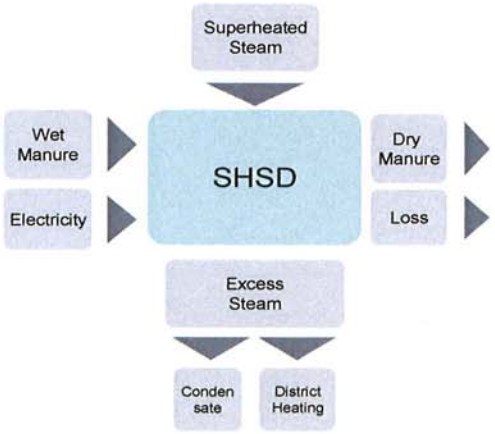
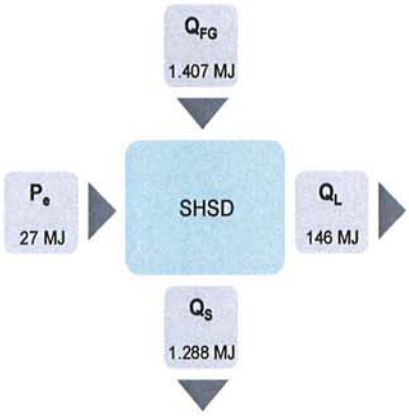


Figure 1c. SHSD flow diagram with energy values (MJ)



7.3 Deviations from test plan

The test was performed according to the test plan. There were no deviations from the test plan regarding measurements, data logging and sampling.

However some process problems occurred during the test, but the influence on the results of the test and the test itself is probably limited or confined when taken care off.

The first problem occurred on the 29th September, where the decanter went faulty due to a blockage. The blockage gave high water content in the inlet to the SHSD system – above the systems limit, and as a result a poor effectiveness over the system. After the problem had been taken care of, the decanter was back on-line. The SHSD system was on stand-by for approximately 30 – 45 minutes. The break is considered as neglect able.

The second problem occurred after the blockage of the decanter and gave an ongoing problem throughout the rest of the test. Dust from the fibrous matter gave some growth on the heat exchanger and could on a long term basis give some problems if not taking care of. A routine, where the SHSD system was inspected every 12 hours, was introduced to take care of the problem.

Signed by	12/5 -10	Signed by	12/5–10
Annemette Geertinger	Date	Ole Tvede Larsen	Date
Technical Vice President		Test Responsible	
DANETV Steering Committee member		DANETV Verification Centre	

8. References

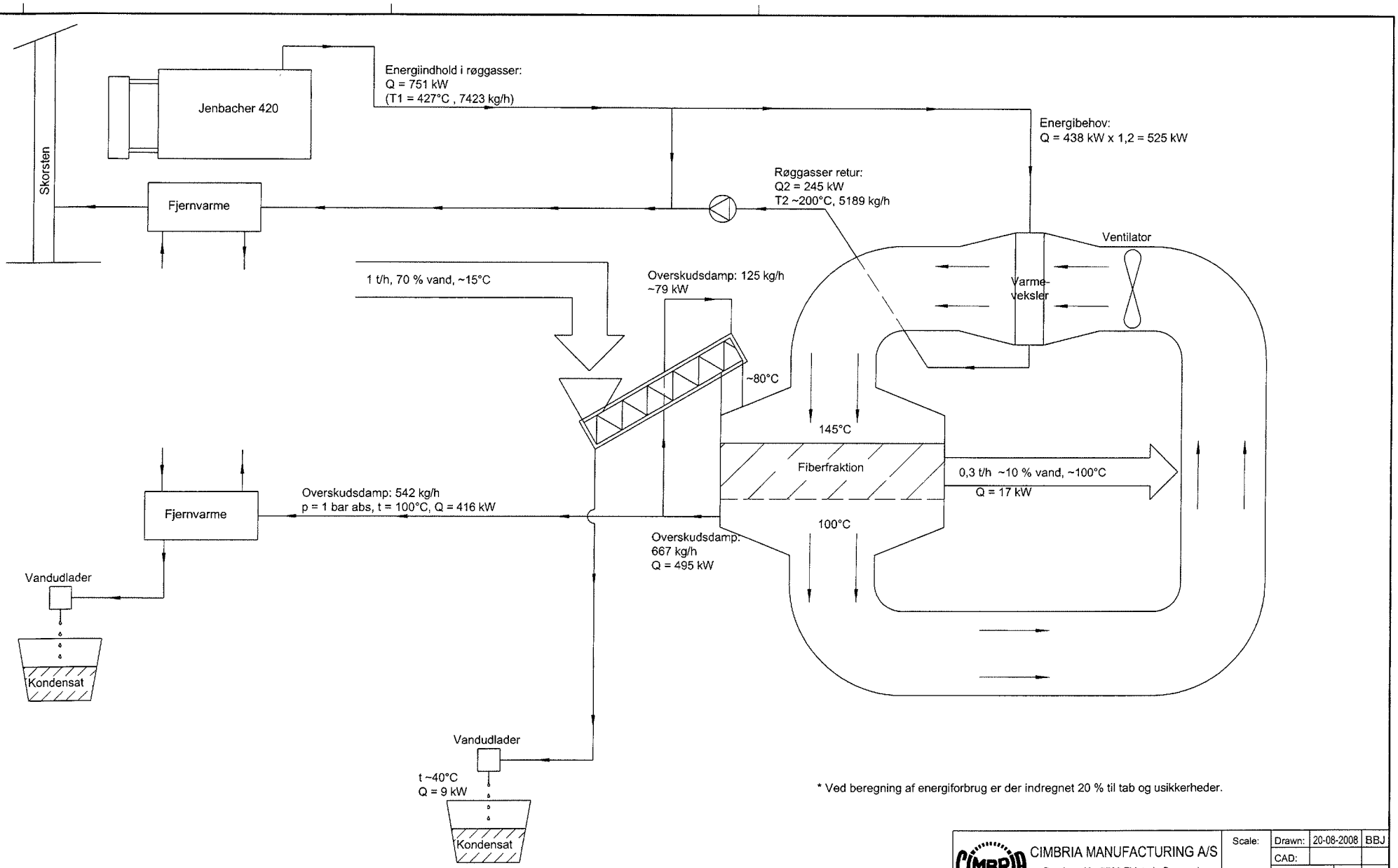
1. Cimbria Manufacturing A/S SHSD, verification protocol, Energy efficient pre-treatment of biomass, November 2009.
2. Vejledning Nr. 2 2001. Luftvejledningen. Miljøstyrelsen (The Danish EPA air pollution guideline).
3. DANETV. Verification Test Centre quality manual. FORCE Technology. 27-2-2
4. US EPA M 1-3. 10780. Determination of volumetric flow of gas stream, velocity measurements, pito tube.
5. VDI 3211 – bl. 2-5. Measurements of temperature of gas streams - NiCr-NiAl and pt 100.
6. US EPA M4. 14790. Measurements of vapour content (H2O) in gas streams.
7. DANAK Accreditation number 51
8. DANAK Accreditation number 65
9. Method for the determination of moisture content. CEN/TS 14774-1
10. Method for the determination of moisture content. CEN/TS 14774-3

11. Appendix

Appendix 1	SHSD flow sheet	
Appendix 4	Calculation formulas	
Appendix 5	Test datasheets	
	5A	Laboratory report dry and wet matter (6 pages)
	5B	Graphs showing the current usage during the test on all relevant components (16 pages)
	5C	Printout of the calculation of the volumetric flow (5 pages)
	5D	Logbook of sample collection and manual measurement of dry, wet matter and condensate (4 pages)
	5E	Printout of flue gas (inlet & outlet), temperatures, flow decanter. Shown as graphs and summarized spreadsheets (11 pages)
	5F	Screen dumps, load gas motor (energy source)
Appendix 6	Results of measurements	
	6A	Manure
	6B	Flue Gas
	6C	Condensate
	6D	Electricity

Appendix 1

Super Heated Steam Drier flow sheet



* Ved beregning af energiforbrug er der indregnet 20 % til tab og usikkerheder.

Part No.:	
Part List:	
Unspecified tolerances according to CIMBRIA Standard	

CIMBRIA MANUFACTURING A/S
Postbox 40, 7700 Thisted, Denmark
Phone +45 96 17 90 00, Fax +45 96 17 90 99

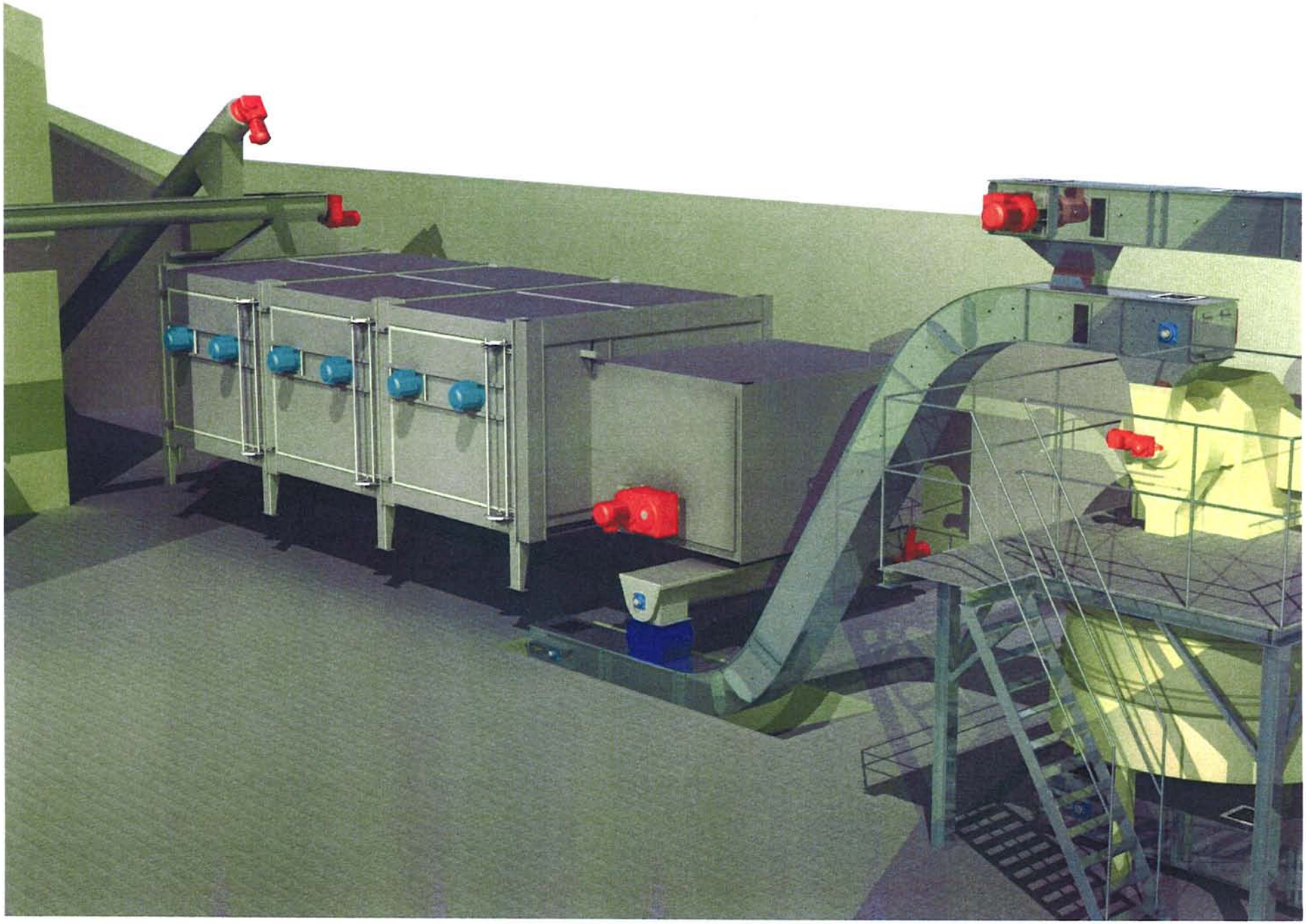
Scale:	Drawn:	20-08-2008	BBJ
	CAD:		
	Language:		
	Q-Level:		

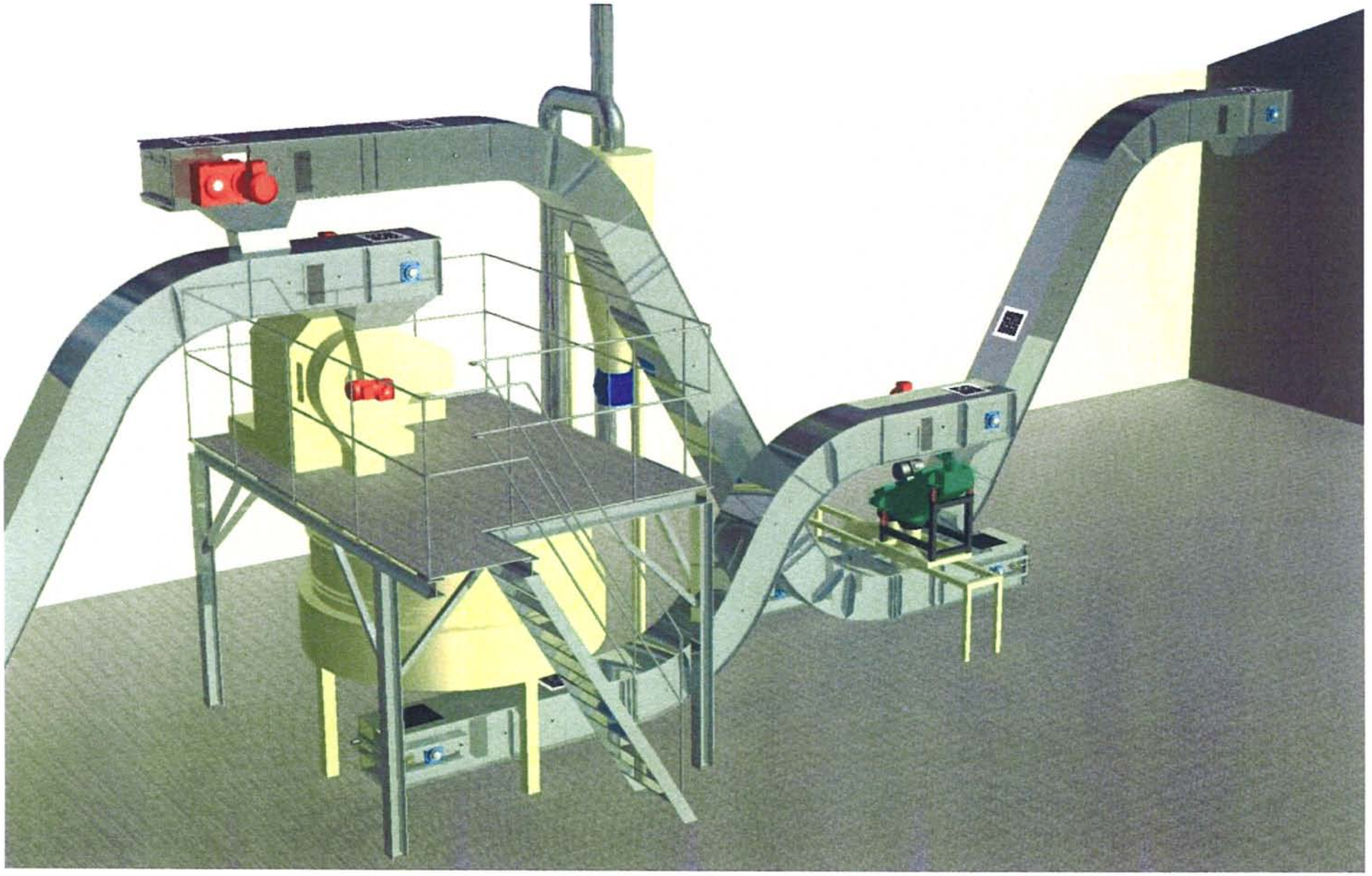
Anlæg for tørring af tørstoffraktion
med overhedet damp, 1 t/h, Røggasveksler
Flowdiagram

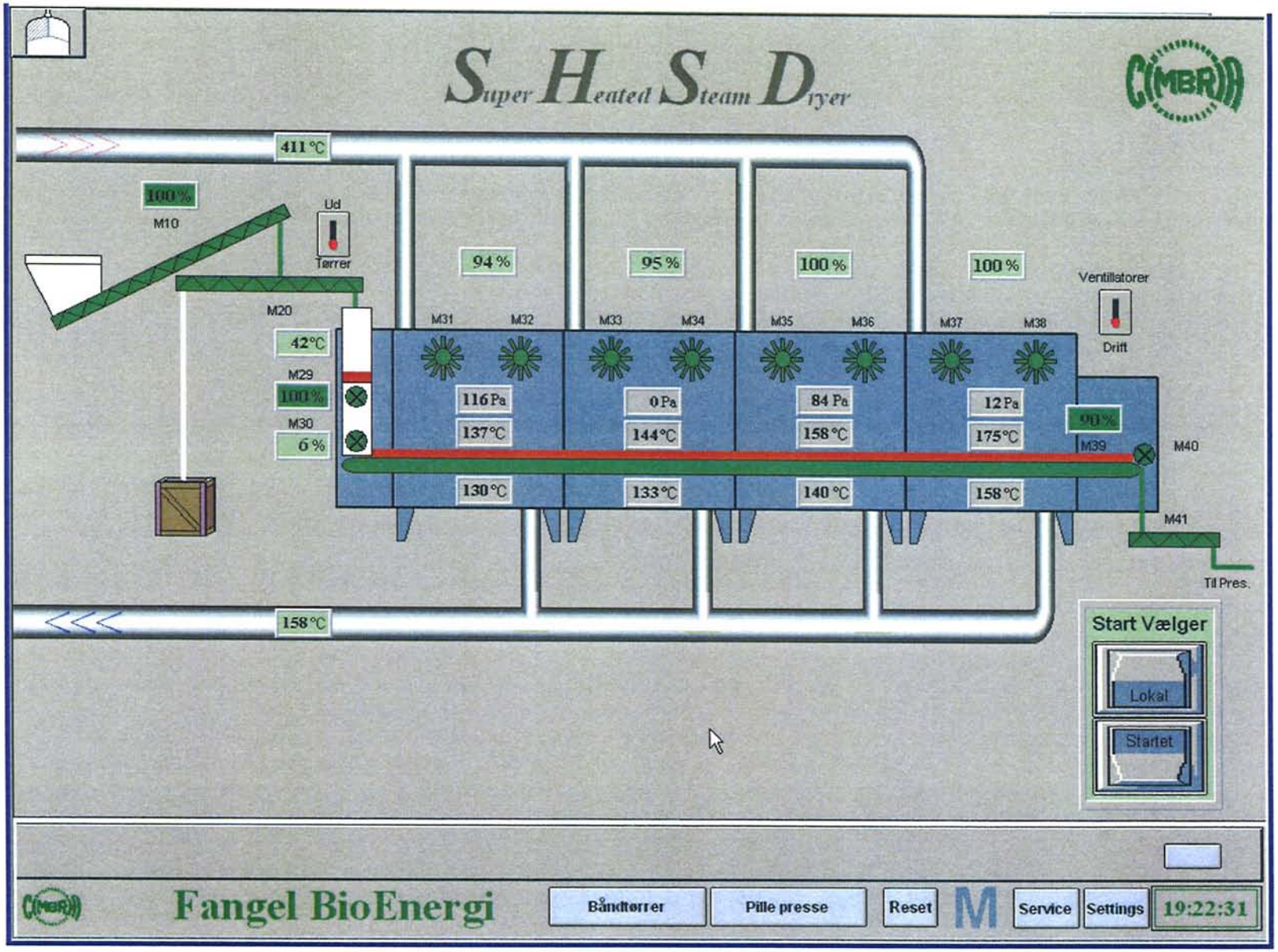
Sub. for:
Drwg. No.: Flowdiagram-1t-Røggas

 Metric System ISO E

CAD-File: Flowdiagram-1t-Røggas.dwg






Super Heated Steam Dryer
411 °C
100 %
M10
Ud
Tørrer
94 %
95 %
100 %
100 %
Ventillatorer
Drift
M20
M31
M32
M33
M34
M35
M36
M37
M38
42°C
M29
100 %
M30
6 %
116 Pa
137°C
130 °C
0 Pa
144°C
133 °C
84 Pa
158 °C
140 °C
12 Pa
175°C
158 °C
90 %
M39
M40
M41
Til Pres.
158 °C
Start Vælger
Lokal
Startet
Fangel BioEnergi
Båndtørrer
Pille presse
Reset
M
Service
Settings
19:22:31

Appendix 4

Calculation formulas

The following table shows the calculated formulas used for energy calculations between different units. All values used in the calculations are average values.

To calculate energy content the following formula in Table 1 is used:

Table 1. Calculation formula used for Energy Calculations

Energy sources	Energy parameter		Calculation formula
Electric Power (Pe)	**Pe**		$Pe^{a} = E^{b} \times I \times \cos\varphi^{c} \times 3.600$ (kJ)
Energy (Q)	**Q_{FG}**		$Q_{FG} = V \times Cp^{d} \times Cv^{e} \times T$ (kJ)
	Q_{C}		$Q_{C} = M \times Cv^{f} \times T$ (kJ)
	Q_{S1}	*120 ^{0}C [g] steam to 100 ^{0}C steam*	$Q_{S1} = M \times Cp^{h} \times \Delta T$ (kJ)
	Q_{S2}	*100 ^{0}C steam to 100 ^{0}C water*	$Q_{S2} = M \times r^{i}$ (kJ)
	Q_{S3}	*100 ^{0}C water to 20 ^{0}C [g] water*	$Q_{S3} = M \times Cp^{j} \times \Delta T$ (kJ)

Nomenclature

Symbol	E	I	cos φ	V	T	Cp	Cv	M	FG	C	S	r
Term	Electric potential	Current	Phase factor	Volumetric flow	Tempe rature	Density	Specific heat	Mass Condensate	Flue Gas	Conden-sate	Excess Steam	Heat of Evaporation
Unit	V	A		m^3	^{0}C	kg/m^3	kJ/kg ^{0}C	Kg				

[a] *For 3 phase motor multiply with 1,73*

[b] *The electric potential (V) for the Pe calculation is 400 Voltage*

[c] *cos φ is used to determine the efficiency of the electric motor. The cos φ value used in the calculation are the values given on the electric motor rating plate, which and can vary from the actual cos φ value.*

[d] *Cp is assumed to be 1,1 kg/m3. Cp varies depending on the fuel.*

[e] *The specific heat for Flue Gas is 1,0 kJ/kg ^{0}C*

[f] *The specific heat for Condensate is 4,2 kJ/kg ^{0}C*

[g] *Temperature is assumed values based on experience.*

[h] *The specific heat for steam is 2,14 kJ/kg ^{0}C*

[i] *The heat of evaporation is 2.257 KJ/kg*

[j] *The specific heat for water is 4,18 kJ/kg ^{0}C*

Appendix 5A

Laboratory report dry and wet matter

Rekvirent :

Sag 109-20531.12.02

Vedr.: Platform 3, Videncenteret

Att.: WHA

Journal nr.: U09-858

2009.10.08

PRØVNINGSRAPPORT

Undersøgelse af fast brændsel

Sag. nr.	:	109-20531.12.02
Rekvisitions nr.	:	-
Prøve modtaget d.	:	2009.10.05
Prøvningstermin	:	2009.10.05-2009.10.08

Resultaterne for prøvningen findes på side: 2

FORCE Technology

Susanne Westborg
Specialist

Kemisk Analyse

Henning Munk Jensen
Tekniker

Kemisk Analyse

ADVANCED TECHNOLOGY GROUP

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Rekvirent :

Sag 109-20531.12.02 **Journal nr.: U09-858**

Vedr.: Platform 3, Videncenteret

PRØVNINGSRAPPORT

Undersøgelse af gyllefibre

Prøve af : 19 stk gyllefibre
Mærket : Tilgang, Pr. 1 - 19

Emballage : 19 stk tætte glasflasker

Prøve mærket	Prøvens størrelse i g	% tørstof bestemt v. 105° C
1	161,8 g	31,7
2	221,5 g	30,6
3	173,5 g	31,2
4	223,4 g	31,3
5	236,6 g	31,2
6	189,7 g	31,8
7	245,1 g	30,4
8	187,6 g	32,1
9	173,1 g	33,1
10	184,4 g	32,6
11	146,2 g	32,8
12	154,9 g	32,5
13	165,9 g	33,3
14	152,0 g	33,1
15	166,9 g	34,0
16	171,1 g	33,6
17	172,3 g	33,1
18-Test	192,6 g	33,0
19-Produktprøve	198,3 g	32,6

Rekvirent :

Sag 109-20531.12.02

Vedr.: Platform 3, Videncenteret

Att.: WHA

Journal nr.:U09-860

2009.10.08

PRØVNINGSRAPPORT

Undersøgelse af kondensat

Sag. nr.	:	109-20531.12.02
Rekvisitions nr.	:	-
Prøve modtaget d.	:	2009.10.05
Prøvningstermin	:	2009.10.05-2009.10.05

Resultaterne for prøvningen findes på side: 2

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Rekvirent :

Sag 109-20531.12.02 **Journal nr.: U09-860**

Vedr.: Platform 3, Videncenteret

Undersøgelse af spildevand					
1. Prøve af	**Kondensat**	Mærke	**Kondensat**	Emballage	**glasflaske**
2. Prøve af		Mærke		Emballage	
3. Prøve af		Mærke		Emballage	

Prøve			**Enhed**	**1.**	**2.**	**3.**
Ledningsevne ved 25 °C		DS/EN 27888	**µS/cm**	//	//	//
pH-værdi ved 25 °C		DS 287		//	//	//
Suspenderet stof		DS/EN 872 (GF/A)	**mg/l**	//	//	//
COD_{CR} Kemisk oxygenforbrug		DS 217	**mg/l**	//	//	//
Chlorid	(Cl^-)	DS 239	**mg/l**	//	//	//
Sulfat	(SO_4^{--})	DS 286	**mg/l**	//	//	//
Total fosfor	(P)	DS/EN ISO 6878	**mg/l**	//	//	//
Syreopløselige metaller:		Oplukning jf. DS 259 og				
Arsen	(As)	DS/ISO 17294-2 (ICP-MS)	**µg/l**	//	//	//
Cadmium	(Cd)	DS/ISO 17294-2 (ICP-MS)	**µg/l**	//	//	//
Cobalt	(Co)	DS/ISO 17294-2 (ICP-MS)	**µg/l**	//	//	//
Chrom	(Cr)	DS/EN ISO11885 (ICP-OES)	**µg/l**	//	//	//
Kobber	(Cu)	DS/EN ISO11885 (ICP-OES)	**µg/l**	//	//	//
Jern	(Fe)	DS/EN ISO11885 (ICP-OES)	**µg/l**	//	//	//
Mangan	(Mn)	DS/EN ISO11885 (ICP-OES)	**µg/l**	//	//	//
Molybdæn	(Mo)	DS/ISO 17294-2 (ICP-MS)	**µg/l**	//	//	//
Nikkel	(Ni)	DS/EN ISO11885 (ICP-OES)	**µg/l**	//	//	//
Bly	(Pb)	DS/ISO 17294-2 (ICP-MS)	**µg/l**	//	//	//
Zink	(Zn)	DS/EN ISO11885 (ICP-OES)	**µg/l**	//	//	//
Vægtfylde	(målt v. 22° C)		**g/ml**	**0,999**	//	//
Udseende				**Uklar gulgrøn**	//	//

Bemærkninger:

// : Ikke analyseret parameter

Rekvirent :

Sag 109-20531.12.02

Journal nr.: U09-859

Vedr.: Platform 3, Videncenteret

2009.10.08

Att.: WHA

PRØVNINGSRAPPORT

Undersøgelse af fast brændsel

Sag. nr.	:	109-20531.12.02
Rekvisitions nr.	:	-
Prøve modtaget d.	:	2009.10.05
Prøvningstermin	:	2009.10.05-2009.10.08

Resultaterne for prøvningen findes på side: 2

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Rekvirent :

Sag 109-20531.12.02 **Journal nr.: U09-859**

Vedr.: Platform 3, Videncenteret

PRØVNINGSRAPPORT

Undersøgelse af gyllefibre

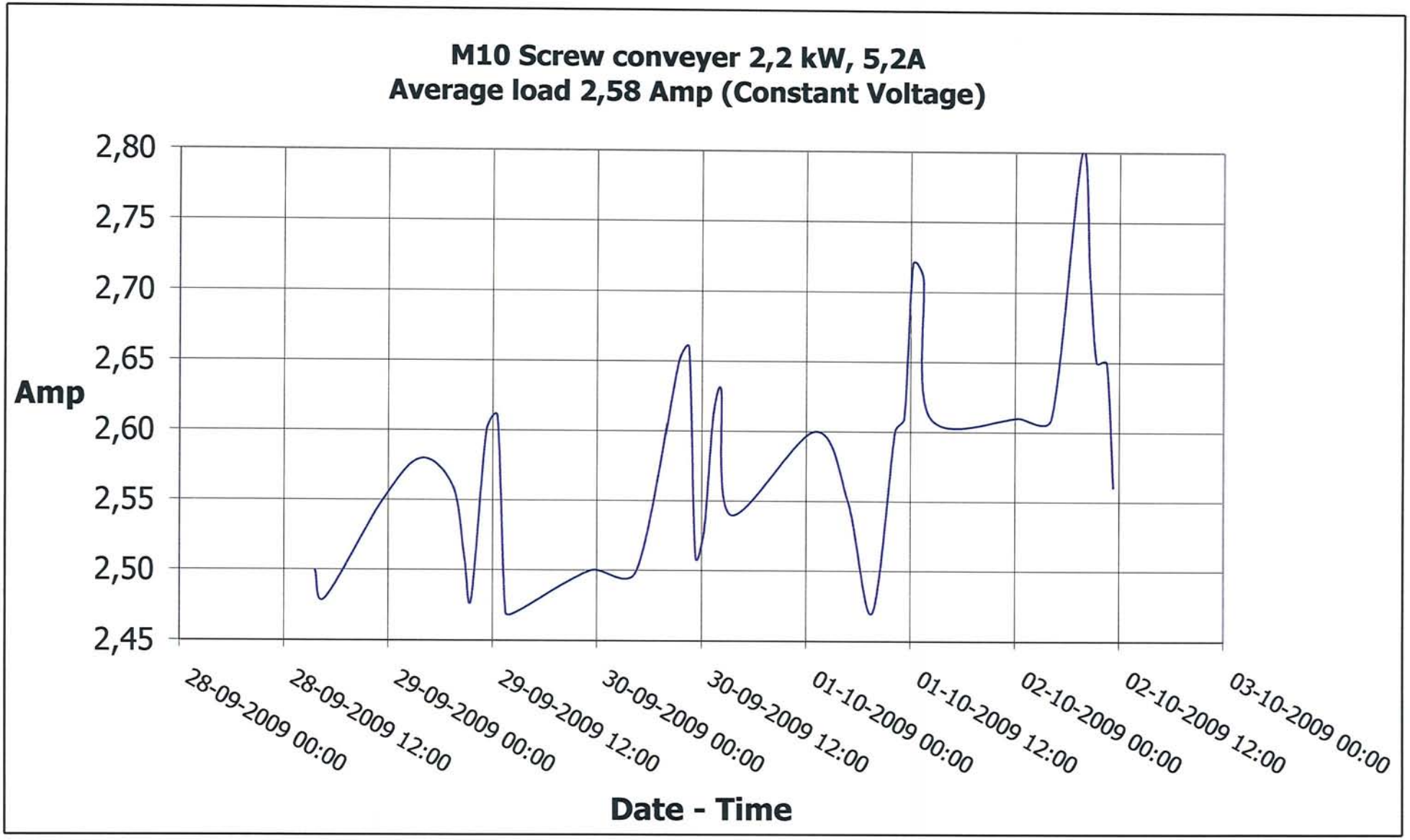
Prøve af : 18 stk gyllefibre
Mærket : Afgang, Pr. 1 - 18

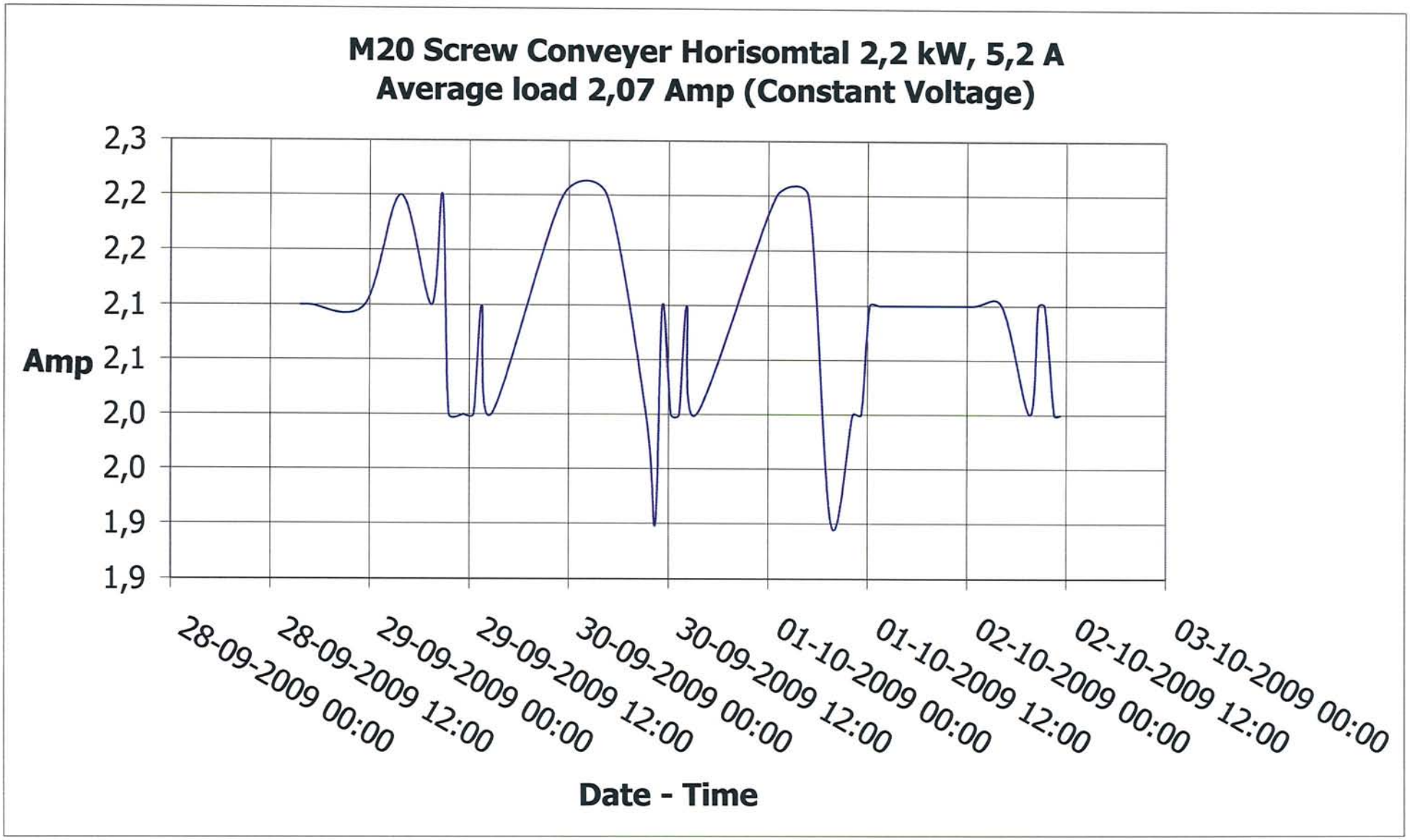
Emballage : 18 stk tætte glasflasker

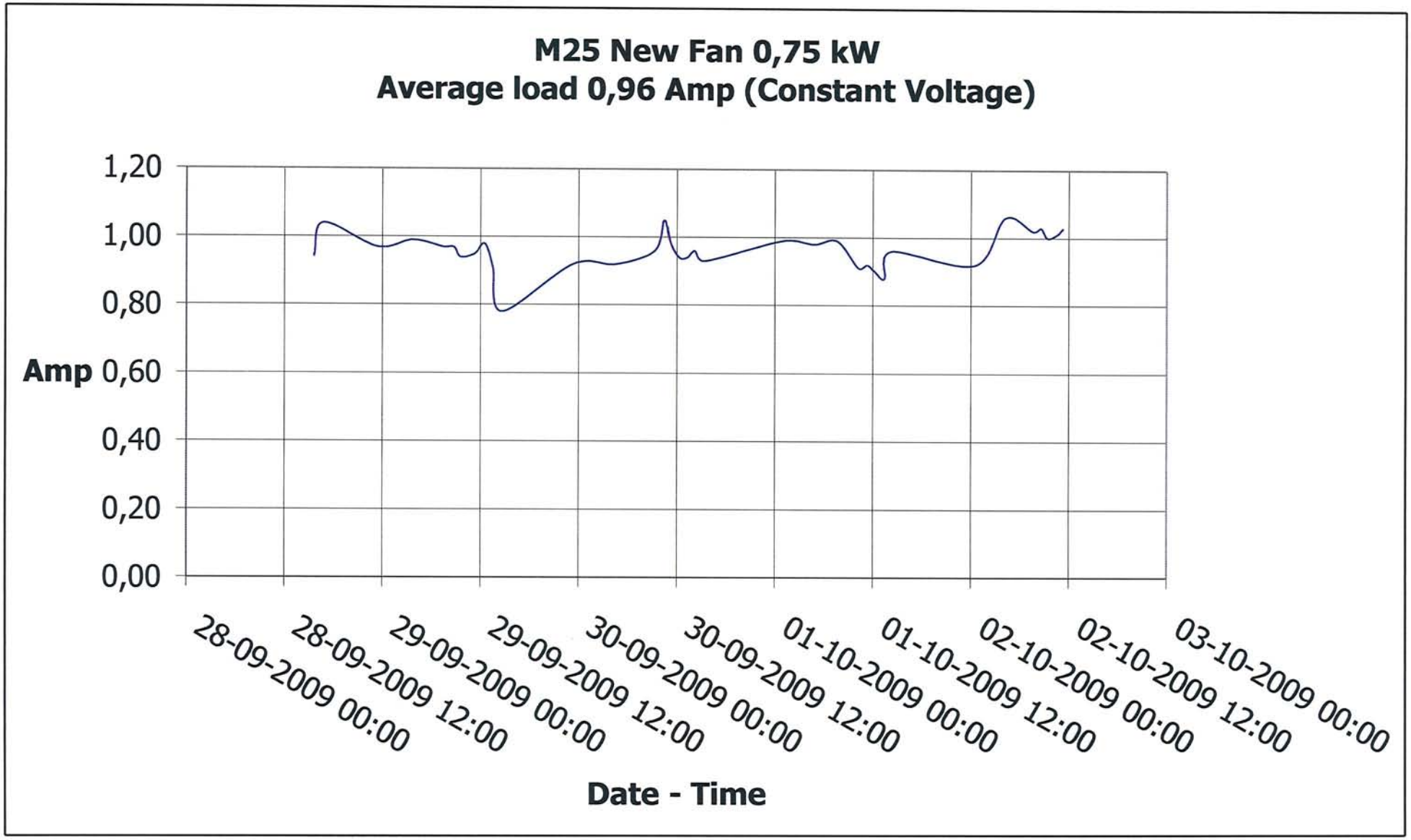
Prøve mærket	Prøvens størrelse i g	% tørstof bestemt v. 105° C
1	75,1 g	96,3
2	66,2 g	95,6
3	81,2 g	83,0
4	88,6 g	96,0
5	93,1 g	96,9
6	72,4 g	95,7
7	100,0 g	60,9
8	98,4 g	87,5
9	73,4 g	93,7
10	80,9 g	95,2
11	93,0 g	81,0
12	97,0 g	89,3
13	93,1 g	81,0
14	79,4 g	96,3
15	88,3 g	88,7
16	111,4 g	85,7
17	114,8 g	81,6
18-test	83,8 g	87,6

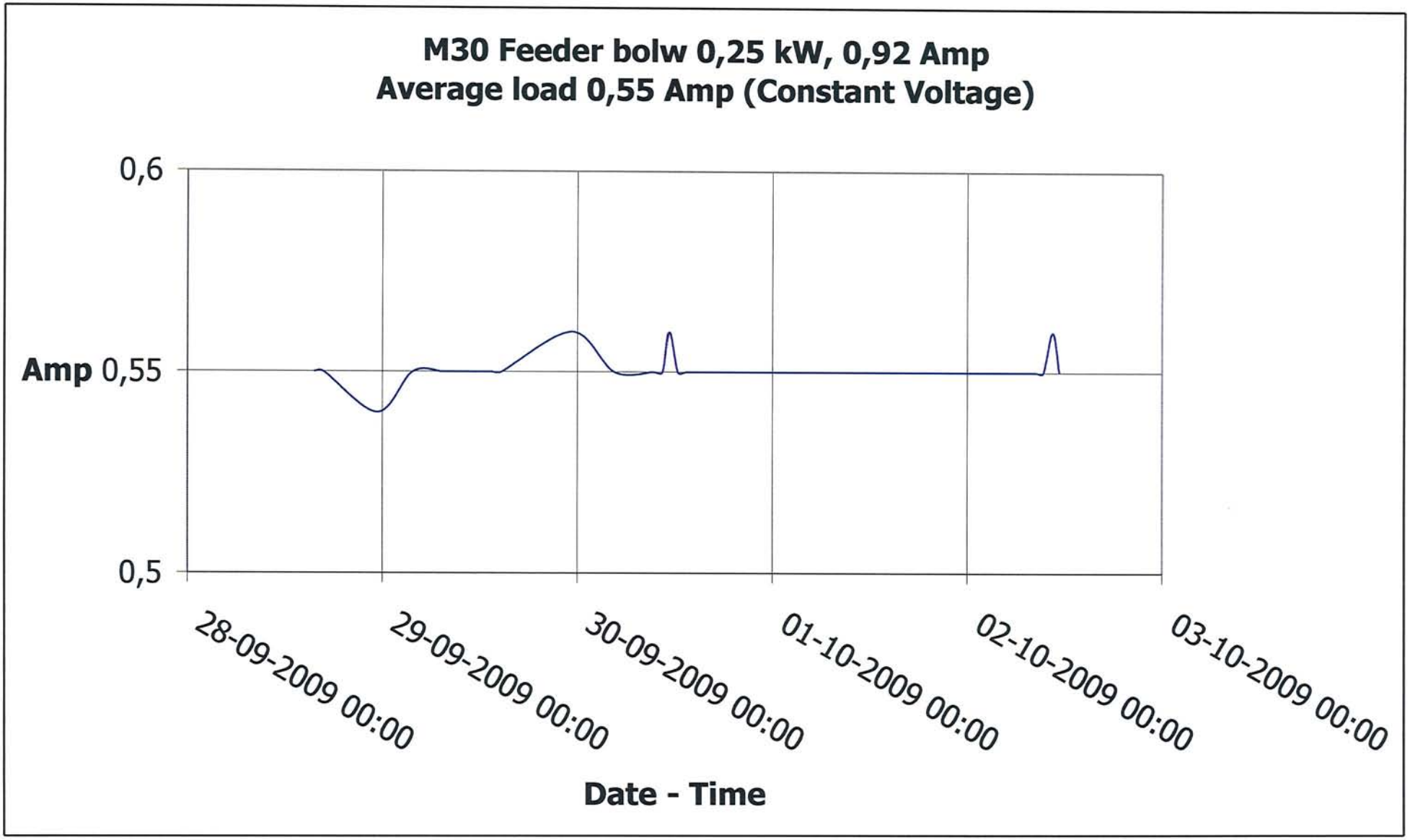
Appendix 5B

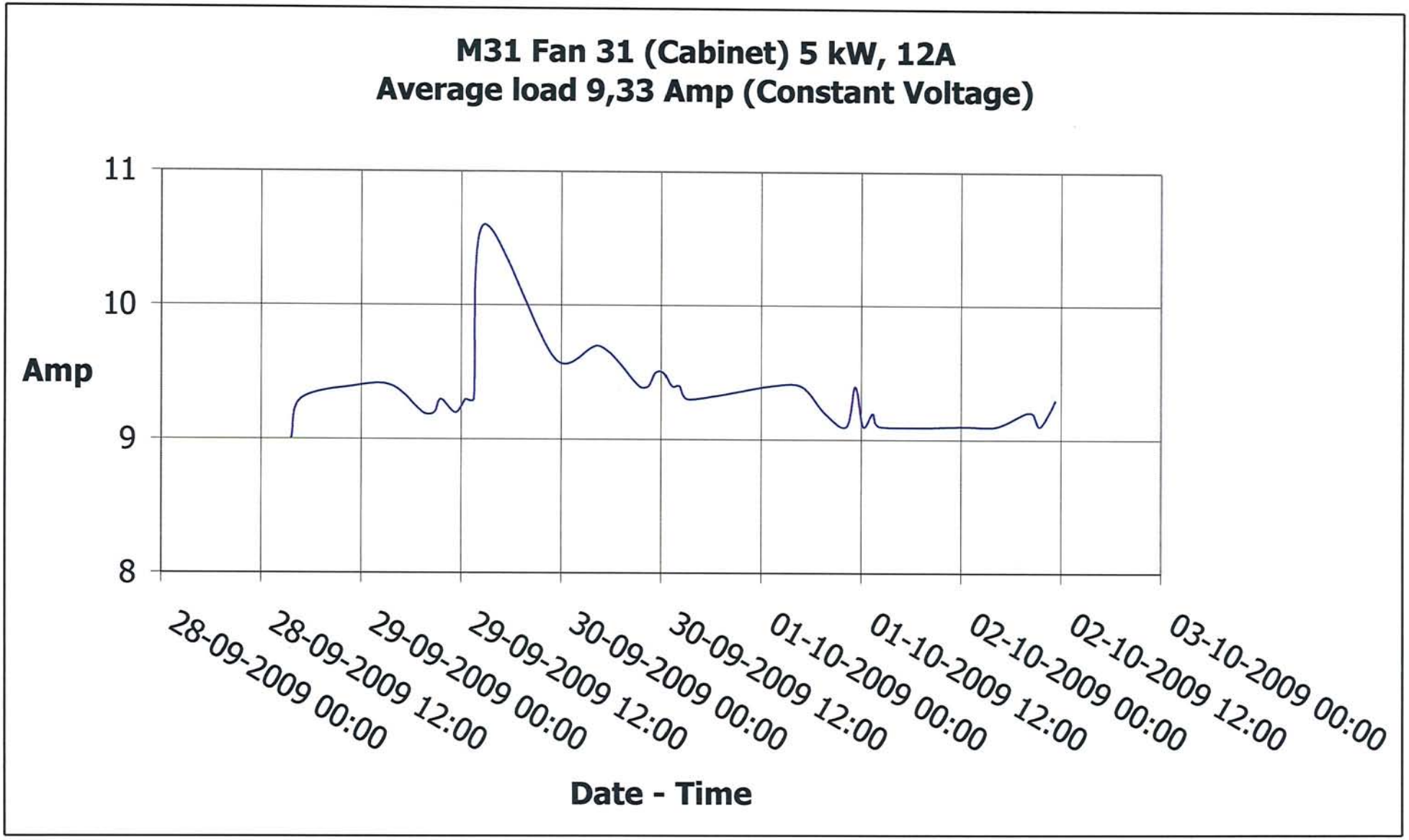
Graphs showing the current usage during the test on all relevant components

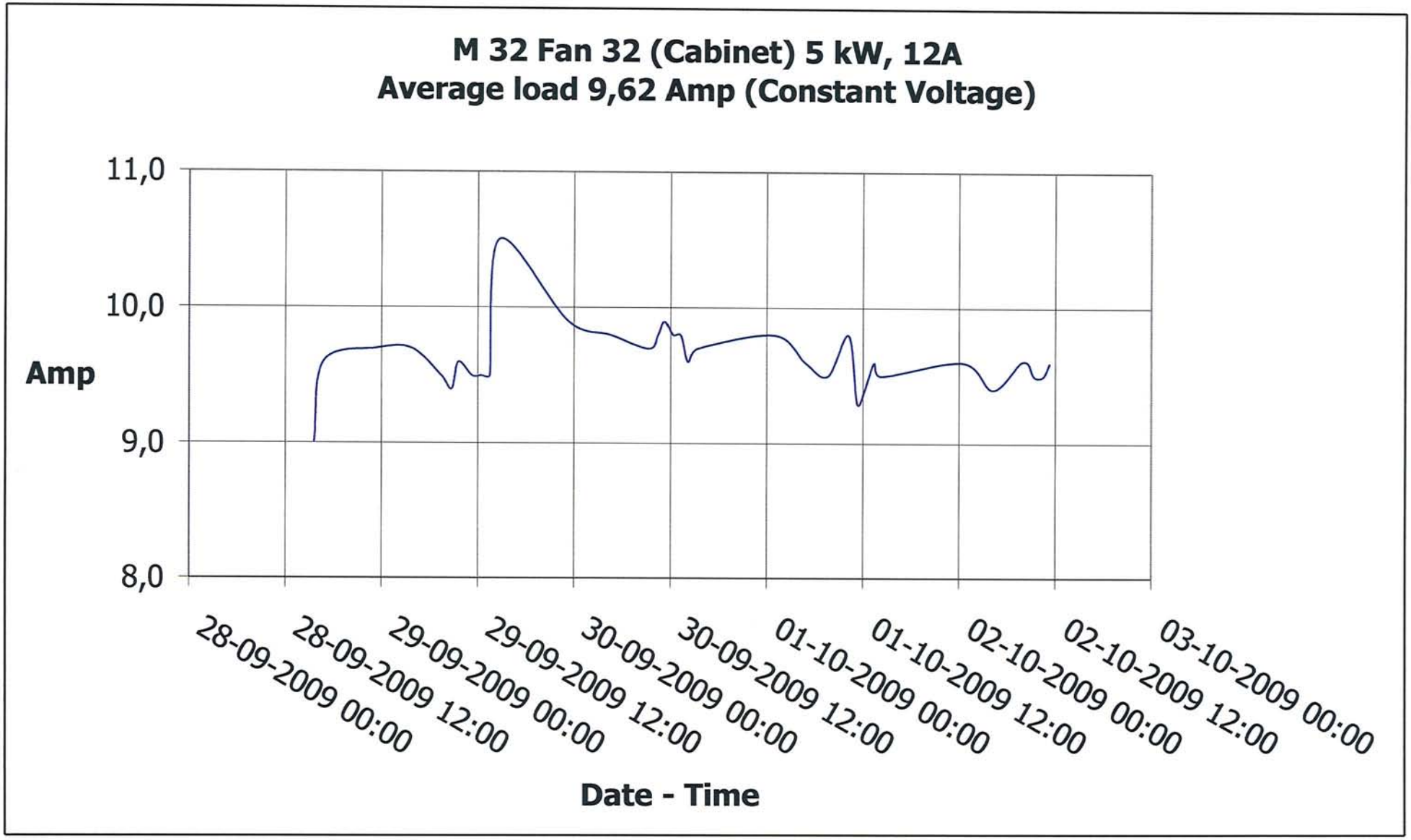

M10 Screw conveyer 2,2 kW, 5,2A
Average load 2,58 Amp (Constant Voltage)
Amp
2,80
2,75
2,70
2,65
2,60
2,55
2,50
2,45
28-09-2009 00:00
28-09-2009 12:00
29-09-2009 00:00
29-09-2009 12:00
30-09-2009 00:00
30-09-2009 12:00
01-10-2009 00:00
01-10-2009 12:00
02-10-2009 00:00
02-10-2009 12:00
03-10-2009 00:00
Date - Time

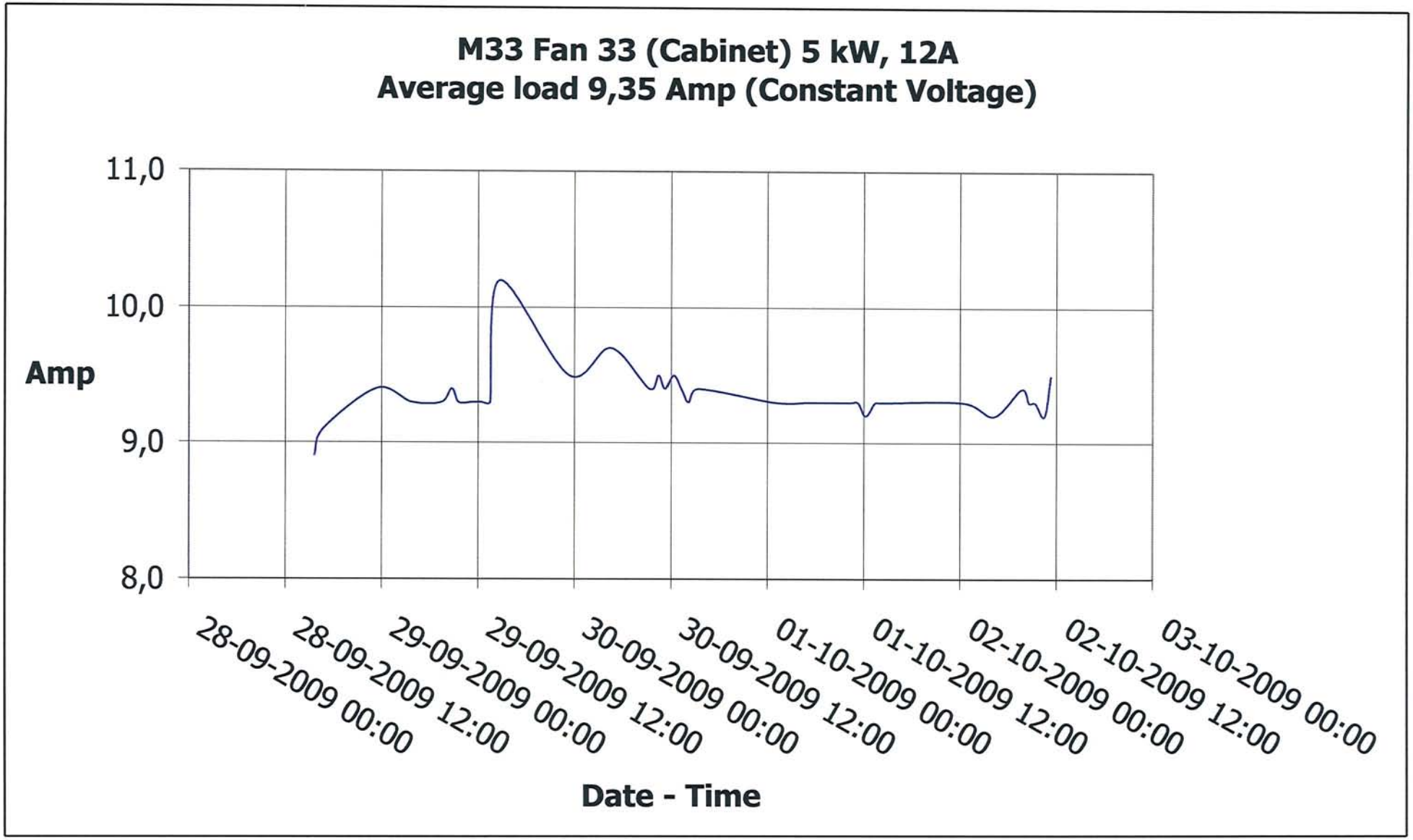

M20 Screw Conveyer Horisomtal 2,2 kW, 5,2 A
Average load 2,07 Amp (Constant Voltage)
Amp
2,3
2,2
2,2
2,1
2,1
2,0
2,0
1,9
1,9
28-09-2009 00:00
28-09-2009 12:00
29-09-2009 00:00
29-09-2009 12:00
30-09-2009 00:00
30-09-2009 12:00
01-10-2009 00:00
01-10-2009 12:00
02-10-2009 00:00
02-10-2009 12:00
03-10-2009 00:00
Date - Time

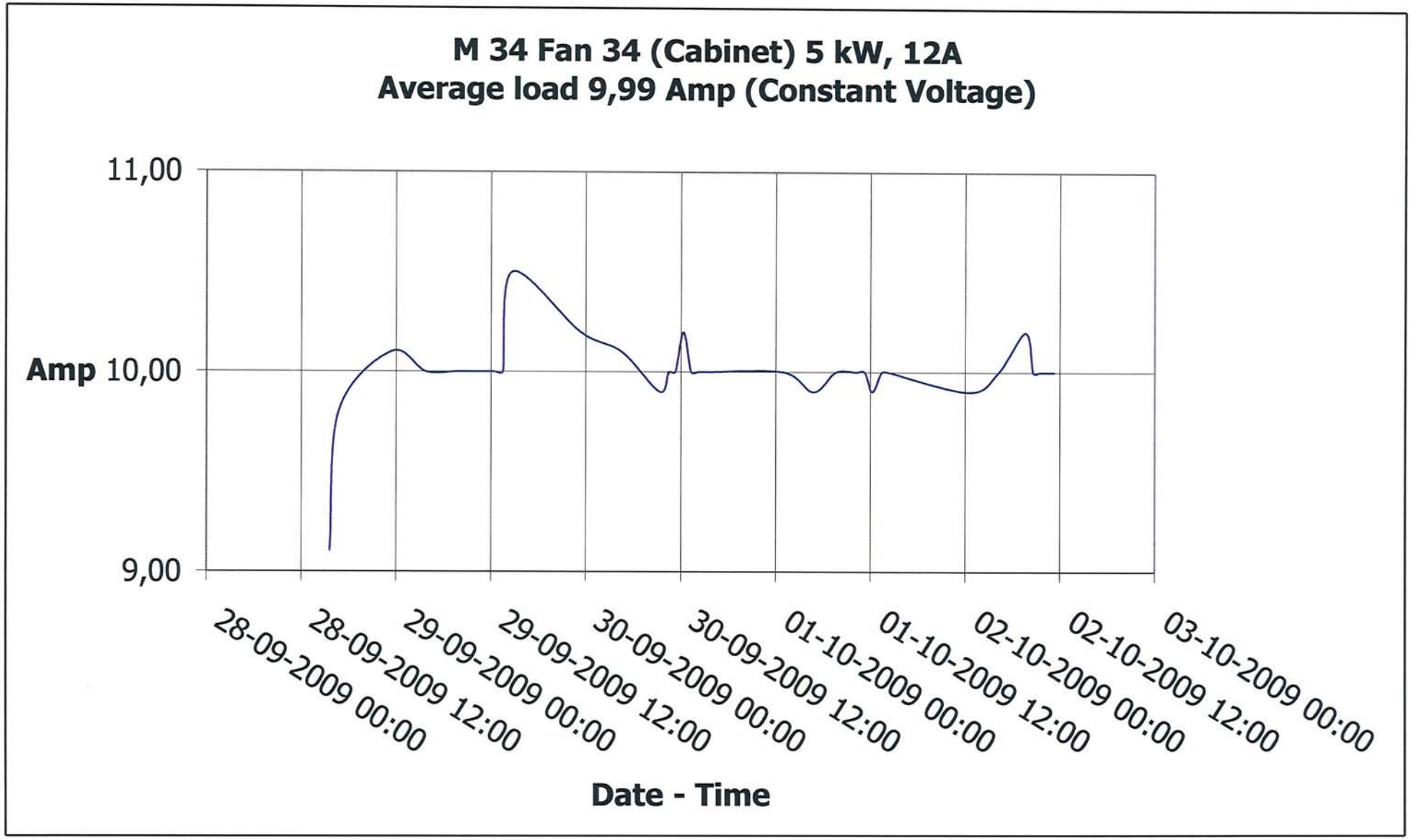

M25 New Fan 0,75 kW
Average load 0,96 Amp (Constant Voltage)
1,20
1,00
0,80
Amp 0,60
0,40
0,20
0,00
28-09-2009 00:00
28-09-2009 12:00
29-09-2009 00:00
29-09-2009 12:00
30-09-2009 00:00
30-09-2009 12:00
01-10-2009 00:00
01-10-2009 12:00
02-10-2009 00:00
02-10-2009 12:00
03-10-2009 00:00
Date - Time

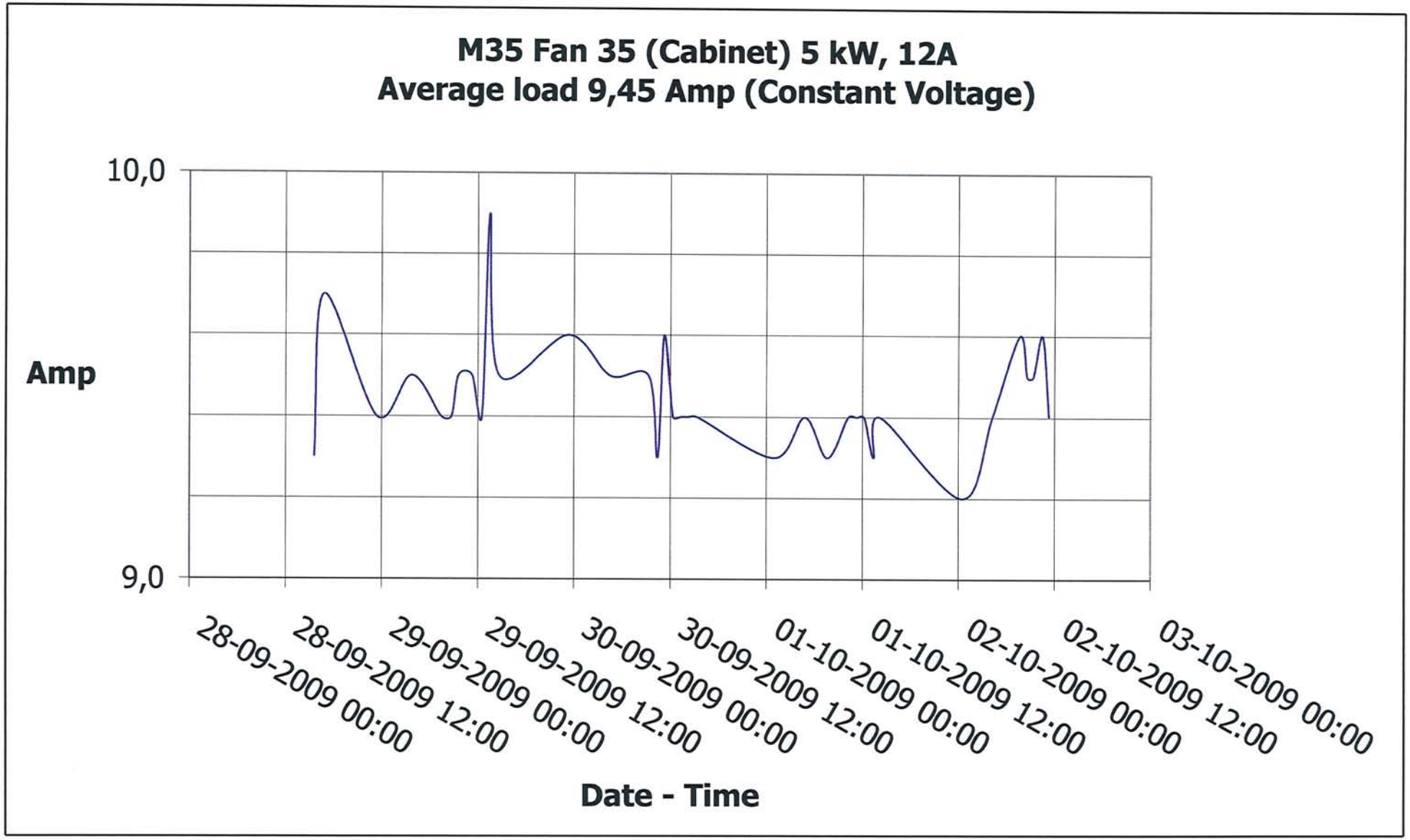

M30 Feeder bolw 0,25 kW, 0,92 Amp
Average load 0,55 Amp (Constant Voltage)
0,6
Amp 0,55
0,5
28-09-2009 00:00
29-09-2009 00:00
30-09-2009 00:00
01-10-2009 00:00
02-10-2009 00:00
03-10-2009 00:00
Date - Time

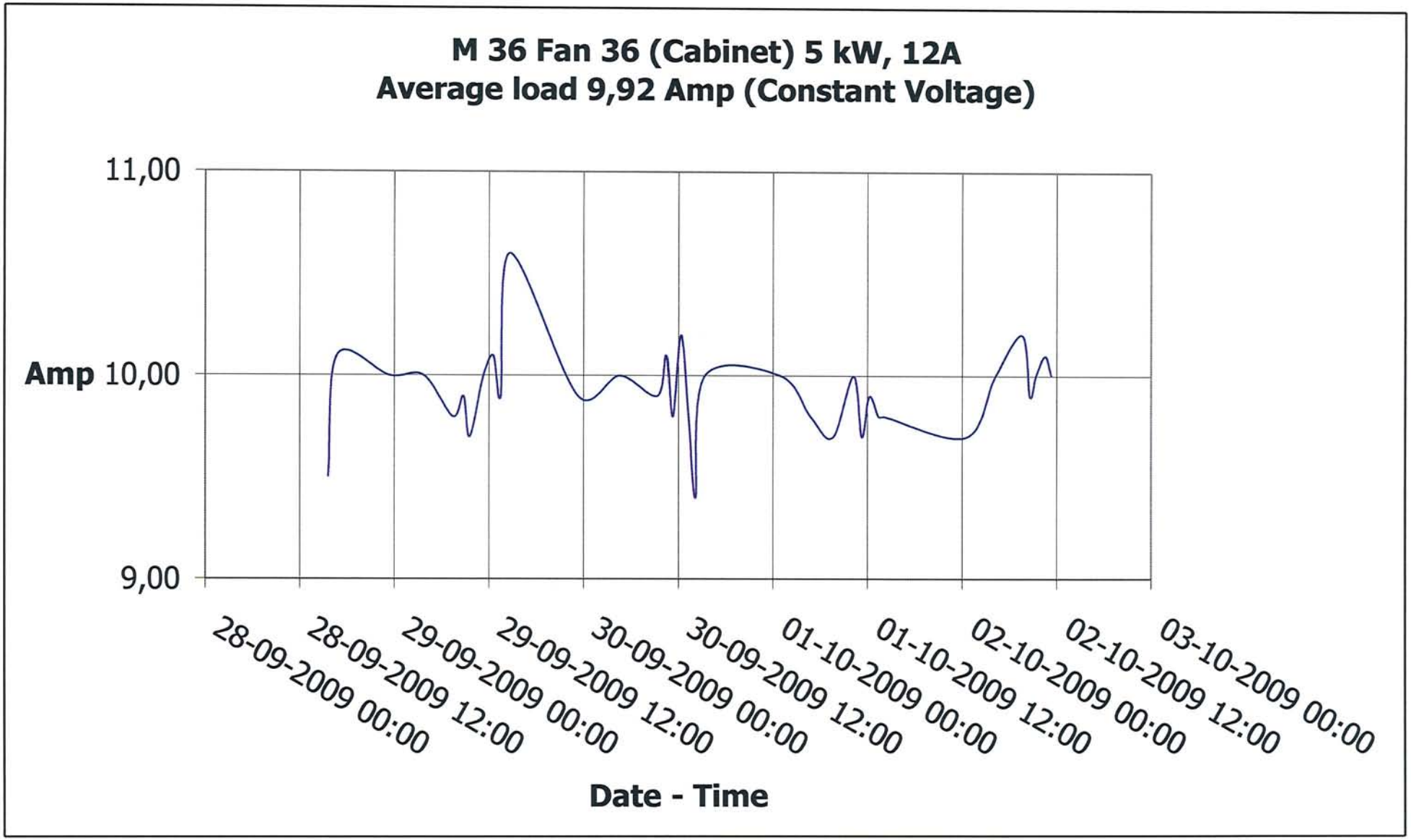

M31 Fan 31 (Cabinet) 5 kW, 12A
Average load 9,33 Amp (Constant Voltage)
11
10
9
8
Amp
28-09-2009 00:00
28-09-2009 12:00
29-09-2009 00:00
29-09-2009 12:00
30-09-2009 00:00
30-09-2009 12:00
01-10-2009 00:00
01-10-2009 12:00
02-10-2009 00:00
02-10-2009 12:00
03-10-2009 00:00
Date - Time

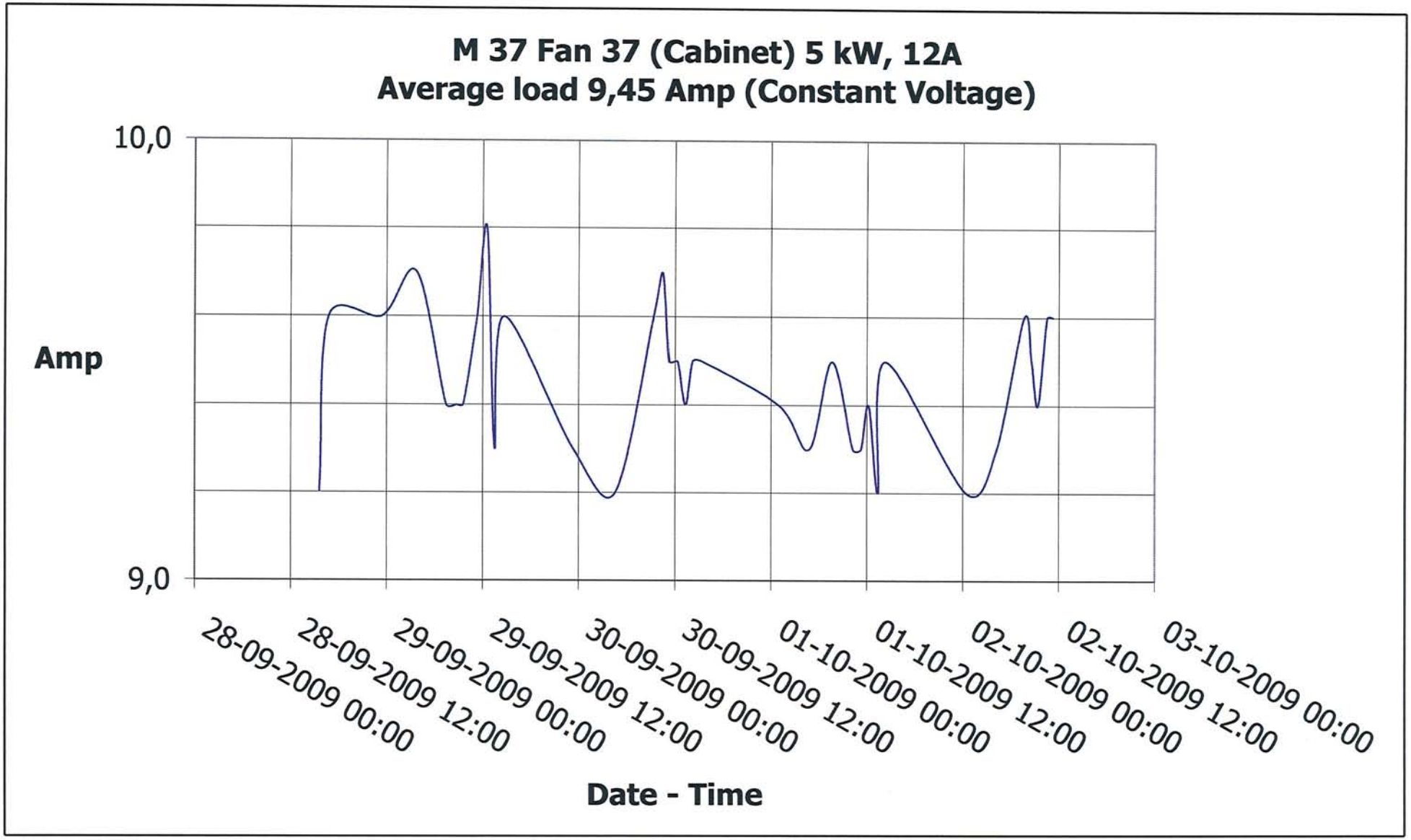

M 32 Fan 32 (Cabinet) 5 kW, 12A
Average load 9,62 Amp (Constant Voltage)
11,0
10,0
9,0
8,0
Amp
28-09-2009 00:00
28-09-2009 12:00
29-09-2009 00:00
29-09-2009 12:00
30-09-2009 00:00
30-09-2009 12:00
01-10-2009 00:00
01-10-2009 12:00
02-10-2009 00:00
02-10-2009 12:00
03-10-2009 00:00
Date - Time

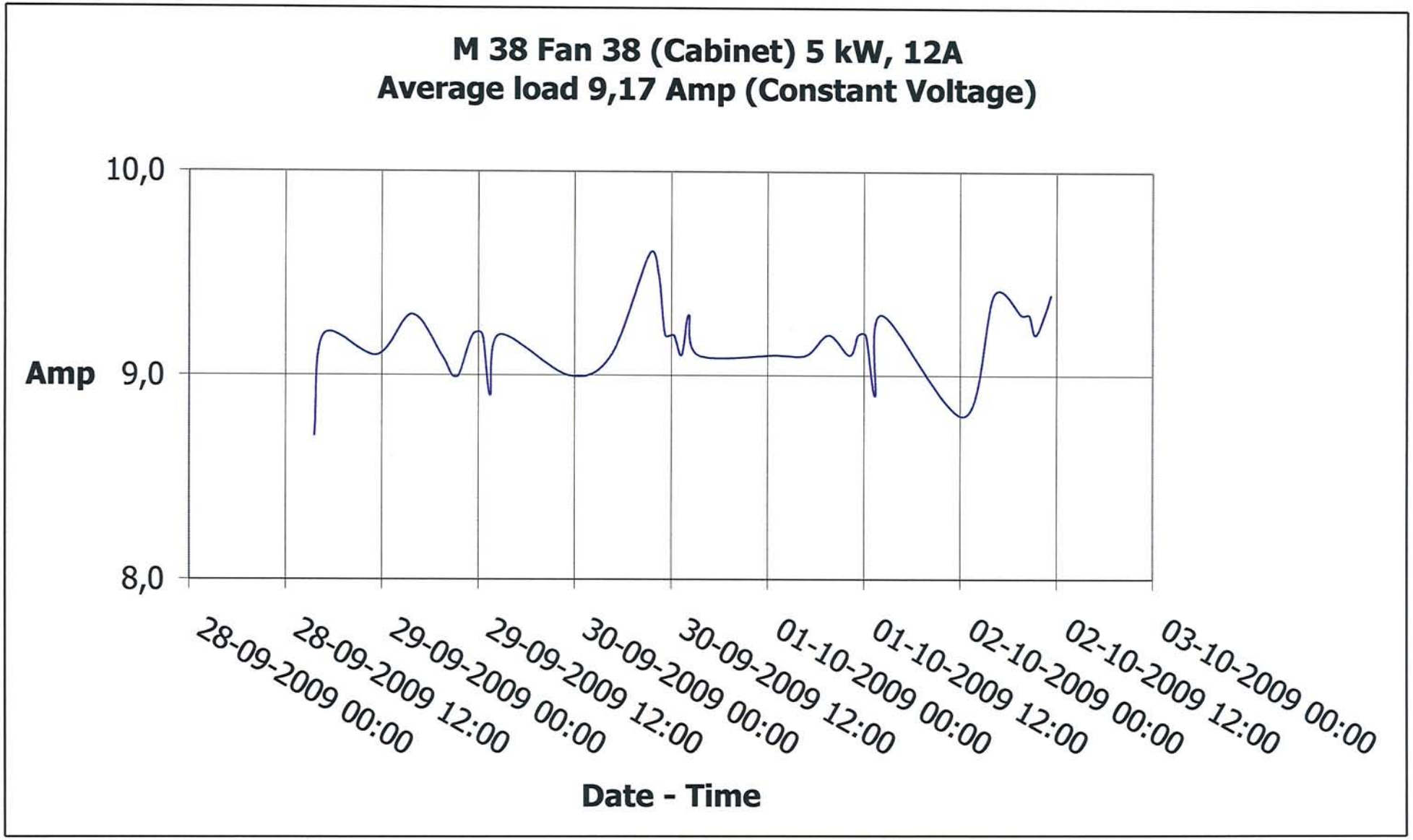

M33 Fan 33 (Cabinet) 5 kW, 12A
Average load 9,35 Amp (Constant Voltage)
11,0
10,0
9,0
8,0
Amp
28-09-2009 00:00
28-09-2009 12:00
29-09-2009 00:00
29-09-2009 12:00
30-09-2009 00:00
30-09-2009 12:00
01-10-2009 00:00
01-10-2009 12:00
02-10-2009 00:00
02-10-2009 12:00
03-10-2009 00:00
Date - Time

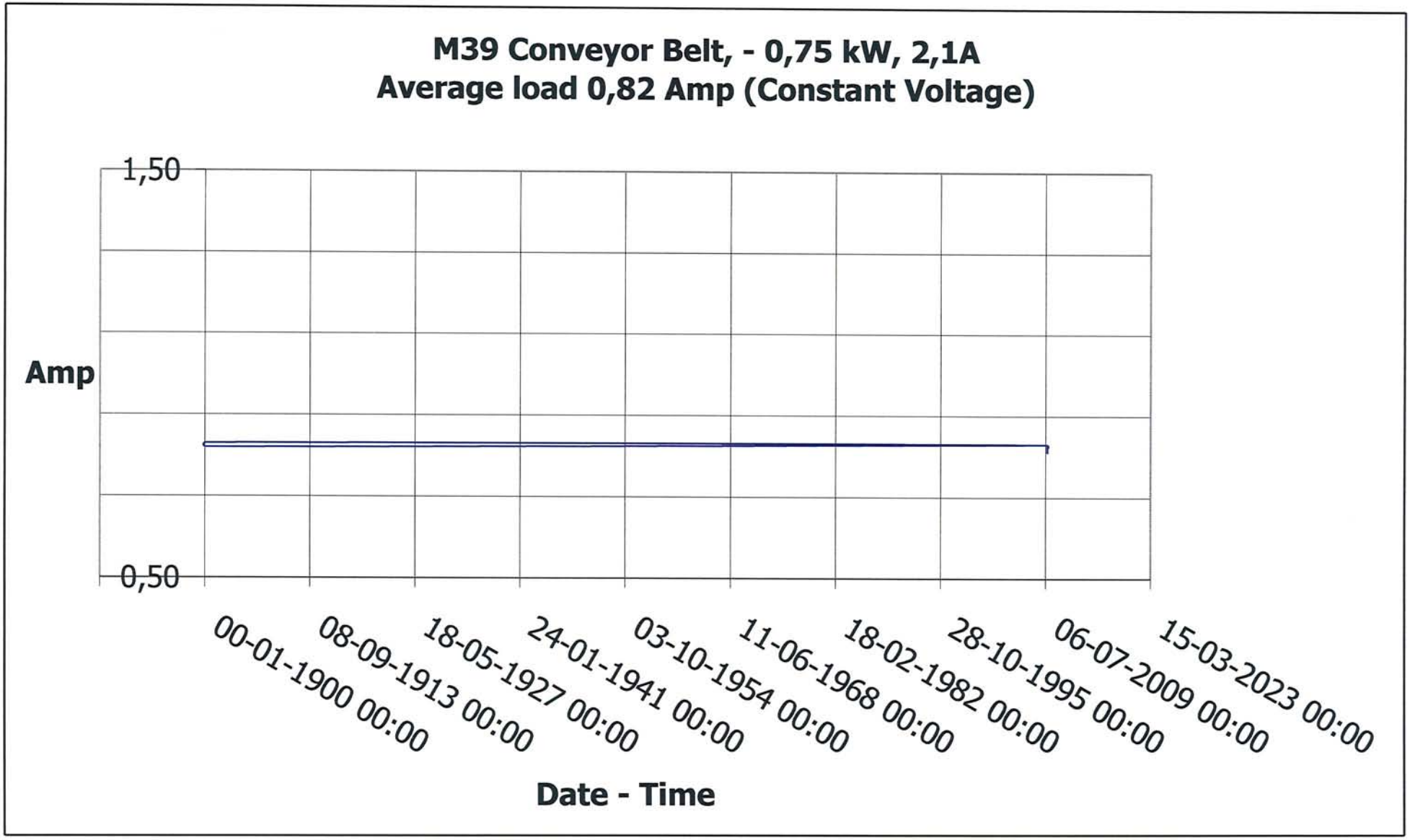

M 34 Fan 34 (Cabinet) 5 kW, 12A
Average load 9,99 Amp (Constant Voltage)
11,00
Amp 10,00
9,00
28-09-2009 00:00
28-09-2009 12:00
29-09-2009 00:00
29-09-2009 12:00
30-09-2009 00:00
30-09-2009 12:00
01-10-2009 00:00
01-10-2009 12:00
02-10-2009 00:00
02-10-2009 12:00
03-10-2009 00:00
Date - Time

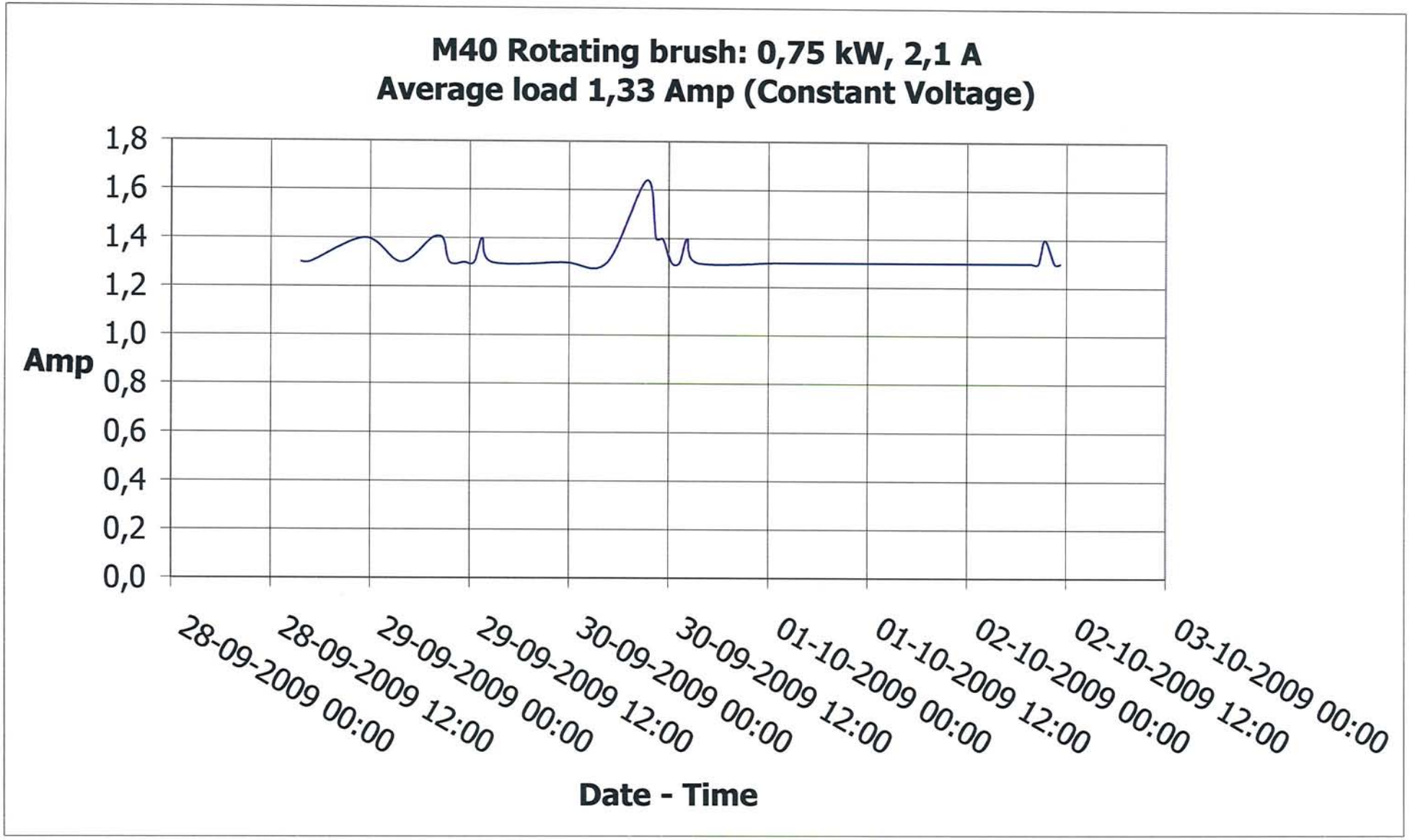

M35 Fan 35 (Cabinet) 5 kW, 12A
Average load 9,45 Amp (Constant Voltage)
10,0
9,0
Amp
28-09-2009 00:00
28-09-2009 12:00
29-09-2009 00:00
29-09-2009 12:00
30-09-2009 00:00
30-09-2009 12:00
01-10-2009 00:00
01-10-2009 12:00
02-10-2009 00:00
02-10-2009 12:00
03-10-2009 00:00
Date - Time

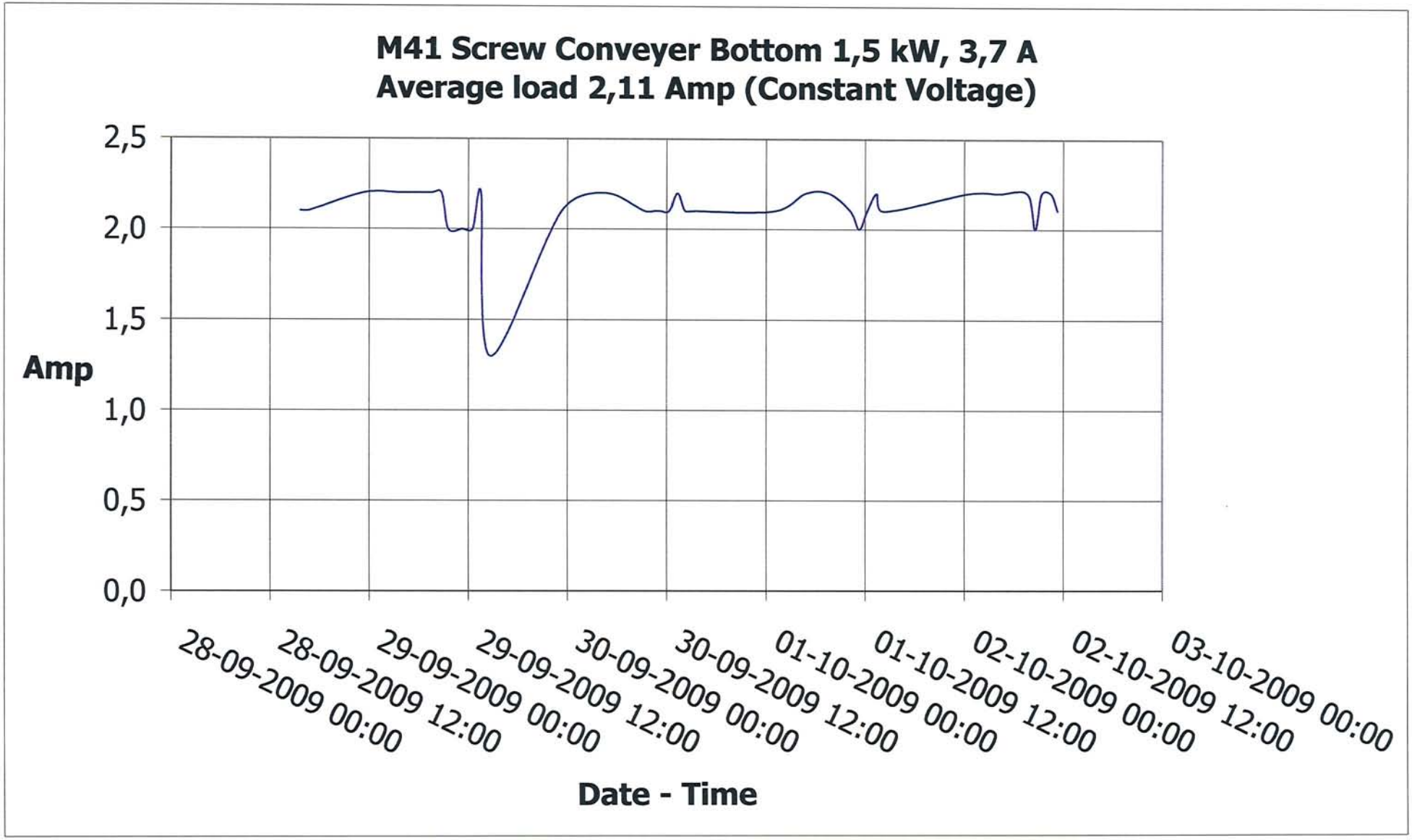

M 36 Fan 36 (Cabinet) 5 kW, 12A
Average load 9,92 Amp (Constant Voltage)
11,00
Amp 10,00
9,00
28-09-2009 00:00
28-09-2009 12:00
29-09-2009 00:00
29-09-2009 12:00
30-09-2009 00:00
30-09-2009 12:00
01-10-2009 00:00
01-10-2009 12:00
02-10-2009 00:00
02-10-2009 12:00
03-10-2009 00:00
Date - Time

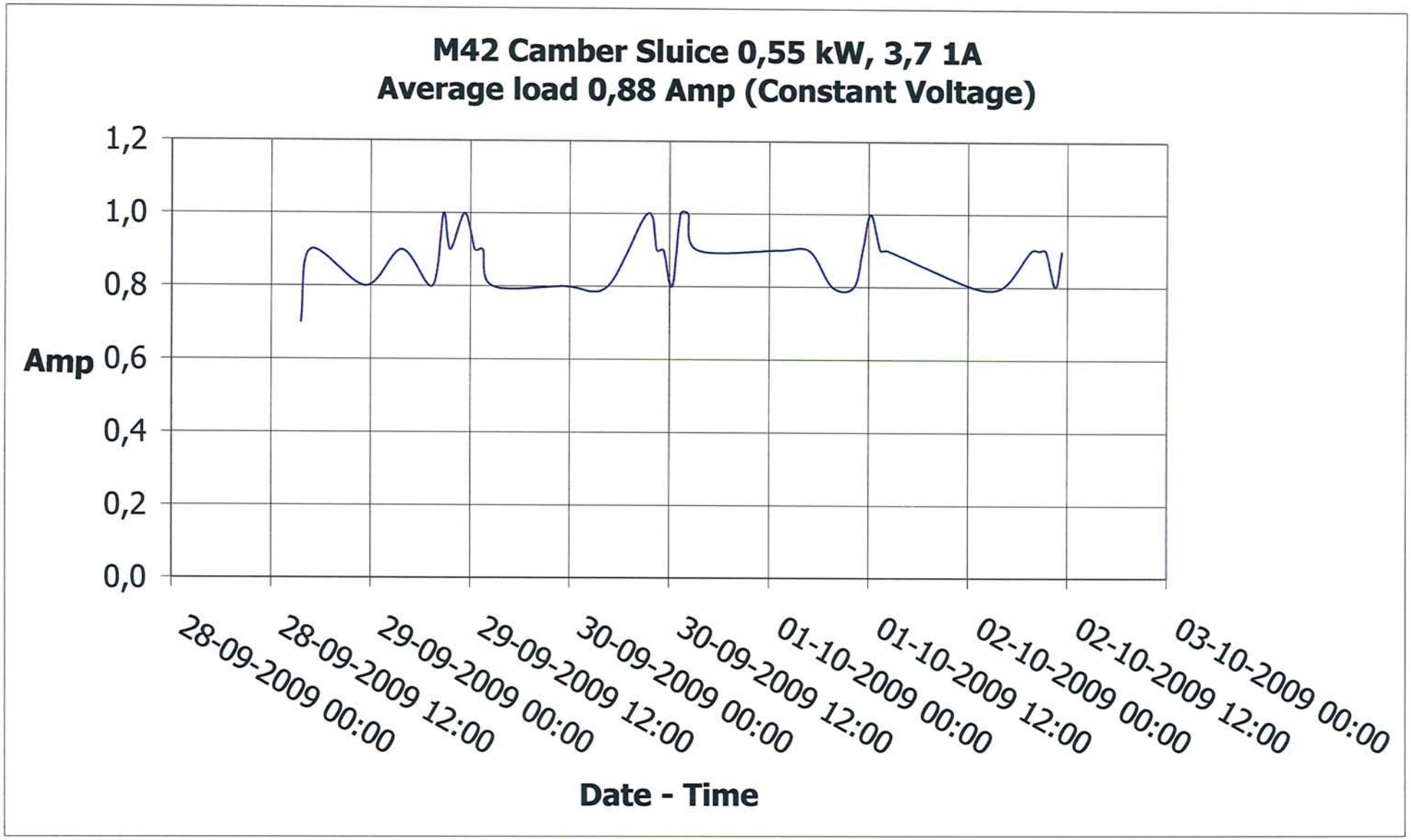

M 37 Fan 37 (Cabinet) 5 kW, 12A
Average load 9,45 Amp (Constant Voltage)
10,0
9,0
Amp
28-09-2009 00:00
28-09-2009 12:00
29-09-2009 00:00
29-09-2009 12:00
30-09-2009 00:00
30-09-2009 12:00
01-10-2009 00:00
01-10-2009 12:00
02-10-2009 00:00
02-10-2009 12:00
03-10-2009 00:00
Date - Time


M 38 Fan 38 (Cabinet) 5 kW, 12A
Average load 9,17 Amp (Constant Voltage)
10,0
Amp
9,0
8,0
28-09-2009 00:00
28-09-2009 12:00
29-09-2009 00:00
29-09-2009 12:00
30-09-2009 00:00
30-09-2009 12:00
01-10-2009 00:00
01-10-2009 12:00
02-10-2009 00:00
02-10-2009 12:00
03-10-2009 00:00
Date - Time


M39 Conveyor Belt, - 0,75 kW, 2,1A
Average load 0,82 Amp (Constant Voltage)
1,50
0,50
Amp
00-01-1900 00:00
08-09-1913 00:00
18-05-1927 00:00
24-01-1941 00:00
03-10-1954 00:00
11-06-1968 00:00
18-02-1982 00:00
28-10-1995 00:00
06-07-2009 00:00
15-03-2023 00:00
Date - Time


M40 Rotating brush: 0,75 kW, 2,1 A
Average load 1,33 Amp (Constant Voltage)
Amp
1,8
1,6
1,4
1,2
1,0
0,8
0,6
0,4
0,2
0,0
28-09-2009 00:00
28-09-2009 12:00
29-09-2009 00:00
29-09-2009 12:00
30-09-2009 00:00
30-09-2009 12:00
01-10-2009 00:00
01-10-2009 12:00
02-10-2009 00:00
02-10-2009 12:00
03-10-2009 00:00
Date - Time


M41 Screw Conveyer Bottom 1,5 kW, 3,7 A
Average load 2,11 Amp (Constant Voltage)
2,5
2,0
1,5
1,0
0,5
0,0
Amp
28-09-2009 00:00
28-09-2009 12:00
29-09-2009 00:00
29-09-2009 12:00
30-09-2009 00:00
30-09-2009 12:00
01-10-2009 00:00
01-10-2009 12:00
02-10-2009 00:00
02-10-2009 12:00
03-10-2009 00:00
Date - Time


M42 Camber Sluice 0,55 kW, 3,7 1A
Average load 0,88 Amp (Constant Voltage)
Amp
1,2
1,0
0,8
0,6
0,4
0,2
0,0
28-09-2009 00:00
28-09-2009 12:00
29-09-2009 00:00
29-09-2009 12:00
30-09-2009 00:00
30-09-2009 12:00
01-10-2009 00:00
01-10-2009 12:00
02-10-2009 00:00
02-10-2009 12:00
03-10-2009 00:00
Date - Time

Appendix 5C

Printout of the calculation of the volumetric flow

Anlæg/afkast: Tilgang rågas

Parameter	Enhed	Måling 1	Middel
Dato	dd-mm-åå	28.9.2009	28.9.2009
Måleperiode	tt:mm	16:21 - 16:29	16:21 - 16:29

Produktions- og driftsoplysninger *

Luftoverskud (tilnærmet værdi) *	λ	1,72	1,72

Hjælpeparametre

Temperatur	°C	405	405
O_2	Vol %, tør	8,80	8,80
Volumenstrøm	$m^3(n,t)/h$	5.400	5.400
Volumenstrøm driftstilstand	m^3/h	15.000	15.000

(n,t) angiver tør gas ved normaltilstanden (0°C, 101,3 kPa)
* betyder "ikke omfattet af akkreditering 51"

Anlæg/afkast: Tilgang rågas

Parameter	Enhed	Måling 1	Måling 2	Måling 3	Middel
Dato	dd-mm-åå	29.09.2009	29.09.2009	29.09.2009	29.09.2009
Måleperiode	tt:mm	7:35 - 7:40	8:20 - 8:25	10:00 - 10:15	7:35 - 10:15

Hjælpeparametre

Temperatur	°C	406	406	406	406
Volumenstrøm	$m^3(n,t)/h$	5.000	5.500	5.500	5.400
Volumenstrøm driftstilstand	m^3/h	14.000	15.000	15.000	15.000

(n,t) angiver tør gas ved normaltilstanden (0°C, 101,3 kPa)

Anlæg/afkast: Tilgang rågas

Parameter	Enhed	Måling 1	Måling 2	Måling 3	Måling 4	Middel
Dato	dd-mm-åå	30.09.2009	30.09.2009	30.09.2009	30.09.2009	30.09.2009
Måleperiode	tt:mm	9:10 - 9:15	9:15 - 9:20	11:15 - 11:20	00:00 - 00:00	9:10 - 00:00

Hjælpeparametre

Temperatur	°C	411	406	412	411	410
Volumenstrøm	$m^3(n,t)/h$	5.800	5.500	5.500	5.200	5.500
Volumenstrøm driftstilstand	m^3/h	16.000	15.000	16.000	15.000	15.000

(n,t) angiver tør gas ved normaltilstanden (0°C, 101,3 kPa)

Anlæg/afkast: Tilgang rågas

Parameter	Enhed	Måling 1	Måling 2	Middel
Dato	dd-mm-åå	01.10.2009	01.10.2009	01.10.2009
Måleperiode	tt:mm	7:52 - 7:57	14:05 - 14:10	7:52 - 14:10

Hjælpeparametre

Temperatur	°C	412	410	411
Volumenstrøm	$m^3(n,t)/h$	6.000	5.600	5.800
Volumenstrøm driftstilstand	m^3/h	17.000	16.000	16.000

(n,t) angiver tør gas ved normaltilstanden (0°C, 101,3 kPa)

Anlæg/afkast: Tilgang rågas

Parameter	Enhed	Måling 1	Middel
Dato	dd-mm-åå	02.11.2009	02.11.2009
Måleperiode	tt:mm	7:28 - 7:38	7:28 - 7:38

Hjælpeparametre

Temperatur	°C	412	412
Volumenstrøm	$m^3(n,t)/h$	6.000	6.000
Volumenstrøm driftstilstand	m^3/h	17.000	17.000

(n,t) angiver tør gas ved normaltilstanden (0°C, 101,3 kPa)

Appendix 5D

Logbook of sampling collection and manual measurement of dry, wet matter and condensate

Samples to analysis: Water content

Taking:

Date	Time	Id.no.	Inlet	Outlet	
28.09.2009	15:15	Pr.1	X	X	
28.09.2009	23:17	Pr.2	X	X	
29.09.2009	03:38	Pr.3	X	X	
29.09.2009	09:53	Pr.4	X	X	
29.09.2009	15:10	Pr.5	X	X	
29.09.2009	23:21	Pr.6	X	X	Decanter problems - high water contents in the inlet sample
30:09.2009	05:02	Pr.7	X	X	
30:09.2009	10:30	Pr.8	X	X	
30:09.2009	15:37	Pr.9	X	X	
01.10.2009	01:08	Pr.10	X	X	
01.10.2009	04:48	Pr.11	X	X	Decanter problems - high water contents in the indlet sample
01.10.2009	13:10	Pr.12	X	X	
01.10.2009	15:13	Pr.13	X	X	
02.10.2009	00:29	Pr.14	X	X	
02.10.2009	04:12	Pr.15	X	X	
02.10.2009	07:50	Pr.16	X	X	

Registrations: Condensate

Date	Weight kg Empty	Weight kg Full	kg Diff	kg Ajusted	Start Time	Stop Time	Total Time	Total kg Time	Mellemregninger		
29.09.2009	2.330	3.200	870	869	12:27	14:11	01:44	501,4	44	1	1,733333
30:09.2009	2.330	3.200	870	869	13:25	14:30	01:05	469,7	51	1	1,85
30.09.2009	2.330	3.200	870	869	01:17	03:11	01:54	457,4	54	1	1,9
01.10.2009	2.330	3.200	870	869	12:38	14:25	01:47	487,3	47	1	1,783333
02.10.2009	2.330	3.200	870	869	08:50	10:28	01:38	532,0	38	1	1,633333

VF condensate:	0,999	869,13

Registrations: Dry amound produced

Date	Weight kg Empty	Weight kg Full	kg Diff	Start Time	Stop Time	Total Time	Total kg Time	Mellemregninger		
29.09.2009	2.520	2.770	250	05:00	06:00	01:00	250,0	0	1	1
29.09.2009	2.520	2.820	300	12:57	13:57	01:00	300,0	0	1	1
30.09.2009	2.520	2.820	300	13:37	14:37	01:00	300,0	0	1	1
01.10.2009	2.520	2.780	260	01:24	02:24	01:00	260,0	0	1	1
01.10.2009	2.520	0		14:49						
02.10.2009	2.520	2.810	290	01:39	02:39	01:00	290,0	0	1	1

Registrations: Raw manure inlet feed

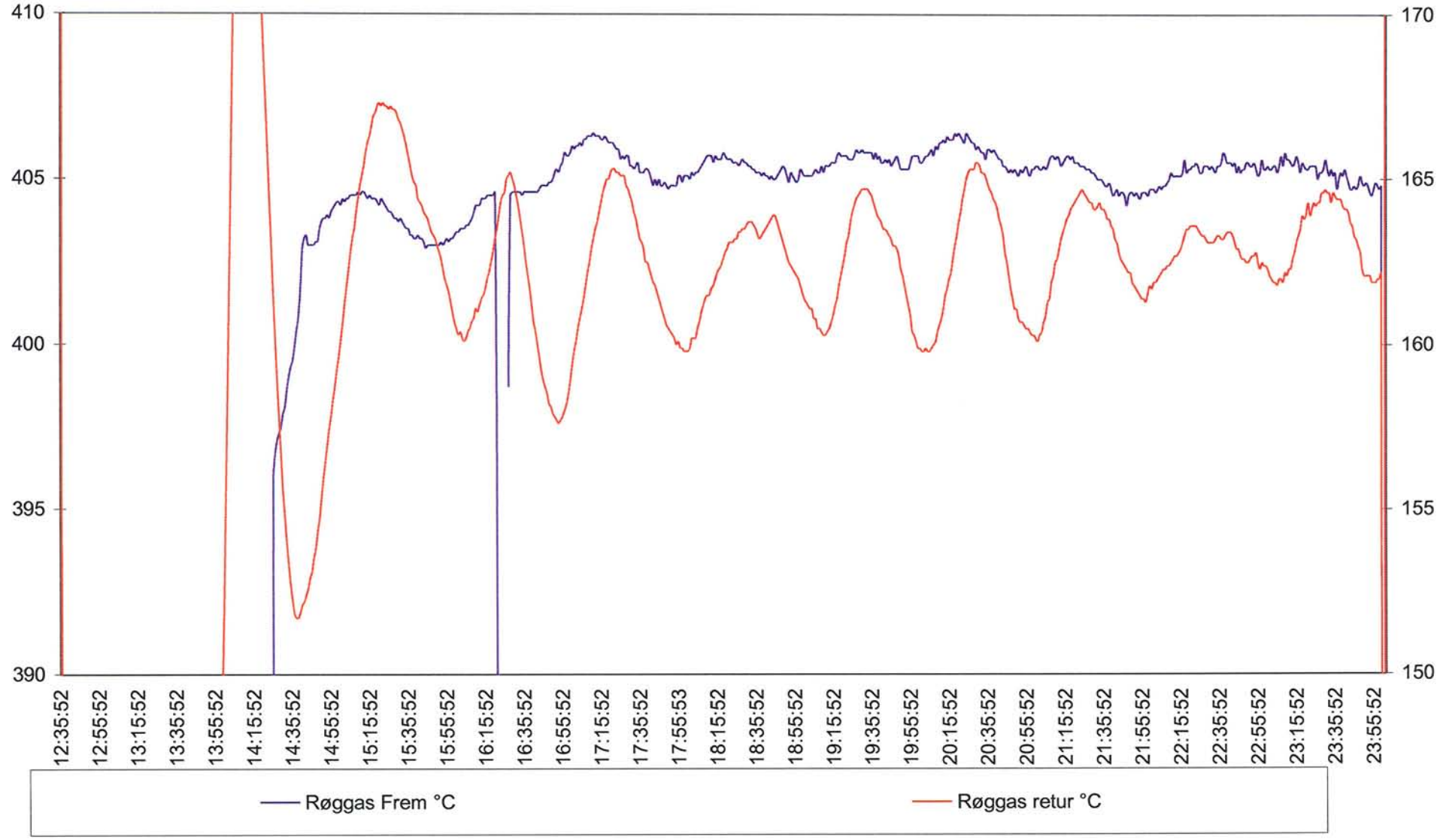
Date	Weight kg Empty	Weight kg Full	kg Diff	Start Time	Stop Time	Total Time	Total kg Time	Mellemregninger		
29.09.2009	2.520	3.600	1.080	11:58	13:13	01:15	864,0	15	1	1,25
02.10.2009	2.520	3.670	1.150	11:29	12:50	01:21	851,9	21	1	1,35

Appendix 5E

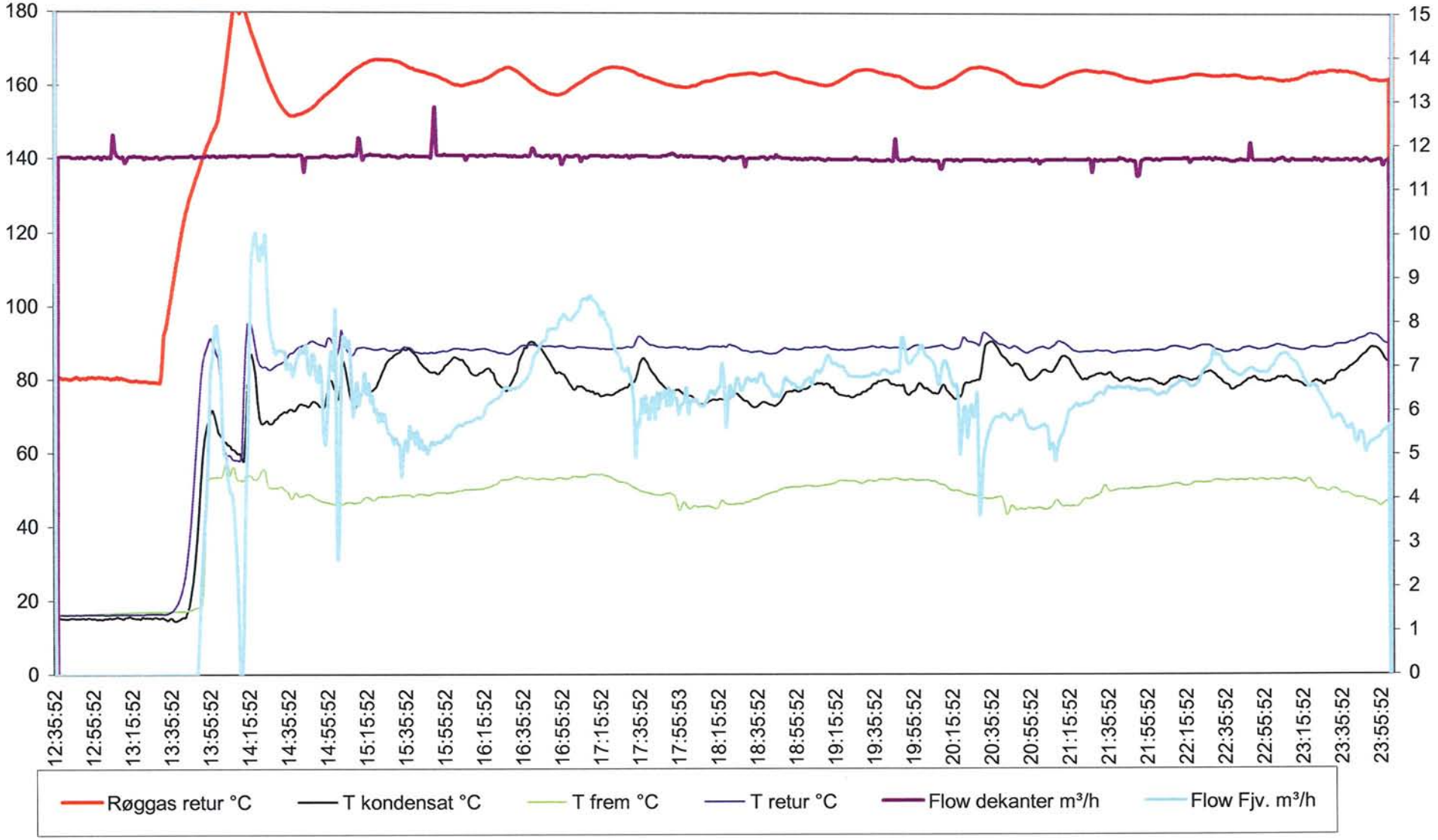
Printout of flue gas (in & outlet), temperatures, flow decanter

Shown as graphs and summarized spreadsheets

Cimbria Manufacturing A/S



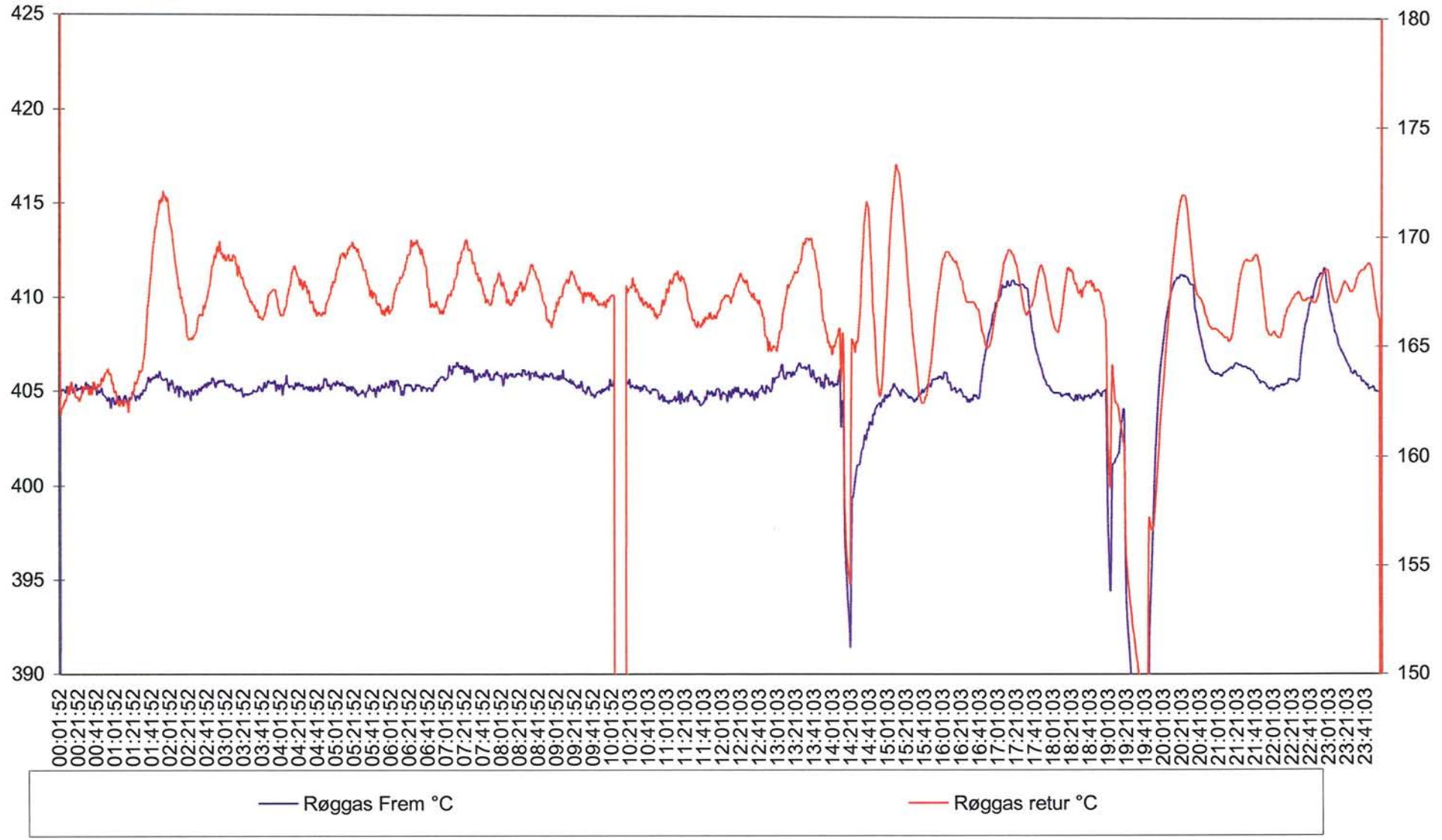
Cimbria Manufacturing A/S



Cimbria Manufacturing A/S

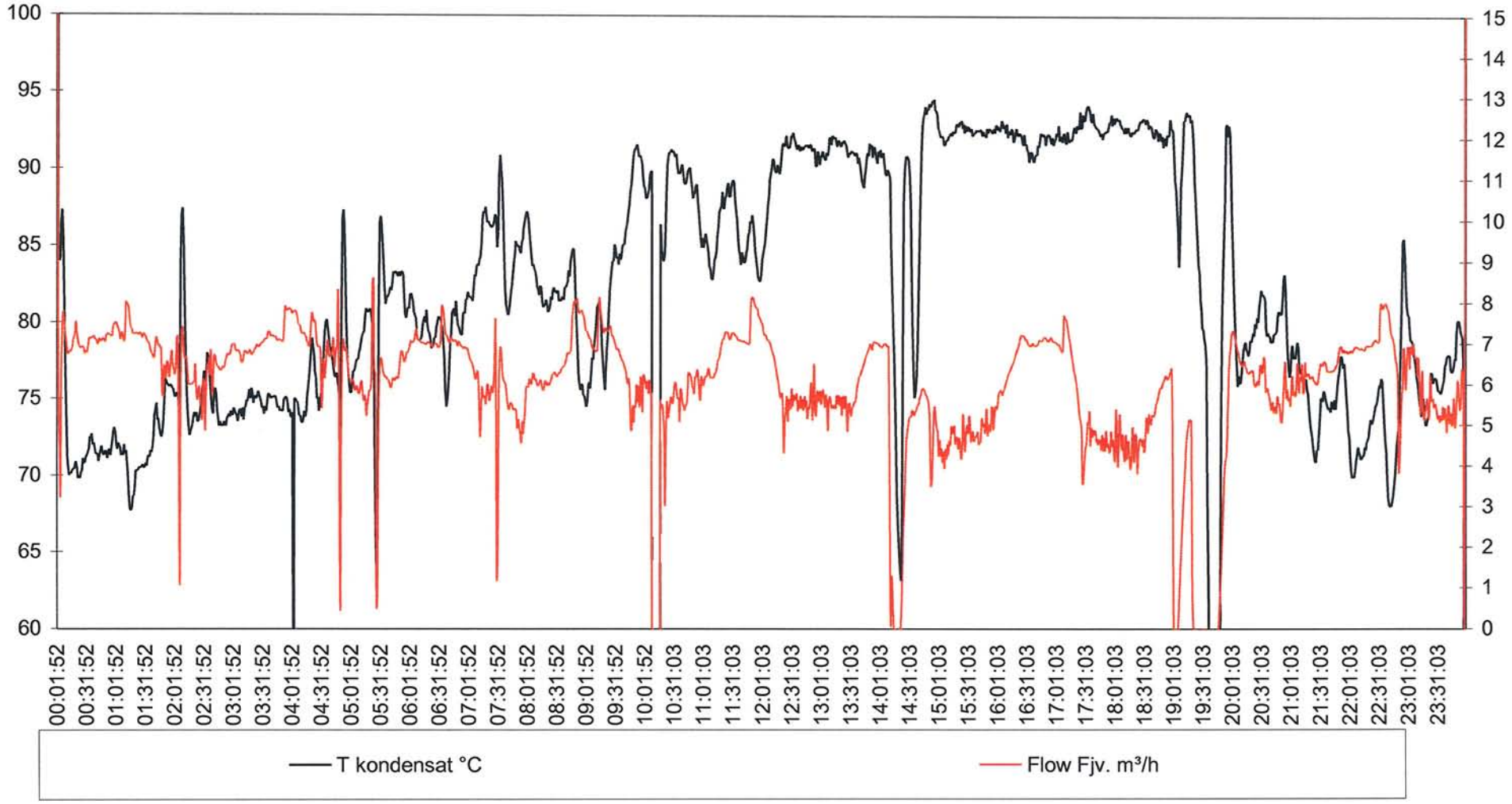
		O2 Vol % (tør) 15012,00	Røggas retur °C 23003,00	Røggas Frem °C 23003,00	T kondensat °C Ch:2 (□C)	Flow dekanter m³/h Ch:13 (mA)	Flow Fjv. m³/h Ch:14 (mA)	T frem °C Ch:15 (mA)	T retur °C Ch:16 (mA)
Periode									
Beskrivelse									
Periode-start	28/09-2009 12.35.00								
Periode-slut	29/09-2009 00.01.00								
Afvis værdier <									
Afvis værdier >									
Middelværdi		8,92	154,35	366,12	72,46	11,70	5,75	46,49	80,80
Spredning		0,58	24,46	99,06	21,05	1,61	2,39	11,61	22,42
Mindste værdi		0	0	0	0	-11	-6	-30	-30
Største værdi		21	200	406	200	45	24	120	120
Antal værdier i middelværdien		686	686	686	686	686	686	686	686
Antal uden for grænser		0	0	0	0	0	0	0	0
Antal markerede som fejl		0	0	0	0	0	0	0	0
Antal fejl		0	0	0	0	0	0	0	0
Periode									
Beskrivelse									
Periode-start									
Periode-slut									
Afvis værdier <									

Cimbria Manufacturing A/S

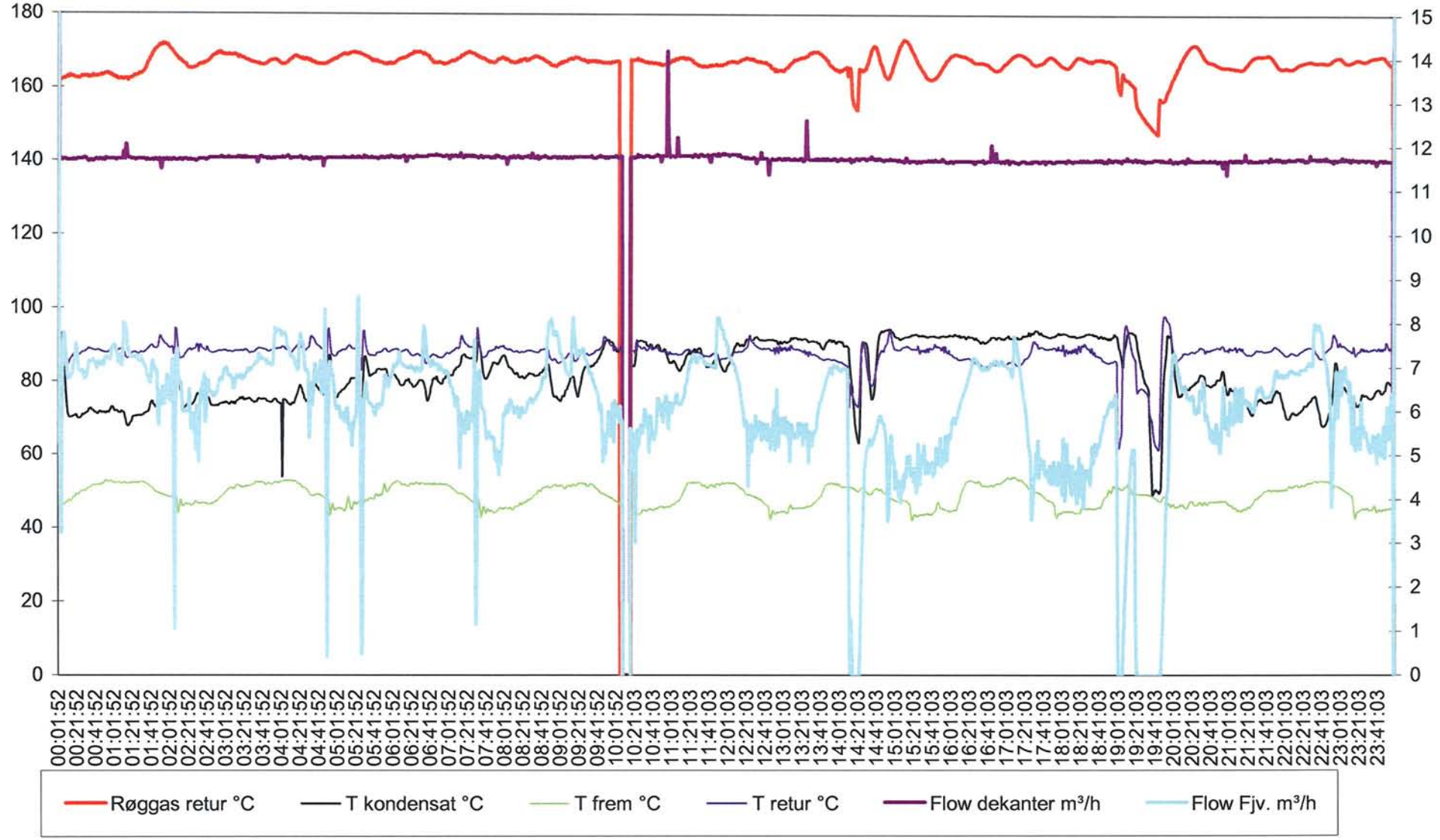


Cimbria Manufacturing A/S

den 29-09-2009



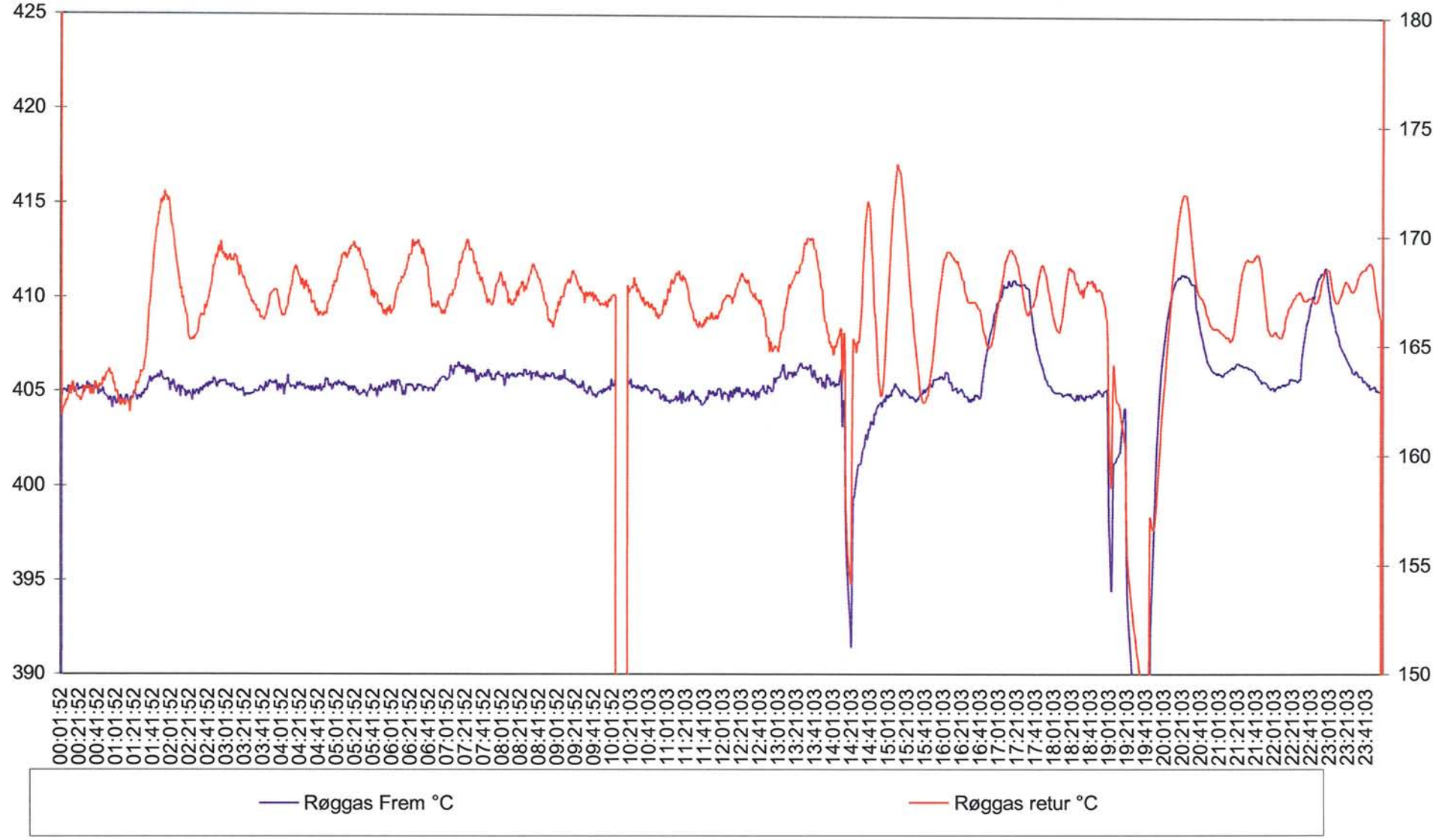
Cimbria Manufacturing A/S



Cimbria Manufacturing A/S

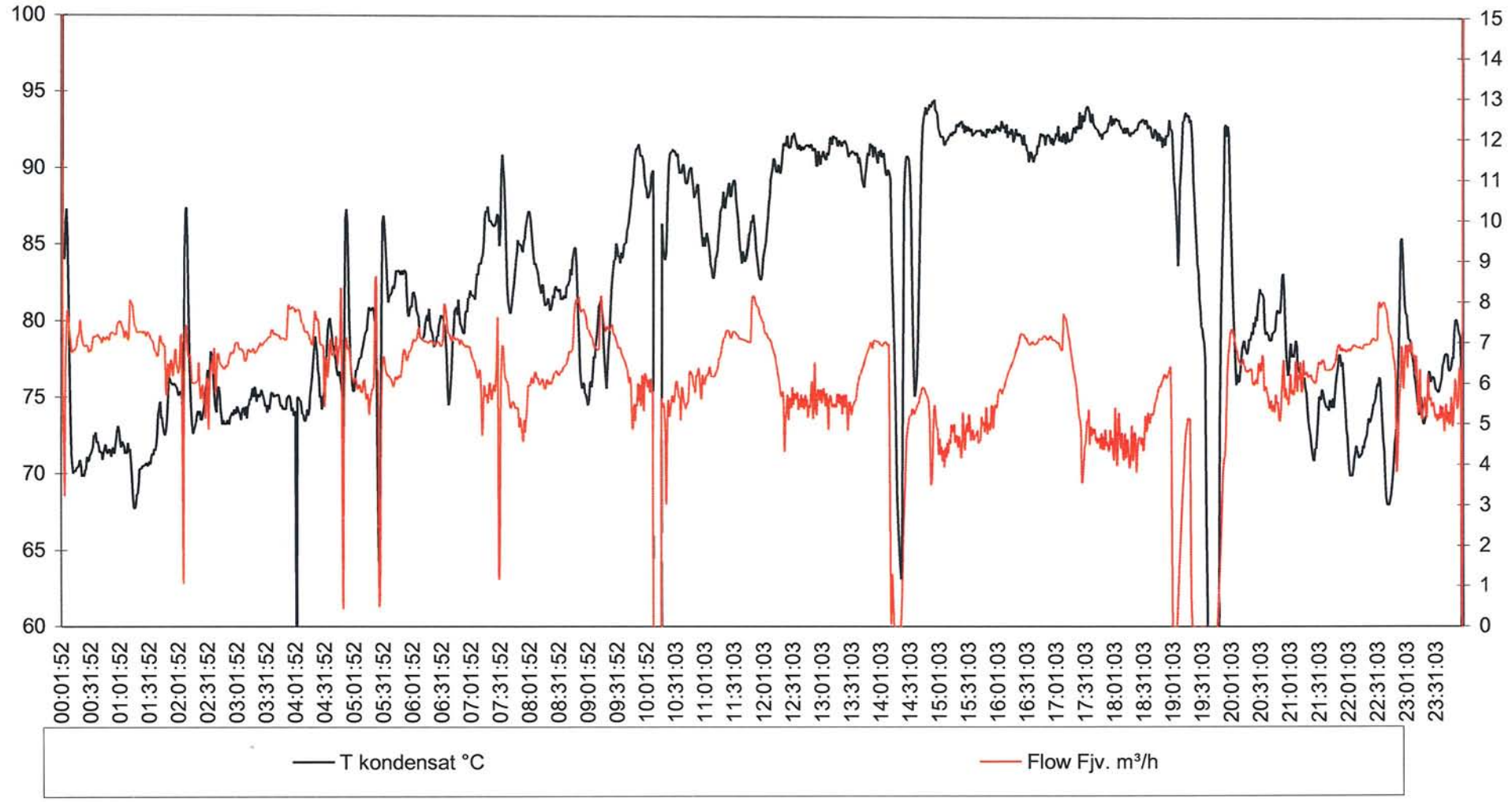
		O2 Vol % (tør) 15012,00	Røggas retur °C 23003,00	Røggas Frem °C 23003,00	T kondensat °C Ch:2 (□C)	Flow dekanter m³/h Ch:13 (mA)	Flow Fjv. m³/h Ch:14 (mA)	T frem °C Ch:15 (mA)	T retur °C Ch:16 (mA)
Periode									
Beskrivelse									
Periode-start	29/09-2009 00.01.52								
Periode-slut	29/09-2009 23.57.03								
Afvis værdier <									
Afvis værdier >									
Middelværdi		**8,88**	**165,25**	**401,84**	**81,93**	**11,59**	**5,92**	**48,49**	**87,08**
Spredning		1,13	15,49	37,06	10,26	1,71	1,75	6,54	9,45
Mindste værdi		0	0	0	0	-11	-6	-30	-30
Største værdi		21	173	412	95	14	9	56	98
Antal værdier i middelværdien		1436	1436	1436	1436	1436	1436	1436	1436
Antal uden for grænser		0	0	0	0	0	0	0	0
Antal markerede som fejl		0	0	0	0	0	0	0	0
Antal fejl		0	0	0	0	0	0	0	0
Periode									
Beskrivelse									
Periode-start									
Periode-slut									
Afvis værdier <									
Afvis værdier >									

Cimbria Manufacturing A/S

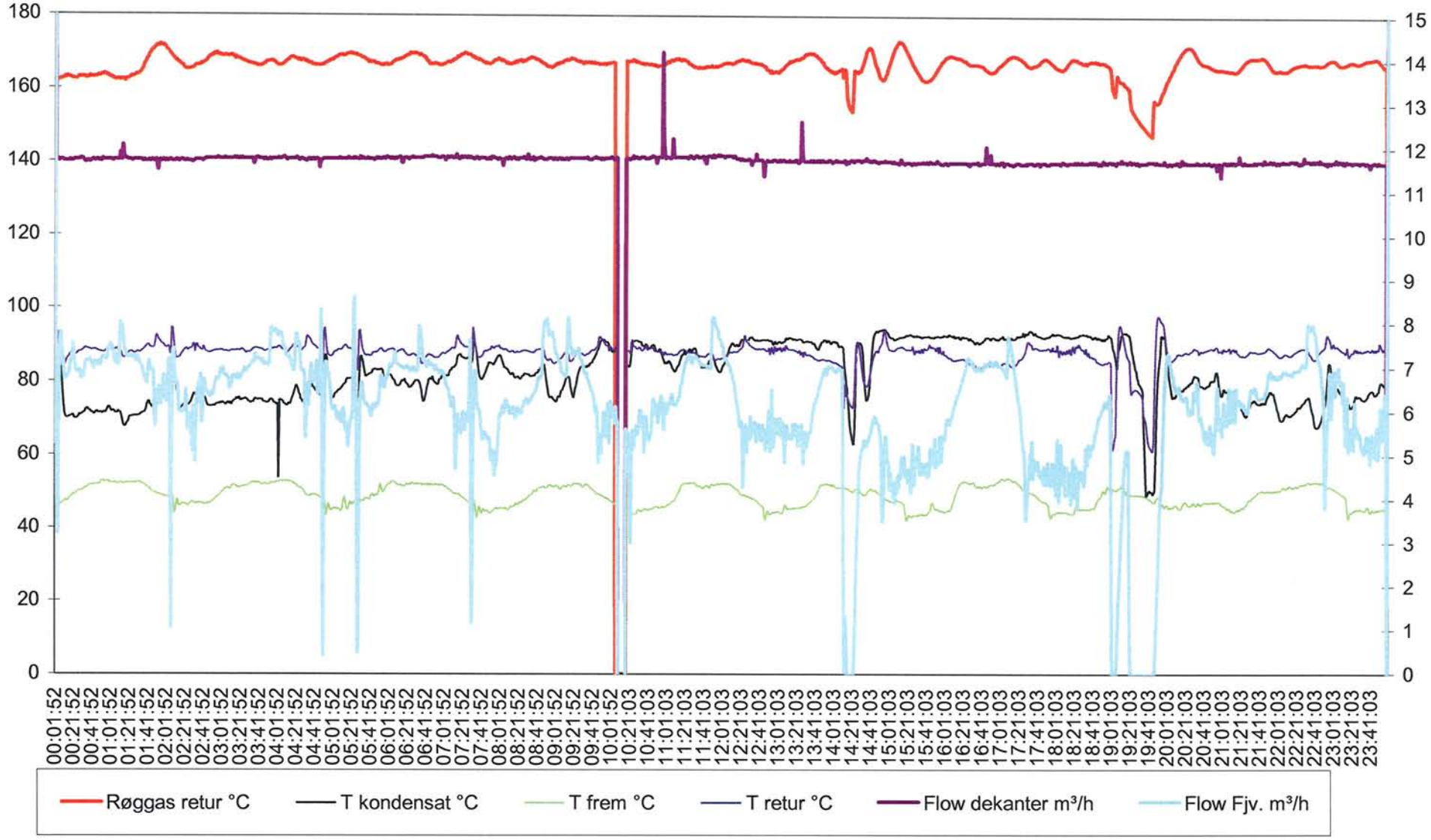


Cimbria Manufacturing A/S

den 29-09-2009



Cimbria Manufacturing A/S



Cimbria Manufacturing A/S

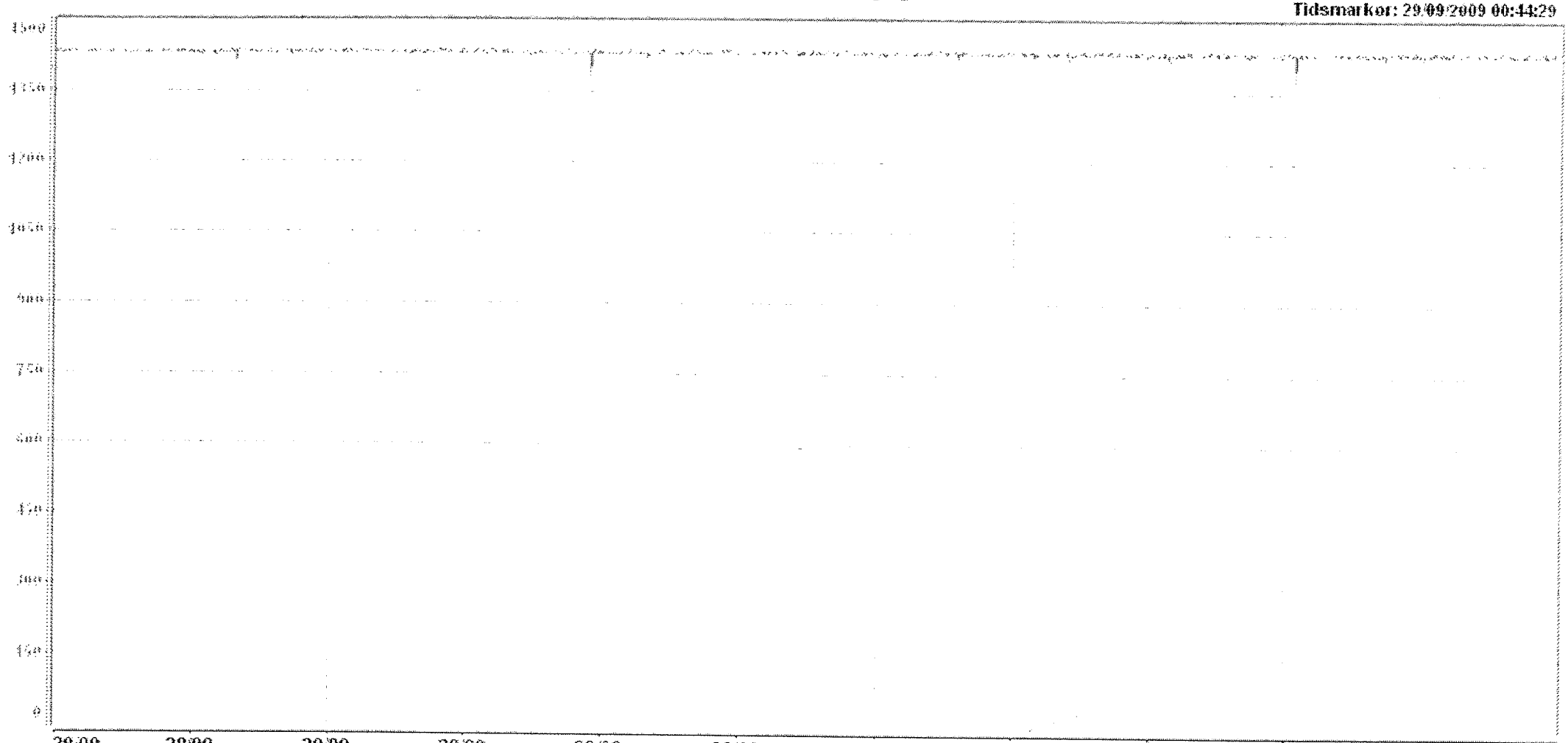
		O2 Vol % (tør) 15012,00	Røggas retur °C 23003,00	Røggas Frem °C 23003,00	T kondensat °C Ch:2 (□C)	Flow dekanter m³/h Ch:13 (mA)	Flow Fjv. m³/h Ch:14 (mA)	T frem °C Ch:15 (mA)	T retur °C Ch:16 (mA)
Periode									
Beskrivelse									
Periode-start	29/09-2009 00.01.52								
Periode-slut	29/09-2009 23.58.03								
Afvis værdier <									
Afvis værdier >									
Middelværdi		**8,87**	**165,13**	**401,56**	**81,88**	**11,58**	**5,91**	**48,45**	**87,01**
Spredning		1,15	16,09	38,53	10,48	1,74	1,75	6,66	9,72
Mindste værdi		0	0	0	0	-11	-6	-30	-30
Største værdi		21	173	412	95	14	9	56	98
Antal værdier i middelværdien		1437	1437	1437	1437	1437	1437	1437	1437
Antal uden for grænser		0	0	0	0	0	0	0	0
Antal markerede som fejl		0	0	0	0	0	0	0	0
Antal fejl		0	0	0	0	0	0	0	0
Periode									
Beskrivelse									
Periode-start									
Periode-slut									

Appendix 5F

Screen dumps, load gas motor (energy source)

Ga motor, gaskedel og gasklo' 'ke

Tidsmarker: 29/09/2009 00:44:29

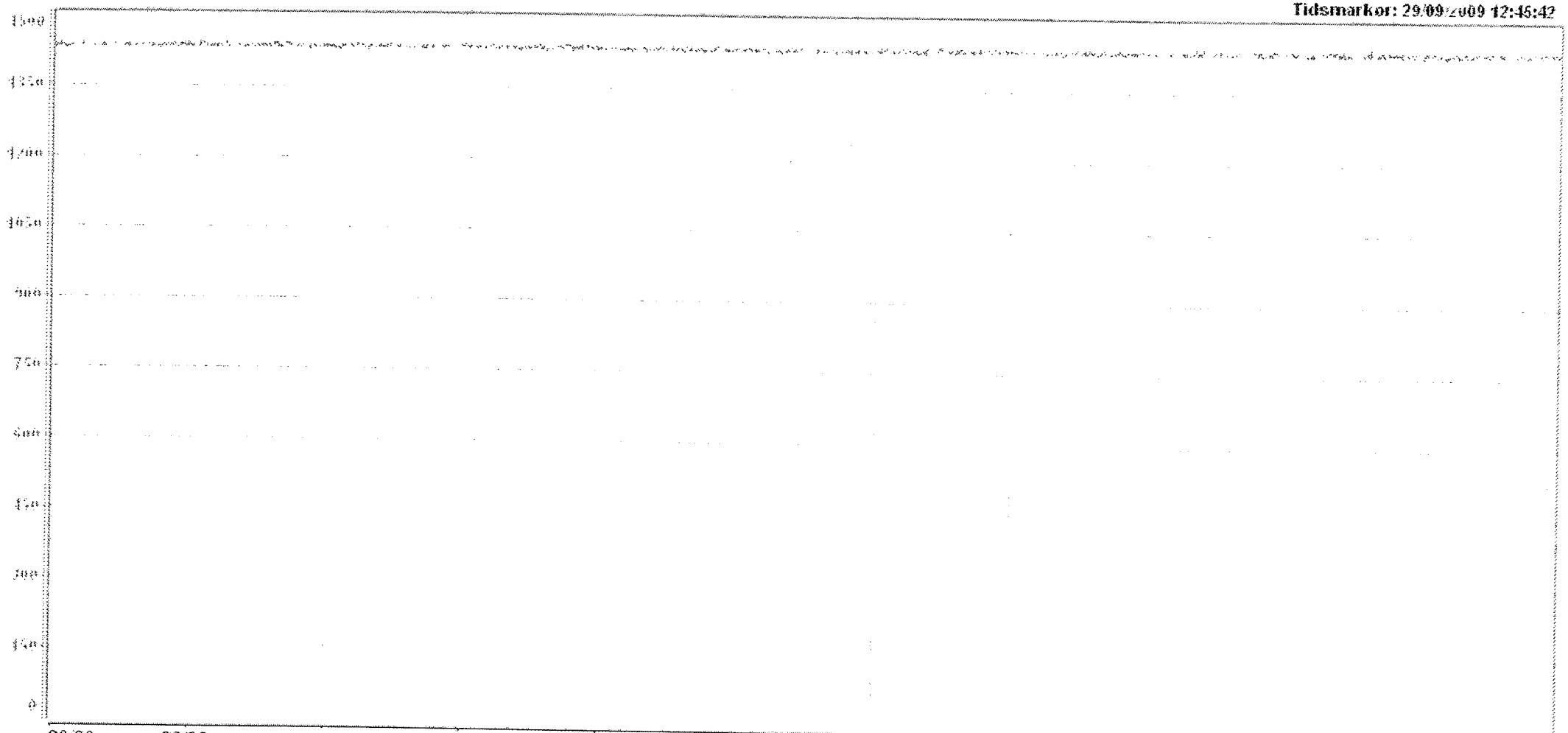


28/09/2009 12:44:29 Duration: 12:00:00 29/09/2009 00:44:29

Cursor	Beskrivelse	Min.	Maks.	Akt. værdi	Enhed
0	Gasflow total 0-1000m³/h	0	1000	0	m³/h
0	Gasflow gaskedel 0-500m³/h	0	500	0	m³/h
-0.2	Motor 2, El-effekt JES generator 2 -225..900kW	-225	900	0	kW
77.5	Motor 2, Gasklokke	0	100	64.6	%
1.4	Motor 1, Sæt-omdrejninger	0	2000	1500	o/m
59.9	Motor 1, Gastryk	0	300	60.3	mbar

Gasmotor, gaskedel og gasklokke

Tidsmarkør: 29/09/2009 12:45:42

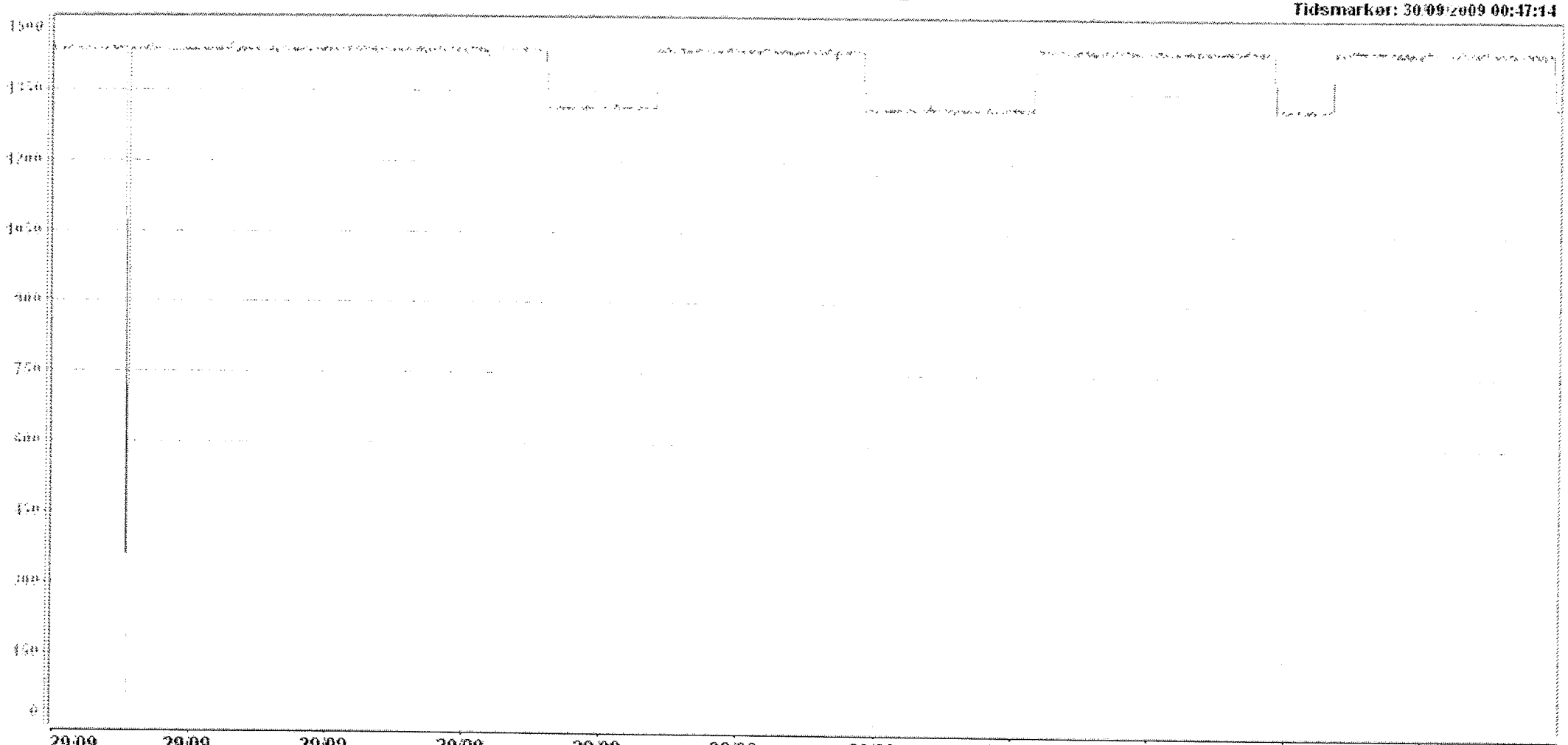


29/09/2009 00:45:42 Duration: 12:00:00 29/09/2009 12:45:42

Cursor	Beskrivelse	Min.	Maks.	Akt. værdi	Enhed
0	Gasflow total 0-1000m³/h	0	1000	0	m³/h
0	Gasflow gaskedel 0-500m³/h	0	500	0	m³/h
-0.1	Motor 2, El-effekt JES generator 2 -225..900kW	-225	900	0	kW
73.6	Motor 2, Gasklokke	0	100	64.6	%
17	Motor 1, Testtemperatur	0	300	162	°C
60.1	Motor 1, Gastryk	0	300	60	mbar

Gasmotor, gaskedel og gasklokke

Tidsmarkør: 30/09/2009 00:47:14

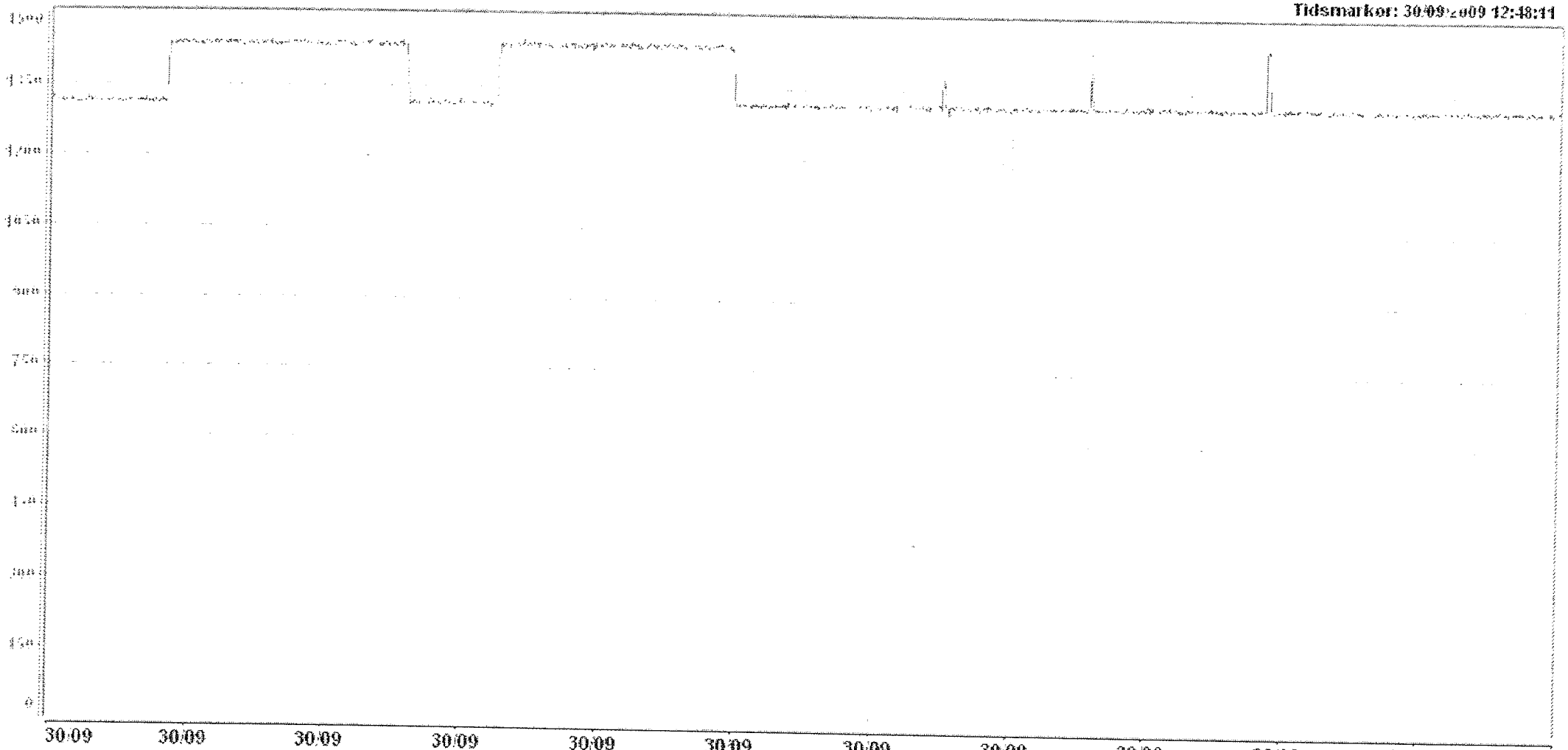


29/09/2009 12:47:14 Duration: 12:00:00 30/09/2009 00:47:14

Cursor	Beskrivelse	Min.	Maks.	Akt. værdi	Enhed
0	Gasflow total 0-1000m³/h	0	1000	0	m³/h
0	Gasflow gaskedel 0-500m³/h	0	500	0	m³/h
0	Motor 2, El-effekt JES generator 2 -225..900kW	-225	900	0	kW
64.8	Motor 2, Gasklokke	0	100	64.6	%
60.4	Motor 1, Gastryk	0	300	60.1	mbar

Gasmotor, gaskedel og gasklokke

Tidsmarkør: 30/09/2009 12:48:11



30/09/2009 00:48:11 Duration: 12:00:00 30/09/2009 12:48:11

Cursor	Beskrivelse	Min.	Maks.	Akt. værdi	Enhed
0	Gasflow total 0-1000m³/h	0	1000	0	m³/h
0	Gasflow gaskedel 0-500m³/h	0	500	0	m³/h
0	Motor 2, El-effekt JES generator 2 -225..900kW	-225	900	0	kW
64,4	Motor 2, Gasklokke	0	100	64,4	%
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
59,9	Motor 1, Gastryk	0	300	59,9	mbar

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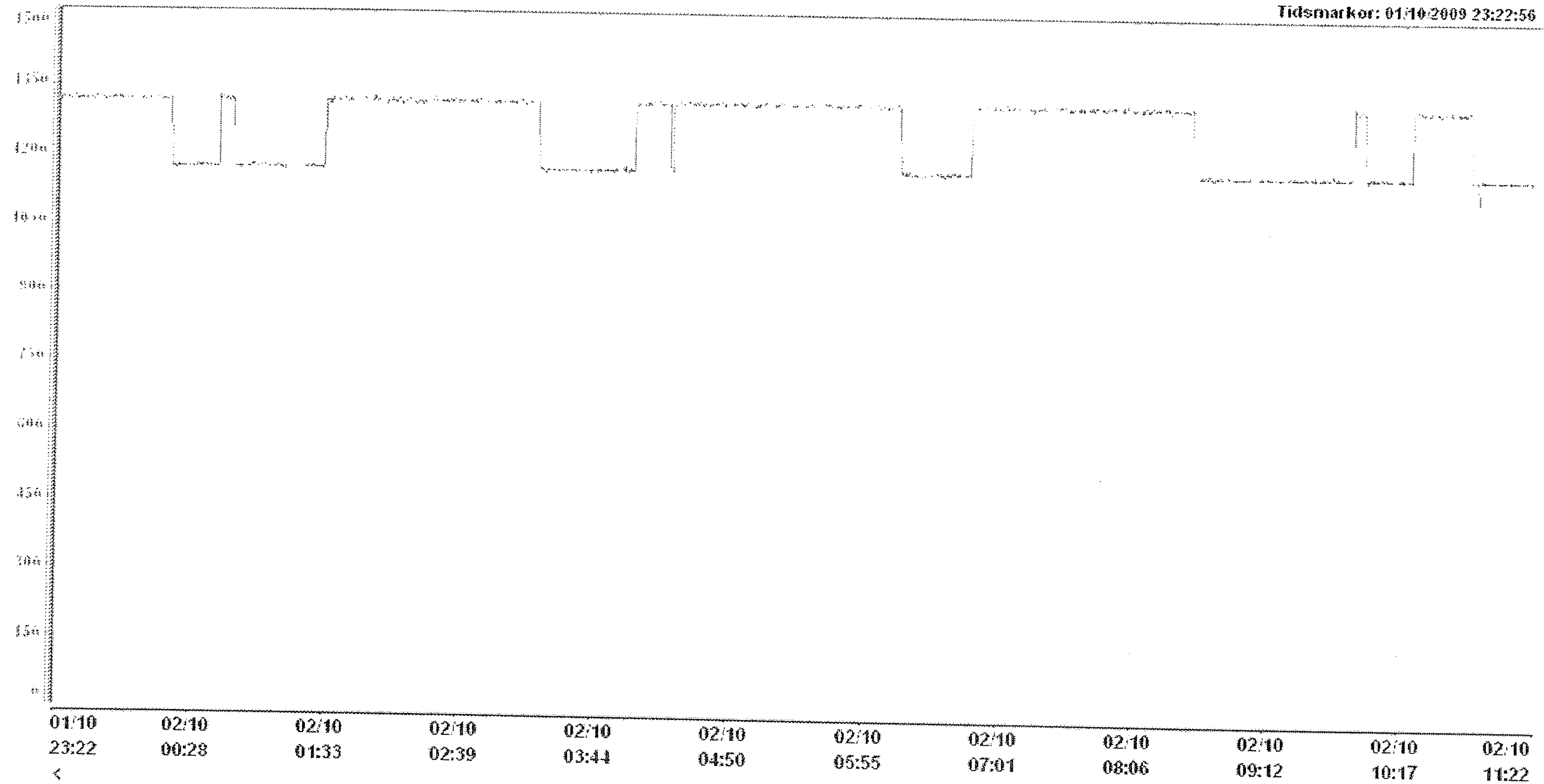
Gasmotor, gaskedel og gasklokke

Tidsmarkør: 01/10/2009 23:22:56



01/10/2009 23:22:56 | Duration: 12:00:00 | 02/10/2009 11:22:56

Cursor	Beskrivelse	Min.	Maks.	Akt. værdi	Enhed
0	Gasflow total 0-1000m³/h	0	1000	0	m³/h
0	Gasflow gaskedel 0-500m³/h	0	500	0	m³/h
-0	Motor 2. El-effekt JES generator 2 -225..900kW	-225	900	0	kW
60.3	Motor 2. Gasklokke	0	100	58.7	%
[illegible]	Motor 1. [illegible]	0	[illegible]	[illegible]	[illegible]

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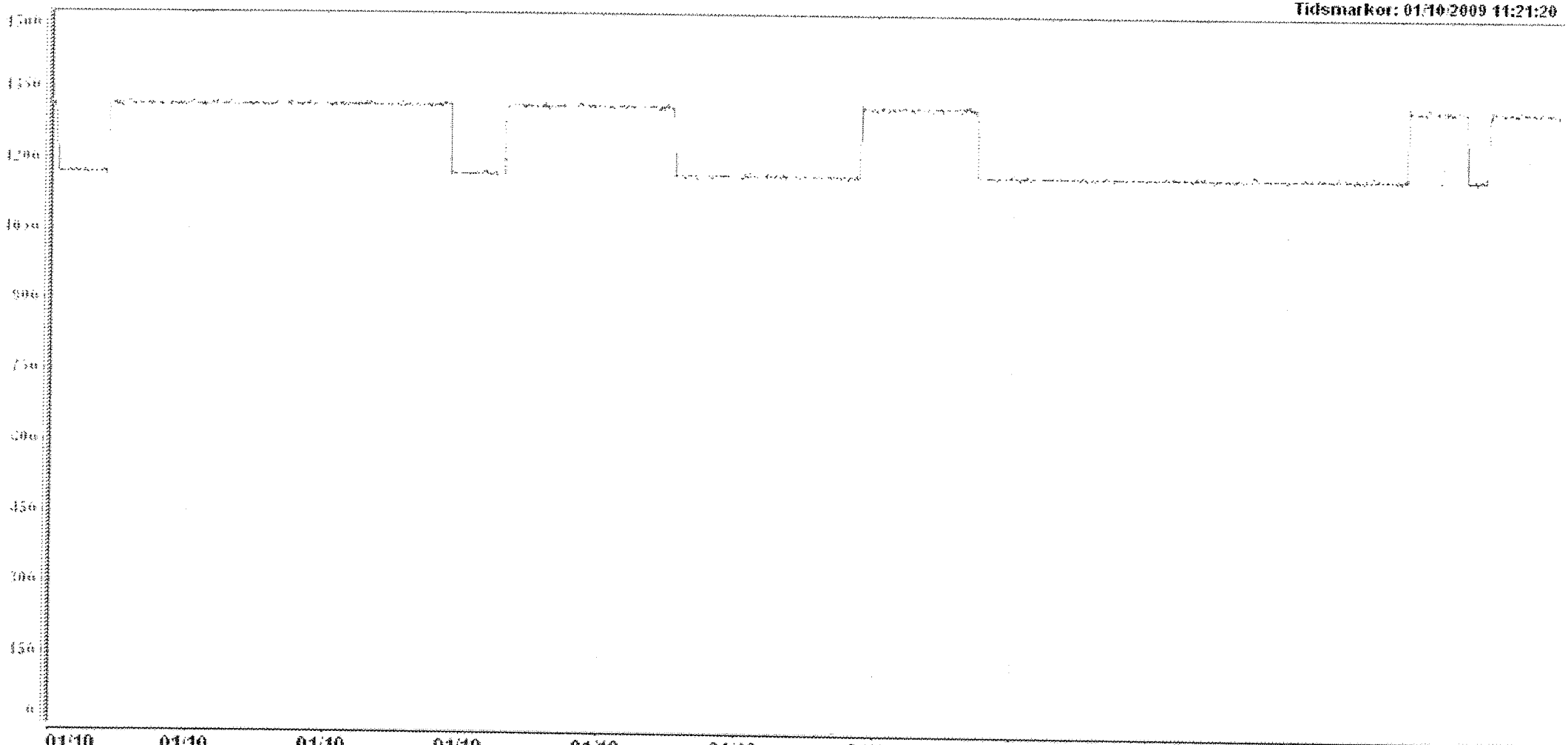
Gasmotor, gaskedel og gasklokke

Tidsmarkør: 01/10/2009 11:21:20



01/10/2009 11:21:20 Duration: 12:00:00 01/10/2009 23:21:20

Cursor	Beskrivelse	Min.	Maks.	Akt. værdi	Enhed
0	Gasflow total 0-1000m³/h	0	1000	0	m³/h
0	Gasflow gaskedel 0-500m³/h	0	500	0	m³/h
0.1	Motor 2, El-effekt JES generator 2 -225..900kW	-225	900	0	kW
60.1	Motor 2, Gasklokke	0	100	58.7	%
1.0	Motor 1, Gasklokke	0	100	15.0	%

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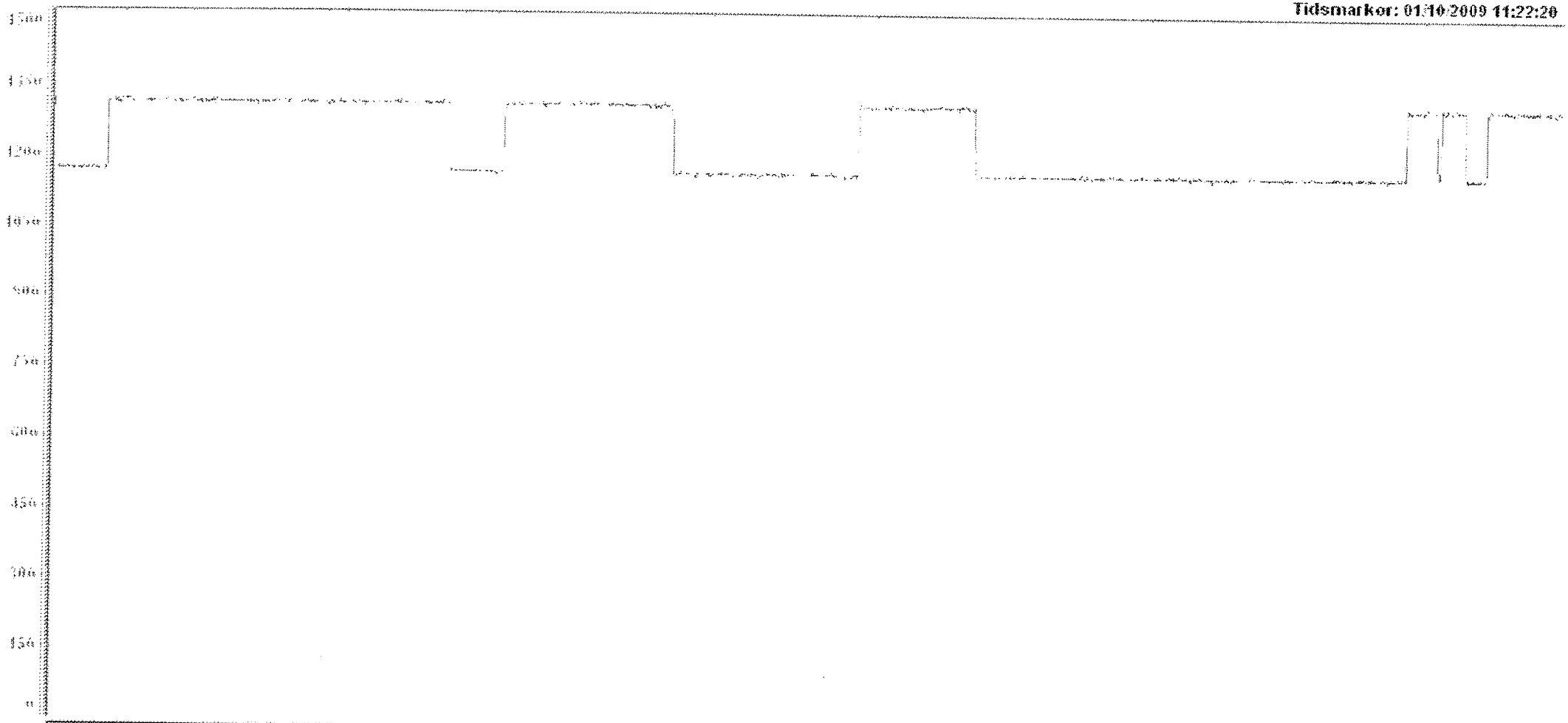
Gasmotor, gaskedel og gasklokke

Tidsmarkør: 01/10/2009 11:22:20



01/10/2009 11:22:20 | Duration: 12:00:00 | 01/10/2009 23:22:20

Cursor	Beskrivelse	Min.	Maks.	Akt. værdi	Enhed
0	Gasflow total 0-1000m³/h	0	1000	0	m³/h
0	Gasflow gaskedel 0-500m³/h	0	500	0	m³/h
-0.1	Motor 2, El-effekt JES generator 2 -225..900kW	-225	900	0	kW
60	Motor 2, Gasklokke	0	100	58.7	%

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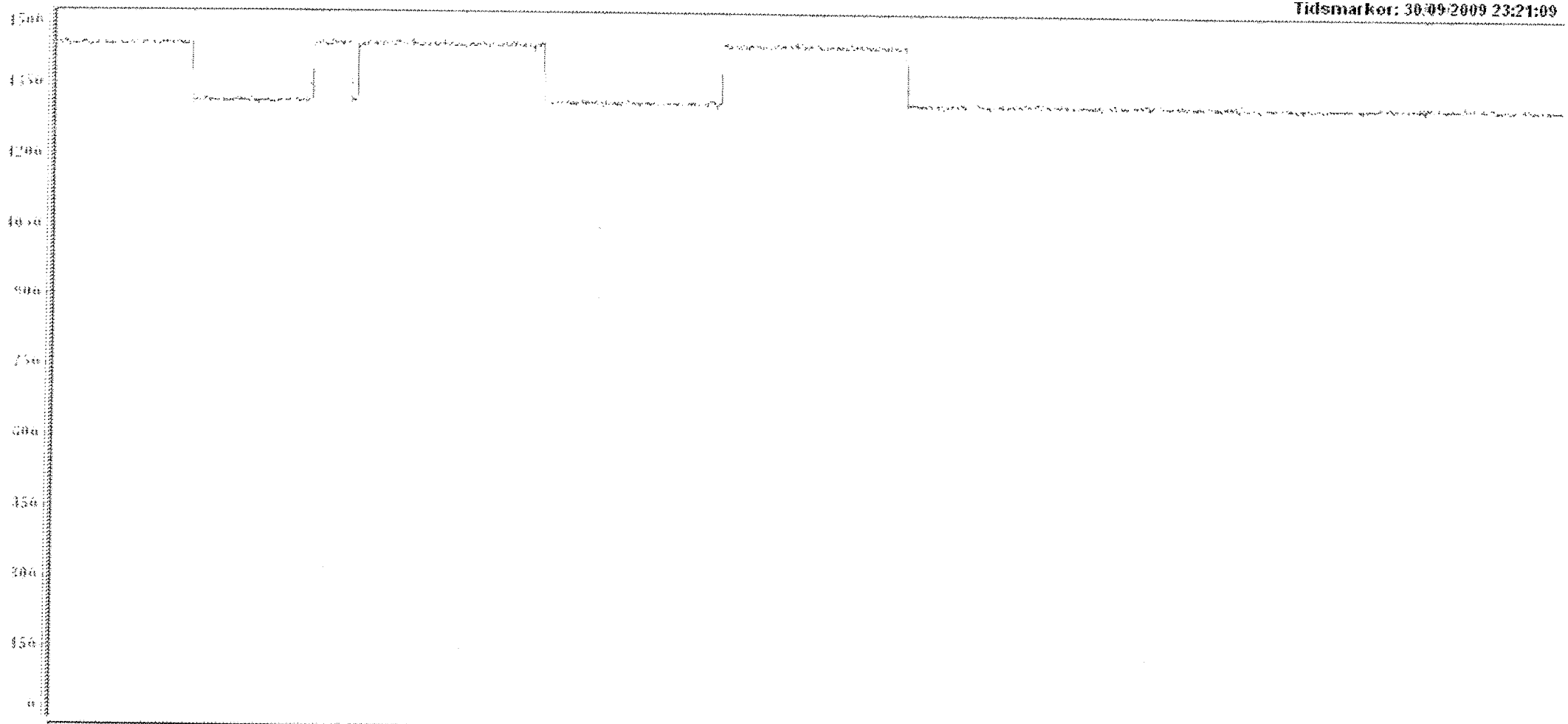
Gasmotor, gaskedel og gasklokke

Tidsmarker: 30/09/2009 23:21:09



30/09/2009 23:21:09 Duration: 12:00:00 01/10/2009 11:21:09

Cursor	Beskrivelse	Min.	Maks.	Akt. værdi	Enhed
0	Gasflow total 0-1000m³/h	0	1000	0	m³/h
0	Gasflow gaskedel 0-500m³/h	0	500	0	m³/h
-0.1	Motor 2, El-effekt JES generator 2 -225..900kW	-225	900	0	kW
65.7	Motor 2, Gasklokke	0	100	58.7	%

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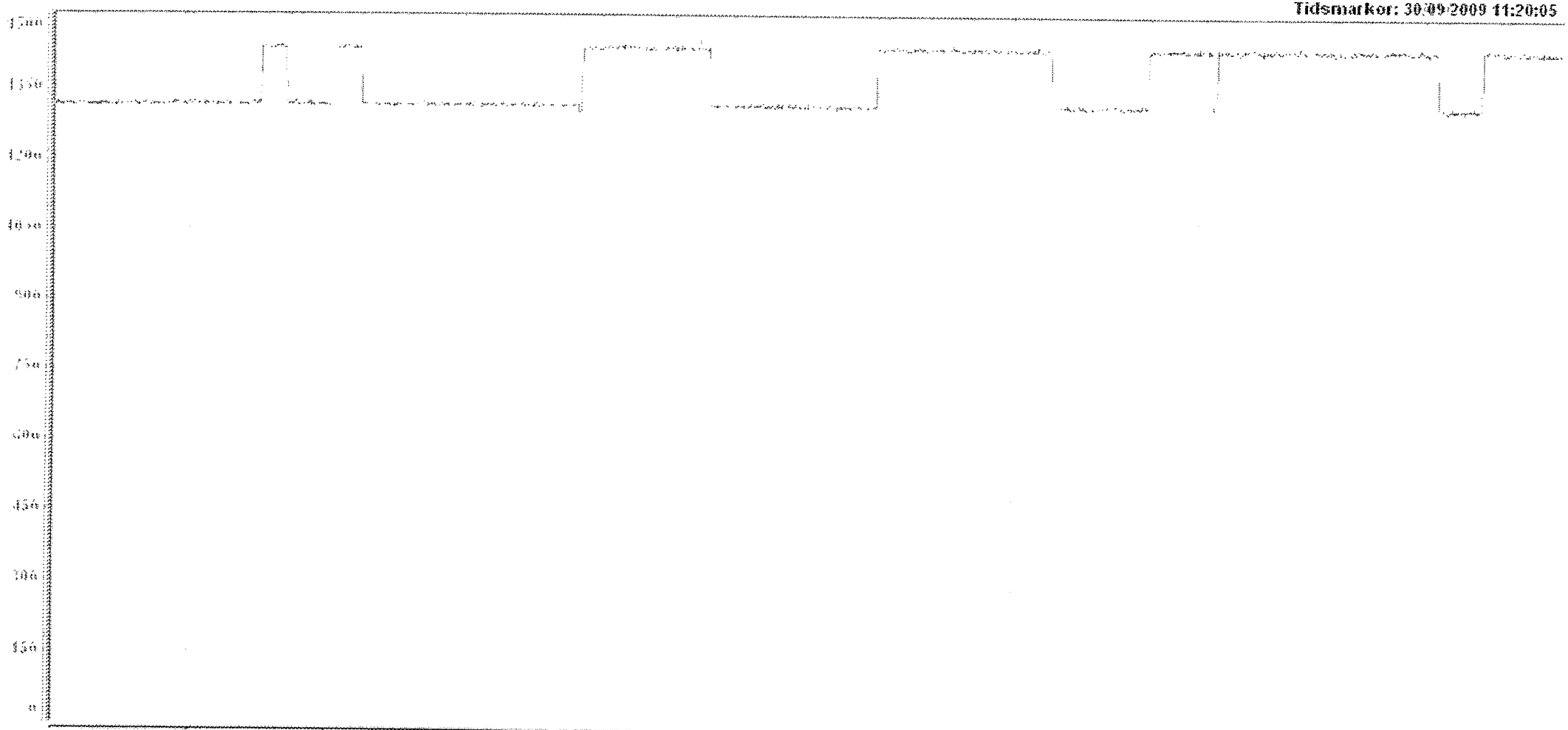
Gasmotor, gaskedel og gasklokke

Tidsmarkør: 30/09/2009 11:20:05



30/09/2009 11:20:05 | Duration: 12:00:00 | 30/09/2009 23:20:05

Cursor	Beskrivelse	Min.	Maks.	Akt. værdi	Enhed
0	Gasflow total 0-1000m³/h	0	1000	0	m³/h
0	Gasflow gaskedel 0-500m³/h	0	500	0	m³/h
0	Motor 2, El-effekt JES generator 2 -225..900kW	-225	900	0.1	kW
63	Motor 2, Gasklokke	0	100	58.7	%

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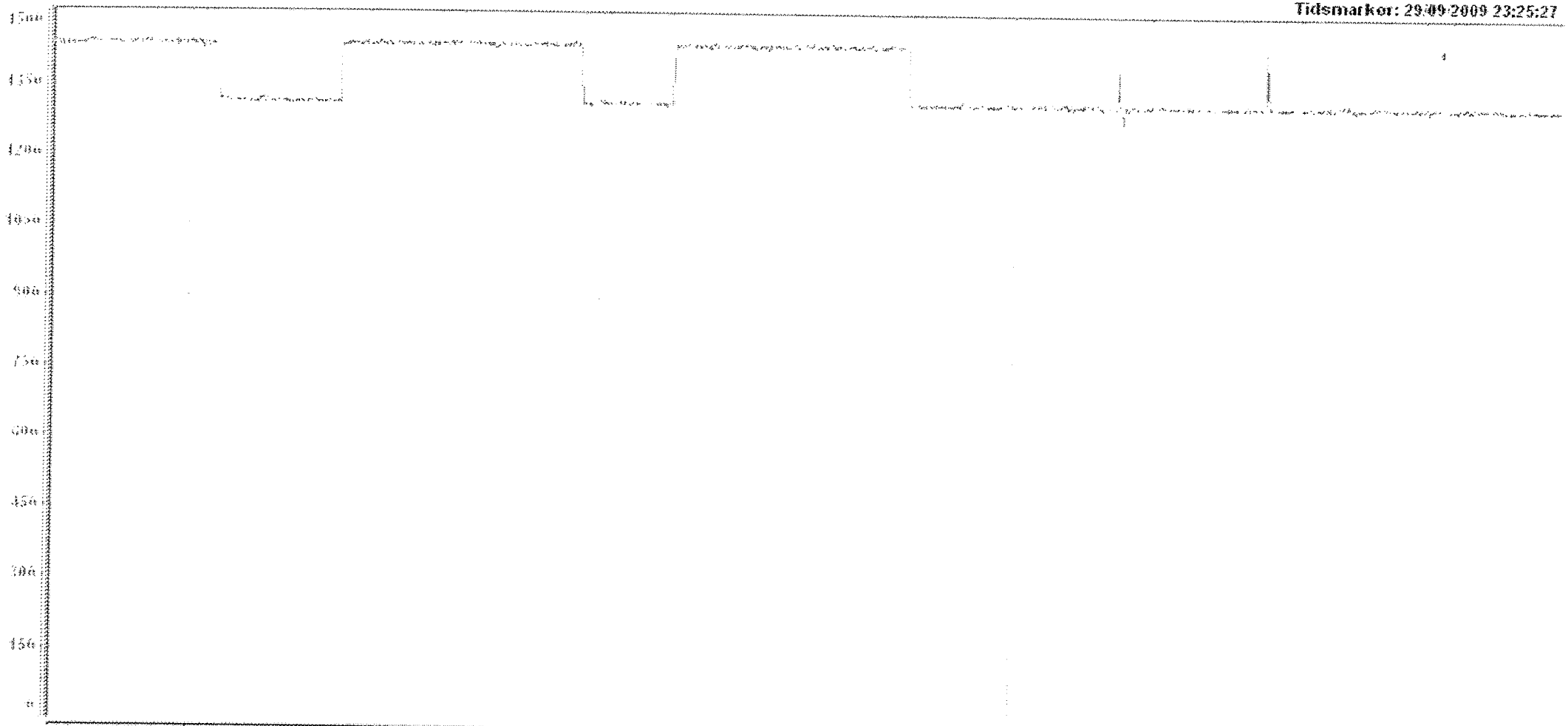
Gasmotor, gaskedel og gasklokke

Tidsmarkør: 29/09/2009 23:25:27



29/09/2009 23:25:27 | Duration: 12:00:00 | 30/09/2009 11:25:27

Cursor	Beskrivelse	Min.	Maks.	Akt. værdi	Enhed
0	Gasflow total 0-1000m³/h	0	1000	0	m³/h
0	Gasflow gaskedel 0-500m³/h	0	500	0	m³/h
-0.1	Motor 2, El-effekt JES generator 2 -225..900kW	-225	900	0.1	kW
65.4	Motor 2, Gasklokke	0	100	58.7	%

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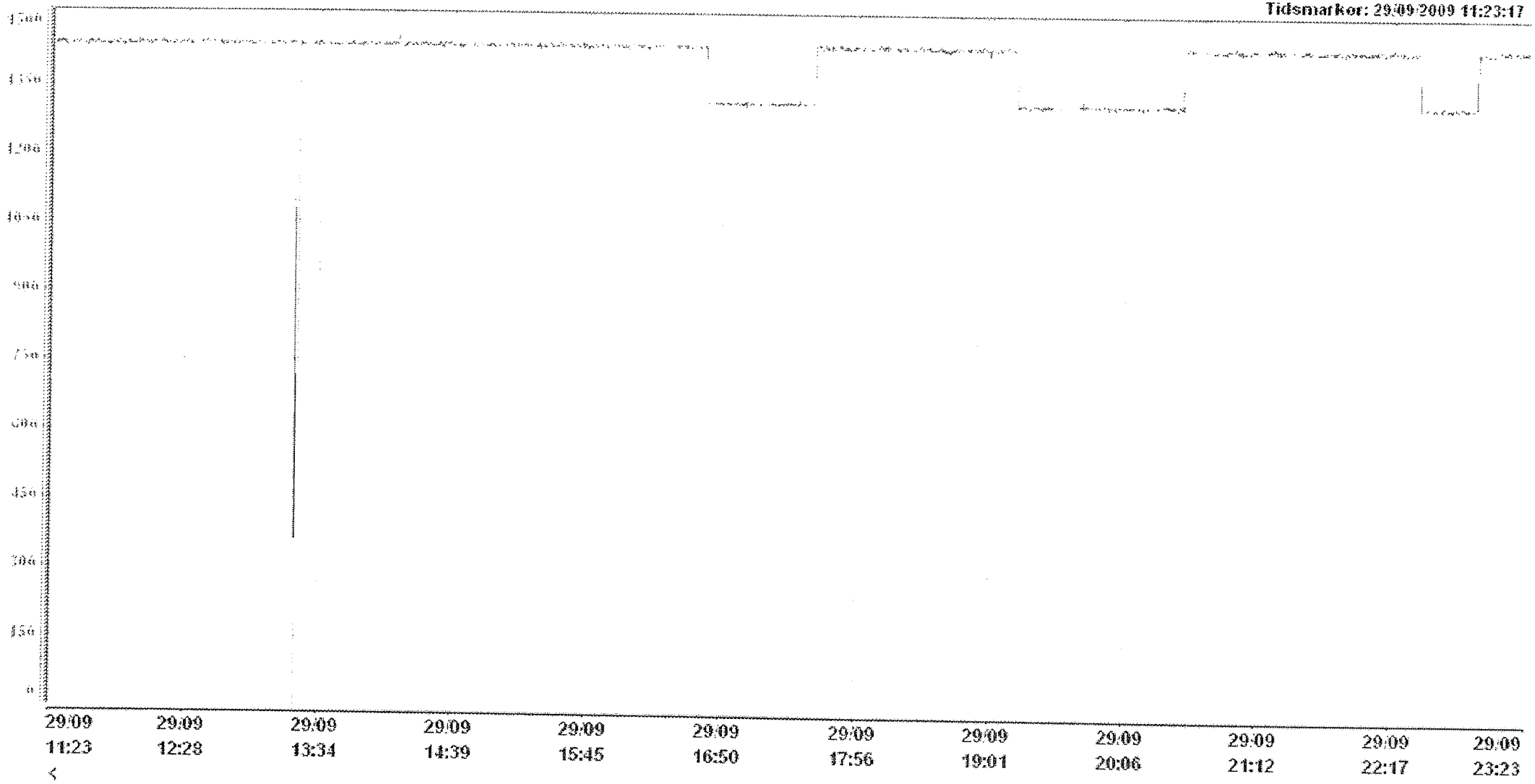
Gasmotor, gaskedel og gasklokke

Tidsmarker: 29/09/2009 11:23:17

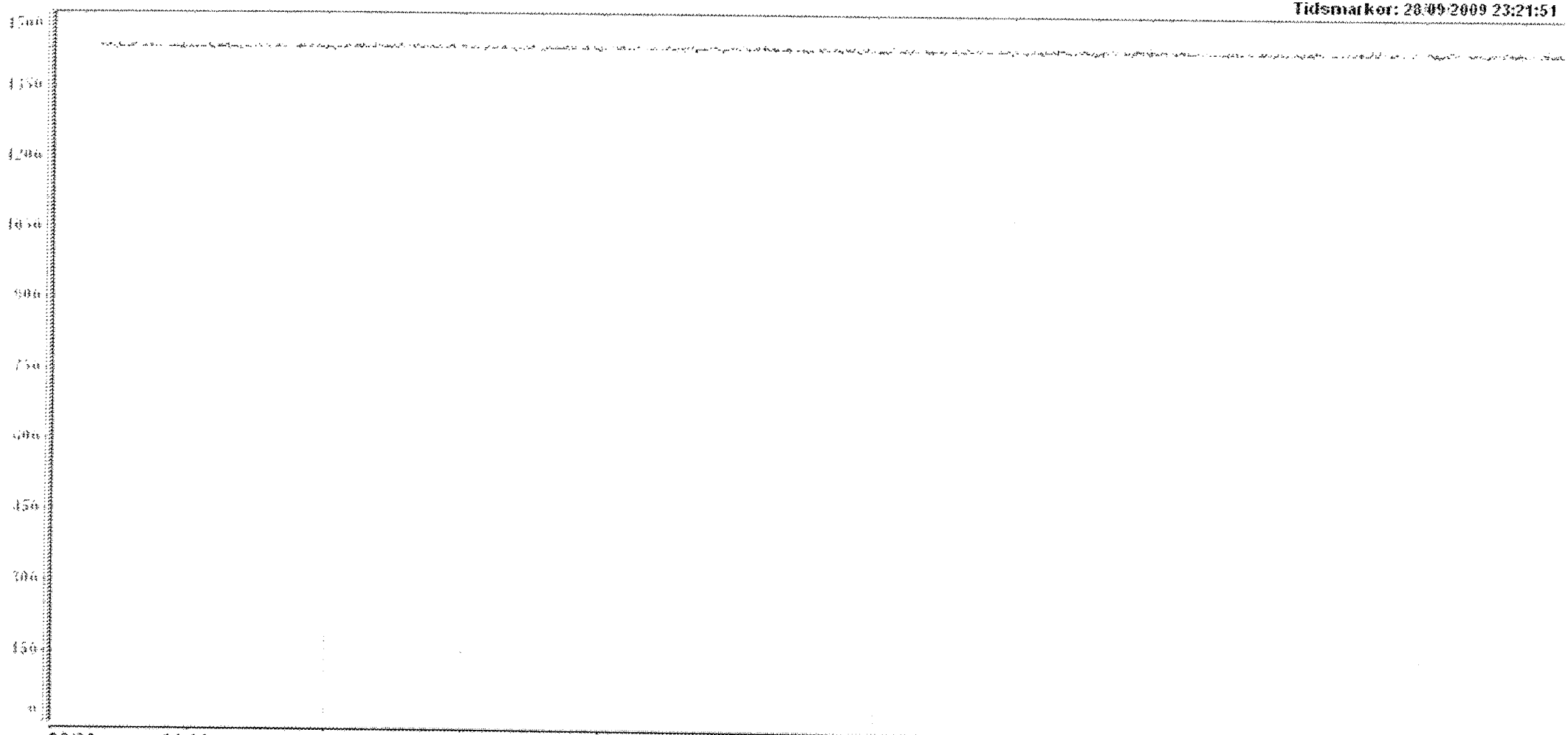


29/09/2009 11:23:17 Duration: 12:00:00 29/09/2009 23:23:17

Cursor	Beskrivelse	Min.	Maks.	Akt. værdi	Enhed
0	Gasflow total 0-1000m³/h	0	1000	0	m³/h
0	Gasflow gaskedel 0-500m³/h	0	500	0	m³/h
-0.1	Motor 2, El-effekt JES generator 2 -225..900kW	-225	900	0.1	kW
74.6	Motor 2, Gasklokke	0	100	58.7	%
105	Motor 1 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Gasmotor, gaskedel og gasklokke

Tidsmarkør: 28/09/2009 23:21:51



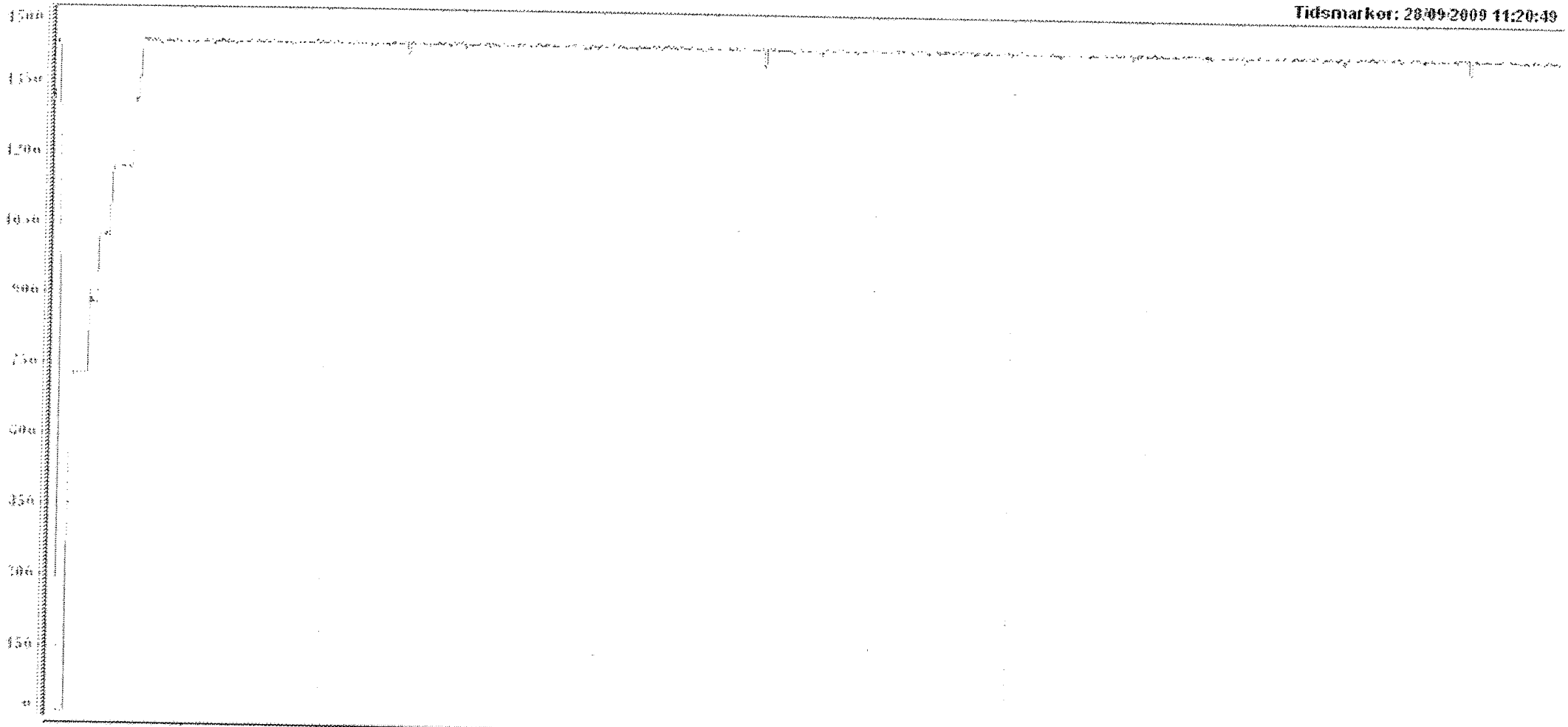
28/09/2009 23:21:51 Duration: 12:00:00 29/09/2009 11:21:51

Cursor	Beskrivelse	Min.	Maks.	Akt. værdi	Enhed
	Gasflow total 0-1000m³/h	0	1000	0	m³/h
	Gasflow gaskedel 0-500m³/h	0	500	0	m³/h
	Motor 2, El-effekt JES generator 2 -225..900kW	-225	900	0	kW
	Motor 2, Gasklokke	0	100	58.7	%
	Motor 2, Gastemperatur	0	300	19	°C

Billeder | Kurver | Alarmer | Rapporter | Hjælp | Bruger | Copyright © PKS Engineering © | Dato: 02-10-2009 | Tid: 11:26:13

Gasmotor, gaskedel og gasklokke

Tidsmarkør: 28/09/2009 11:20:49



28/09/2009 11:20:49 Duration: 12:00:00 28/09/2009 23:20:49

Cursor	Beskrivelse	Min.	Maks.	Akt. værdi	Enhed
0	Gasflow total 0-1000m³/h	0	1000	0	m³/h
0	Gasflow gaskedel 0-500m³/h	0	500	0	m³/h
0	Motor 2, El-effekt JES generator 2 -225..900kW	-225	900	0	kW
86.8	Motor 2, Gasklokke	0	100	58.7	%

Appendix 6A

Results of measurements Manure

The following tables 1 – 3 shows the results from measurements of the manure during the test. All data are average values.

Table 1. Dry matter content (%) in the manure measured in inlet & outlet.

Date	Sample no[a]	Time	Dry matter in manure %	
			Inlet	Outlet
29.09.2009	1	15:15	31,7	96,3
	2	23:17	30,6	95,6
	3	03:38	31,2	83,0
	4	09:53	31,3	96,0
	5	15:10	31,2	96,9
	6	23:21	31,8	95,7
30.09.2009	8	10:30	32,1	87,5
	9	15:37	33,1	93,7
01.10.2009	10	01:08	32,6	95,2
	11	04:48	32,8	81,0
	12	13:10	32,5	89,3
	13	15:13	33,3	81,0
02.10.2009	14	00:29	33,1	96,3
	15	04:12	34,0	88,7
	16	07:50	33,6	85,7
	17		33,1	81,6
		Average	**32,4**	**90,2**
		RSD[b]	**3,1**	**6,9**

[a] *Sample 7 is discarded due to malfunction during the test*

[b] *Relative standard deviation in %*

Appendix 6A

Results of measurements Manure

Table 2. Amount of manure - Inlet.

Date	Raw manure (kg)		Δ Kg	Time		$Time_{Total}$	Total Raw manure (inlet)
	Empty	Full		Start	Stop		Kg/h
29.09.2009	2.520	3.600	1.080	11:58	13:13	01:15	**864**
02.10.2009	2.520	3.670	1.150	11:29	12:50	01:21	**852**
						Average	858

Table 3. Amount of manure - Outlet.

Date	Dry manure (kg)		Δ Kg	Time		$Time_{Total}$	Total Dry manure (outlet)
	Empty	Full		Start	Stop		Kg/h
29.09.2009	2.520	2.770	250	05:00	06:00	01:00	**250**
29.09.2009	2.520	2.820	300	12:57	13:57	01:00	**300**
30.09.2009	2.520	2.820	300	13:37	14:37	01:00	**300**
01.10.2009	2.520	2.780	260	01:24	02:24	01:00	**260**
02.10.2009	2.520	2.810	290	01:39	02:39	01:00	**290**
						Average	280

Appendix 6B

Results of measurements
Flue Gas

The following Table 1 shows the results from measurements of the flue gas during the test. All data are average values.

Table 1. Flue Gas – Energy source (Q_{FG})

Date	Measured			Calculated[a]	
	Volumetric Flow m3/h (n,d)[b]	Temperature (^{0}C)		Q_{FG} (MJ/h)	
		Inlet	Outlet	Inlet	Outlet
28.09.2009	5.400	366	154		
29.09.2009	5.400	402	165		
30.09.2009	5.500	404	171		
01.10.2009	5.800	397	187		
02.10.2009	6.000	418	172		
Average	**5.620**	**397**	**170**	**2.457**	**1.050**

[a] *For the calculation formula see Appendix 4*

[b] *Standard condition, dry (0°C, 1013 mbar, dry gas)*

Appendix 6C

Results of measurements Condensate

The following Table 1 shows the results from measurements of the flue gas during the test. All data are average values.

Table 1. Condensate (outlet) – Energy source (Q_C)

Date	Measured		Calculated[a]
	Mass (kg/h)	Temperature (^{0}C)	Q_C (MJ/h)
	Outlet		Outlet
28.09.2009	501	72,5	
29.09.2009	470	81,9	
30.09.2009	457	73,9	
01.10.2009	487	76,7	
02.10.2009	532	81,9	
Average	489	77,4	**159**

[a] *For the calculation formula see Appendix 4*

Appendix 6D

Results of measurements Electricity

The following Tables 1 shows the results from measurements of the electricity during the test. All data are average values.

Table 1. Electricity - Energy source (Pe).

Item	Installed[a]		Measured		Calculated[bc]	
	I (A)	P (kW)	I (A)	COS φ[d]	P_e (kW)	P_e (MJ)
Fan 31 (cabinet M31)	12,00	5,50	9,33	0,93	6,0	
Fan 32 (cabinet M32)	12,00	5,50	9,62	0,93	6,2	
Fan 33 (cabinet M33)	12,00	5,50	9,35	0,93	6,0	
Fan 34 (cabinet M34)	12,00	5,50	9,99	0,93	6,4	
Fan 35 (cabinet M35)	12,00	5,50	9,45	0,93	6,1	
Fan 36 (cabinet M36)	12,00	5,50	9,92	0,93	6,4	
Fan 37 (cabinet M37)	12,00	5,50	9,45	0,93	6,1	
jFan 38 (cabinet M38)	12,00	5,50	9,17	0,93	5,9	
				Average	**49,1**	**176,8**

Nomenclature					
Symbol	V	p	I	cos φ	T
Term	Volumetric Flow	Effect Power	Current	Phase factor	Temperature
Unit	m^3	J kW	A	(None)	^0C

[a] *The electric motor rating plate current*

[b] *For the calculation formula see Appendix 4*

[c] *The electric potential (V) for the Pe calculation is 400 Voltage*

[d] *cos φ are used to determine the efficiency of the electric motor. The cos φ value used in the calculation are the values given on the electric motor rating plate, which and can vary from the actual cos φ value*

Appendix 3

Review Reports

Review report 1			
Document title:	Cimbria Test Report FINAL draft	Document date:	09.12.2009
Reviewer name:	Stig Lind Schmidt	Review date:	18.12.2009
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Review results					
Rate items	*Satisfactory*	*Unsatisfactory*		*Overall recommendation*	
Contents	x				
Scope	x			Acceptable as is	
Organization	x			Minor revisions	x
Data quality	x			Major revisions	
Method validity	x			Not acceptable	
Conclusions	x				
Other (specify)			Reason		

Revision details				
Topic	*Report chapter, section, page*	*Revision required*	*Reason*	*Revision action(to be filled in by document owner during revision after review)*
COS φ	7 7.2 / page 13	X	Argument for using COS φ is missing	Adjusted in accordance with recommendations

Appendix 3

Review Reports

Review report 2			
Document title:	Cimbria Test Report FINAL draft	Document date:	9.12.2009
Reviewer name:	Orla Munk Jensen	Review date:	20.12.2009
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Review results					
Rate items	*Satisfactory*	*Unsatisfactory*		*Overall recommendation*	
Contents	x				
Scope		x		Acceptable as is	
Organization	x			Minor revisions	x
Data quality	x			Major revisions	
Method validity	x			Not acceptable	
Conclusions		x			
Other (specify)			Reason Object to be formulated more specific Conclusions were not clear		

Revision details				
Topic	*Report chap-ter, section, page*	*Revision required*	*Reason*	*Revision action(to be filled in by document owner during revision after review)*
Table 6	7 7.2 / 14	X	Different order in data Results converted into kg/h	Adjusted in accordance with recommendations
Table 12	7 7.3 / 17	X	Cp as density and not mass	Adjusted in accordance with recommendations
Energy balance	7 7.3 / 16	X	Missing outline chart with testresults	Adjusted in accordance with recommendations