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Project No. US/URT/02/117, FC/URT/04/118, SF/URT/05/119-

UNIDO Contractor no.: 16001023

Design, Construction, Erection, Installation, Training and Commissioning of a Pilot Demonstration Facility

for the

Production, Generation and Distribution of Electricity from biogas produced from sisal leaf waste in Tanzania

Final Report on

Installation and Commissioning For the Sisal Biogas Plant in Tanzania

Berlin, 27th October, 2007

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1 SUMMARY OF PROJECT STATUS

The UNIDO Demonstration Biogas Project "Cleaner Integral Utilization of Sisal Waste for Biogas and Bio-Fertilizer at Halle in Tanzania" is completely finished by contractor BEB BioEnergy Berlin through one year hard work of all experts and workers. The project handover has been done on 29 September 2007 by the project Counterpart Tanzania Sisal Board (TSB) and Katani Ltd together with contractor BEB BioEnergy Berlin in according to the Term of Reference and contract.

BEB Berlin has also done the technical acceptance test at the project site on 13th August together with the under contractors. BEB subcontractor Sichuan Guojiao Energy and Environmental Protection Engineering Ltd from Chengdu has erected and constructed all of the steel tanks and Jinan Diesel Engine Ltd from Jinan has supplied and installed the180 kW biogas co-generator. BEB Berlin has carried out the start-up and commissioning of the biogas plant. All of the construction, installation, start-up and commissioning works have been done under the control and supervision of BEB Berlin.

There are some more spare parts, which should delivery from China to project site, have been agreed in the official Hand-over Protocol.

2 PROJECT MILESTONE

The project milestone after the Installation and Commissioning Report as like follows:

4th August 2007:	International Dissemination Workshop on Sisal from UNIDO, FAO, CFC, TSB, Katani, Sisal association of Tanzania, relevant Government ministries, BEB Berlin and participants from world sisal producing countries;
13th August 2007:	Technical acceptance test for the biogas plant with subcontractors Sichuan Guojiao Energy and Environmental Protection Engineering Ltd and Jinan Diesel Engine Ltd from China and counterpart TSB/Katani;
29th September 2007:	Hand-over with Tanzania Sisal Board (TSB) and Katani Ltd, the Hand-over Protocol has been signed by all parties involved;
29-30th Sep. 2007:	Trainee on Job side for 14 managers, engineers and technicians from TSB/Katani and other Sisal Estates in Tanzania.

3 UP-DATED PERFORMANCE

3.1 The process scheme

The process scheme of the biogas plant is shown in following figure 1:

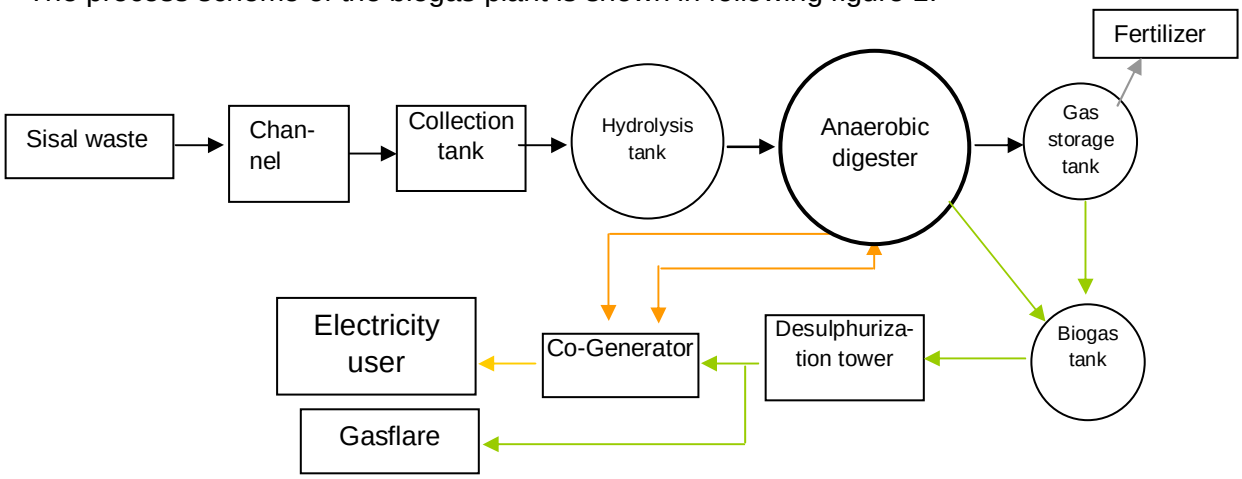

Fig.1: The flow scheme of biogas project for the treatment of sisal waste at Halle Estate

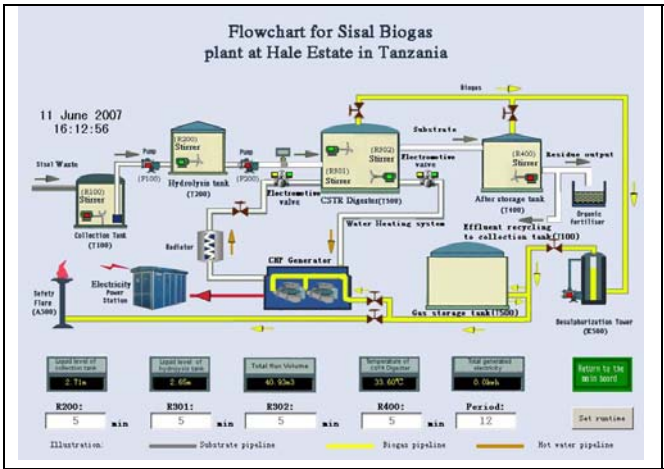

Fig. 2: The computer monitoring diagram

Fig.3: The site picture of biogas project

3.2 Description of components

The total biogas plant included 50m^3 collection tank, 300m^3 hydrolysis tank, 1700m^3 anaerobic CSTR digester, 350m^3 wet-type gas storage tank, 500m^3 after-storage tank, 12m^3 desulphurization tower, CHP unit, computer controlling system, piping system, valves, pumps, electric equipment, instruments, power distribution.

3.2.1 Collection system of sisal waste

The collection system mainly includes two parts, one was the filter equipment, and another is collection tank. The weeds and the long fiber should be removed though the filter equipment, and the waste liquid should be gathered in the collection tank for temporary material; the volume of collection tank is 50m^3, a 4kW stirrer and 2.2 kW pump have been installed in the collection tank. The fermentation material was mixed well by the running of stirrer. After the mixture of input in the collection tank, the substrate should be pumped into the hydrolysis tank where fermentation material could be acidified.

3.2.2 Hydrolysis tank

The tank was constructed on the ground, it was a column tank made of bow steel plate, the volume of hydrolysis tank is 300 m^3, the sisal material was pre-hydrolyzed in the tank, so the complex organic matter should be converted into fatty acids, which are a good substrate for biogas anaerobic fermentation. A 15kW stirrer and liquid level meter were installed in the hydrolysis tank. In the wall of tank, sampling pipes were designed. Near the tank, a 4kW feeding pump integrated an ultrasonic flow meter was installed, and the feeding pump supplies hydrolyzed material to anaerobic digester in fixed quantities at fixed times according to requirement of technology process.

3.2.3 Anaerobic digester

The digester was built up on the ground, it was a column tank made of bow armor steel plates, its volume is about 1700 m^3, and it is a key part in the whole biogas project. The sisal material used to produce biogas in the anaerobic digester. The heat pipeline system and two 15kW stirrers were installed on the inside wall of the tank. The water seal system and defoaming system were set to protect the tank and eliminate the foam. In the out side wall of tank, sampling pipes were designed, and the designed pressure of the tank was 3500Pa.

3.2.4 After-storage tank

It is a 500m^3 steel plate tank which built on the ground. It was the second fermentation system after the anaerobic digester. A 15kW stirrer and overflowing device were installed inside the tank, and some sampling pipes were intercalated on the outer wall, and a water seal system and defoaming system were equipped at the top of the tank as well.

3.2.5 Gas storage tank

The tank was built up on the ground, and it is a column tank made of bow steel plate with a volume of 350m^3. The biogas should be stored with water pressure seal principle. At the top of the tank, automatic and manual releasers were installed to protect the tank.

3.2.6 Biological desulphurization tower

It is a column tower which constructed on the ground. It was made of bow steel plate with a volume of 12m^3. In the middle of tank, a flow meter was applied, and manholes and biogas inlet pipes were set up at the bottom and on the top of tank. In the middle of the tower, an air pump and its pipes were equipped, at the bottom of the tower, a recycling pump and its pipes were equipped correspondingly.

3.2.7 Co-Generator system

The generator is a special biogas co-generator with a maximum electricity output of 180kW, and the optimal operation capacity is 150kW. The pressure and the concentration of CH_4 required by the generator should be ca. 3000Pa and more than 50% respectively. During the operation, the practical biogas pressure and CH_4 content are higher than required.

3.2.8 Pipe system

The feeding pipes was laid on the ground, they were composed of feeding pipes, efferent pipes, overflowing pipes and circular pipes. The sisal waste was fed to all tanks through the top of feeding pipes. The fermented material from after-storage tank is discharged by manual ways through efferent pipes and circular pipes, and the overflowing material is let out by automatic way.

Gas pipes were set underground; they were formed by dehydration devices, fire backup devices, gas flow meter and torch.

3.2.9 Heat system

The heating system with hot water consists of 4-cycles stainless pipes, which installed in inner wall of anaerobic digester, manual and automatic valve that can adjust the temperature of the fermentation. The heating energy comes from the co-generator. The fermentation temperature with 37°C could be ensured through such kind of heating system.

3.2.10 Control system

Control system composes of manual time control parts and automatic control parts. The manual time control part consists of site control fittings and remote control fittings. During the running of manual control system, the figures and curves of all equipments and devices can be displayed and recorded in the monitor computer. The running conditions of the biogas project can be automatically monitored. There is also alarm system for the biogas plant, and the alarm system could be worked if there is some problem during the operation time.

3.3 Start-up of the biological process

In the collection tank, 600m^3 fresh water was infused into the anaerobic digester, and then 25t cow dung (TS=15%) and 50m^3 sisal waste (TS=1.2%) were added to the tank again. After complete mixture of cow dung, fresh water and sisal waste by the stirrer, the mixture substrate in the collection tank were pumped into the anaerobic digester, where total volume of the fermentation liquid reached about 950m^3. Then the anaerobic digester was started to operate. After five days, pH of fermentation substrate reached 7.0. At the same time, 20m^3 sisal waste in every two day was added into the anaerobic digester continuously until the 1500m^3 activated fermentation volume reached.

3.4 Operation results of the biogas project

After several days' operation of the anaerobic digester, the fermentation process with biogas production was begun. The biogas components and production rate were tested every two days, and the results have shown in the following figure1 and figure 2. In figure 1, we can see clearly that the CH_4 content in biogas was increased gradually with the increase of operation time, and the CH_4 content reached 60.8% after 20 operation days. Subsequently, the CH_4 content was stable around 60.5% during the whole operation time. In figure 2, it is shown that the biogas production rate was lower at the beginning. But after operation 6 days, the gas production rate increased quickly. The volume gas production rate reached 0.62m^3/m^3.d in the 12 operation day. Thereafter, the volumetric gas production rate was stable around 0.62m^3/m^3.d., which has reached designed gas production rate. The total biogas production reached 1500 m^3 daily. The produced biogas can operate 140-150kW co-generator.

In the first ten days' operation, the produced biogas could be burned and the burning flame was red. The CH_4 content was only 30.5% in the start-up phase. The fermentation temperature in the digester reached 35 . On the fourteenth day, the CH_4 content reached about 50% and the burning flame was blue. Thereafter, The CH_4 content keeps around 65%.

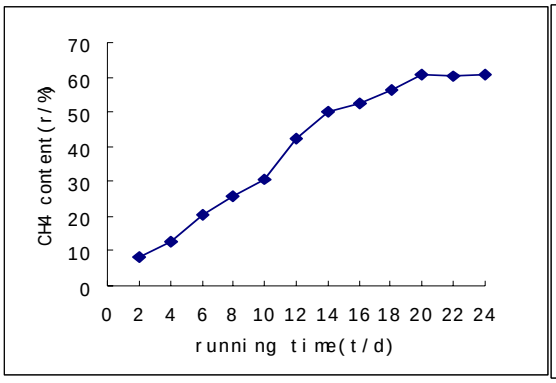

Fig.4: Change of CH_4 content of biogas

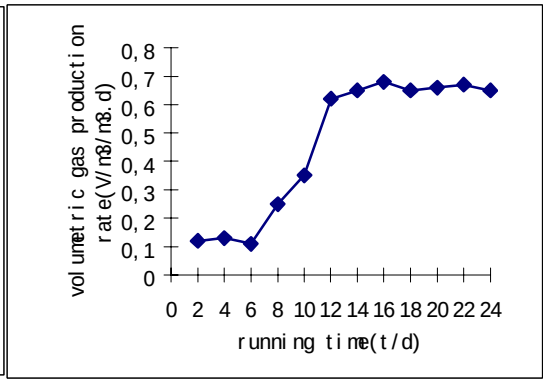

Fig.5: Change of volumetric biogas production rate

4 SUMMARY OF ACTIVITIES

Under the efforts of all the engineers, technicians and workers from BEB, Guojiao, BRTC and Katani, the construction of UNIDO Sisal Biogas Project at Halle in Tanzania is overall completed. Equipment commissioning and trial operation is going normal. The following is the summary of the project construction and commissioning.

4.1 General

The installation and commissioning of the whole biogas plant have been carried out under the BEB controlling and project time schedule. The Tanzanian team which consists of managers, engineers, technicians and works on the Job side has followed strictly BEB time schedule and guide to start the trial test and operation of the biogas plant. As soon as the start up phase finished, a technical acceptance test has been taken place at the project site on 13 August. Then after, BEB has done further supervision and guide to counterpart. When the operation performances of the biogas plant reached designed parameters, the Hand-Over has been done by BEB and counterpart (TSB/Katani) on 29 September under the management of UNIDO.

4.2 Technical acceptance

The whole project construction and installation completely finished at the mid of April 2007. Then the start up of biological process and the trial test of the biogas plant begun. Base on the clause 3.09 of the Contract (No. 16001023) between BEB and UNIDO, an acceptance test has been taken place by BEB, Tanzania Sisal Board and Katani on 13 August. All components of the biogas plant including the construction, installation and performance have been inspected and examined respectively during the technical acceptance test.

The results of the technical acceptance test showed that the main components of the biogas plant have passed this examination without big problem. This inspection, which has been done by BEB team and counterpart team, is affirmatively accord with the demands of designing and Chinese relevant Standard. However, some defects and shortcomings about the plant have been detected, and the problems which have been found through this examination have to be rectified until Hand-over.

The documents concerning the technical acceptance test of the biogas plant has been presented in Appendix 1.

4.3 Hand-Over

After 3 months trial operation, the main parameters have been reached the demands of the design for the demonstration biogas plant. On the 29th September, the performances of the plant and the components have been evaluated again together with the counterparts TSB and Katani Ltd. according to the contract clauses 3.11 and 3.12. The counterparts accepted the hand-over with some restrictions. BEB is willing to rectify the open points which have noted in the hand over protocol. The expected extra equipment which has been mentioned in the hand over protocol has been already purchased by BEB, and will be shipped to project site in next week.

BEB is also agreed to assist to find solutions for forwards utilisation of the biogas such as for cocking system. BEB is willing to further guide and supervision the operation of the biogas plant.

Appendix 2 has shown the complete Hand-over Protocol.

4.4 Practical Training on Project Side

A 2-days practical training has taken place again on the project side by BEB engineer in October 2007 according to the requirement of project counterpart. The participates came from different Sisal Estates in Tanzania. Many sisal producing companies are interesting in the new sisal biogas plant, which has shown a technical and economic possibility to produce biogas, electricity and bio-fertilizer from sisal waste.

The main aim of this training for the local counterpart is to provide the understanding of the technical, operational and safety aspects of the biogas plant on the project side. The local counterpart will be enabled to take responsibility in operation and maintenance of the biogas plant after hand-over.

5 APPENDIX

5.1 Appendix 1: Acceptance test protocol

5.2 Appendix 2: Hand-over protocol

5.3 Appendix 3: Foundation certificate

5.4 Appendix 4: Design and Drawings

- Process flow scheme
- Layout plan with pipeline
- Layout plan with levelling
- Collection tank (B100) – layout
- Pre-storage a. Hydrolise tank (B200) – layout
- CSTR digester tank (B300) – layout
- After storage tank (B400) – layout
- Gasstorage tank (B500) – layout
- Desulphruric tower (K500) – layout
- CHP Unit - layout

5.5 Appendix 5: Manual and maintenance handbook

APPENDIX 1: Acceptance test protocol

PERFORMANCE TEST PROTOCOL

√ ☐ **Intermediate acceptance** ☐ **Final acceptance**

Customer/User	Tanzania Sisal Board/KATANI Ltd
Project:	US/URT/02/117, FC/URT/04/118, SF/URT/05/119
Supplier/Manufacturer:	BEB (Bio Energy Berlin GmbH)
Contract-No.:	16001023
Object/Plant part:	COLLECTION TANK

√ ☐ Installation √ ☐ Build up √ ☐ Performance ☐ Repair measure ☐ Rework

---

The object was jointly inspected on 6th August 2007 and checked out after the following criteria:

√ ☐ Visual Examination / Visual Inspection

√ ☐ Examination on completeness

Remarks: Build up and installation - completed and operates under capacity due to inefficiency of the stirrer and the pump. BEB promised to replace the stirrer and pump.

No further defects were noticed. The object is regarded as passed. √ ☐ Yes ☐ No

Approval under reservation ☐ Yes ☐ No

Hale Eskota 13/08/2007
(Place / date)

Yan Zhifeng BEB
(Signature of Contractors representative)

TANZANIA SISAL BOARD
P.O. BOX 277
TANGA

Signature Customer (TSB)

Signature User (KATANI Ltd)

KATANI LTD
P.O. BOX 123
TANGA

PERFORMANCE TEST PROTOCOL

√ ☐ **Intermediate acceptance** ☐ **Final acceptance**

Customer/User Tanzania Sisal Board/KATANI Ltd

Project: US/URT/02/117, FC/URT/04/118, SF/URT/05/119

Supplier/Manufacturer: BEB (Bio Energy Berlin GmbH)

Contract-No.: 16001023

Object/Plant part: HYDROLYSIS TANK

√ ☐ Installation √ ☐ Build up √ ☐ Performance ☐ Repair measure ☐ Rework

---

The object was jointly inspected on 6th August 2007 and checked out after the following criteria:

√ ☐ Visual Examination / Visual Inspection

√ ☐ Examination on completeness

Remarks: Installation and build up –completed. And performance of all attachments is good. Some parts of the tank such as the manhole cover requires painting with coal tar.

No further defects were noticed. The object is regarded as passed. √ ☐ Yes ☐ No

Approval under reservation ☐ Yes ☐ No

Hale Eshete 17/8/2007
(Place / date)

Yan Zhifang BEB
(Signature of Contractors representative)

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Signature User (KATANI Ltd)

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PERFORMANCE TEST PROTOCOL

√ ☐ **Intermediate acceptance** ☐ **Final acceptance**

Customer/User Tanzania Sisal Board/KATANI Ltd

Project: US/URT/02/117, FC/URT/04/118, SF/URT/05/119

Supplier/Manufacturer: BEB (Bio Energy Berlin GmbH)

Contract-No.: 16001023

Object/Plant part: CSTR - DIGESTER

√ ☐ Installation √ ☐ Build up √ ☐ Performance ☐ Repair measure ☐ Rework

The object was jointly inspected on 6th August 2007 and checked out after the following criteria:

√ ☐ Visual Examination / Visual Inspection

√ ☐ Examination on completeness

Remarks: Build up and Installation– completed and all attachments are working perfectly. Only that the water heating system valves –the EM Valves does not close. The outer parts of the tank need some repainting.

No further defects were noticed. The object is regarded as passed. √ ☐ Yes ☐ No

Approval under reservation ☐ Yes ☐ No

Hale Estate 13/08/2007
(Place / date)

Yan Zhijing BEB
(Signature of Contractors representative)

TANZANIA SISAL BOARD P.O. BOX 277 TANGA

Signature - Customer (TSB)

Signature User (KATANI Ltd)

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PERFORMANCE TEST PROTOCOL

√ ☐ **Intermediate acceptance** ☐ **Final acceptance**

Customer/User Tanzania Sisal Board/KATANI Ltd

Project: US/URT/02/117, FC/URT/04/118, SF/URT/05/119

Supplier/Manufacturer: BEB (Bio Energy Berlin GmbH)

Contract-No.: 16001023

Object/Plant part: DESULPHURIC TOWER

√ ☐ Installation √ ☐ Build up √ ☐ Performance ☐ Repair measure ☐ Rework

---

The object was jointly inspected on 6th August 2007 and checked out after the following criteria:

√ ☐ Visual Examination / Visual Inspection

√ ☐ Examination on completeness

Remarks: Disulphuric tower build up and installation - completed and is operating properly.

No further defects were noticed. The object is regarded as passed. √ ☐ Yes ☐ No

Approval under reservation ☐ Yes ☐ No

Hale Ebute 13/08/2007
(Place / date)

Yan Zhiying BEB
(Signature of Contractors representative)

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PERFORMANCE TEST PROTOCOL

√ ☐ **Intermediate acceptance** ☐ **Final acceptance**

Customer/User Tanzania Sisal Board/KATANI Ltd

Project: US/URT/02/117, FC/URT/04/118, SF/URT/05/119

Supplier/Manufacturer: BEB (Bio Energy Berlin GmbH)

Contract-No.: 16001023

Object/Plant part: GAS STORAGE TANK

√ ☐ Installation √ ☐ Build up √ ☐ Performance ☐ Repair measure ☐ Rework

---

The object was jointly inspected on 6th August 2007 and checked out after the following criteria:

√ ☐ Visual Examination / Visual Inspection

√ ☐ Examination on completeness

Remarks: Gas Storage tank Build up and installation - completed and is operating properly.

No further defects were noticed. The object is regarded as passed. √ ☐ Yes ☐ No

Approval under reservation ☐ Yes ☐ No

Hale Estate 13/08/2007
(Place / date)

Yan Zhiying BEB
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ANGA

Signature User (KATANI Ltd)

PERFORMANCE TEST PROTOCOL

√ ☐ **Intermediate acceptance** ☐ **Final acceptance**

Customer/User Tanzania Sisal Board/KATANI Ltd

Project: US/URT/02/117, FC/URT/04/118, SF/URT/05/119

Supplier/Manufacturer: BEB (Bio Energy Berlin GmbH)

Contract-No.: 16001023

Object/Plant part: SAFETY FLARE

√ ☐ Installation ☐ Build up √ ☐ Performance ☐ Repair measure ☐ Rework

---

The object was jointly inspected on 6th August 2007 and checked out after the following criteria:

√ ☐ Visual Examination / Visual Inspection

√ ☐ Examination on completeness

Remarks: Safety Flare build up and Installation – completed and it is operating

No further defects were noticed. The object is regarded as passed. √ ☐ Yes ☐ No

Approval under reservation ☐ Yes ☐ No

Hale Estate 13/08/2007
(Place / date)

Yan Zhifeng BEB
(Signature of Contractors representative)

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PERFORMANCE TEST PROTOCOL

√ ☐ **Intermediate acceptance** ☐ **Final acceptance**

Customer/User Tanzania Sisal Board/KATANI Ltd

Project: US/URT/02/117, FC/URT/04/118, SF/URT/05/119

Supplier/Manufacturer: BEB (Bio Energy Berlin GmbH)

Contract-No.: 16001023

Object/Plant part: WATER SYSTEM

√ ☐ Installation ☐ Build up ☐ Performance ☐ Repair measure ☐ Rework

---

The object was jointly inspected on 6th August 2007 and checked out after the following criteria:

√ ☐ Visual Examination / Visual Inspection

√ ☐ Examination on completeness

Remarks: Water system Installation – Piping system and one water hydrant installed.
Two water hydrants were required as per drawing but only one was provided in the shipping list.

No further defects were noticed. The object is regarded as passed. ☐ Yes ☐ No

Approval under reservation √ ☐ Yes ☐ No

Hale Tegete 13/08/2007
(Place / date)

Yan Zhifang BEB
(Signature of Contractors representative)

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PERFORMANCE TEST PROTOCOL

√ ☐ **Intermediate acceptance** ☐ **Final acceptance**

Customer/User Tanzania Sisal Board/KATANI Ltd

Project: US/URT/02/117, FC/URT/04/118, SF/URT/05/119

Supplier/Manufacturer: BEB (Bio Energy Berlin GmbH)

Contract-No.: 16001023

Object/Plant part: CHP UNIT

√ ☐ Installation ☐ Build up √ ☐ Performance ☐ Repair measure ☐ Rework

---

The object was jointly inspected on 6th August 2007 and checked out after the following criteria:

√ ☐ Visual Examination / Visual Inspection

√ ☐ Examination on completeness

Remarks: CHP UNIT installation - completed and is operating to 150 kW
Some wire at CHP control system melt. The cause is yet to be established. All the fuses were intact. The battery charging system does not work properly.

No further defects were noticed. The object is regarded as passed. √ ☐ Yes ☐ No

Approval under reservation ☐ Yes ☐ No

Hula Eshete 13/08/2007
(Place / date)

Yan Zhifang BEB
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Signature User (KATANI Ltd)

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PERFORMANCE TEST PROTOCOL

√ ☐ **Intermediate acceptance** ☐ **Final acceptance**

Customer/User Tanzania Sisal Board/KATANI Ltd

Project: US/URT/02/117, FC/URT/04/118, SF/URT/05/119

Supplier/Manufacturer: BEB (Bio Energy Berlin GmbH)

Contract-No.: 16001023

Object/Plant part: CONTROL SYSTEM

√ ☐ Installation ☐ Build up √ ☐ Performance ☐ Repair measure ☐ Rework

---

The object was jointly inspected on 6th August 2007 and checked out after the following criteria:

√ ☐ Visual Examination / Visual Inspection

√ ☐ Examination on completeness

Remarks: Control system Installation – completed and it is operating properly.
But the computer operation system is Chinese Windows 2000.

No further defects were noticed. The object is regarded as passed. √ ☐ Yes ☐ No

Approval under reservation ☐ Yes ☐ No

Hale Ejkte 13/08/2007
(Place / date)

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PERFORMANCE TEST PROTOCOL

√ ☐ **Intermediate acceptance** ☐ **Final acceptance**

Customer/User Tanzania Sisal Board/KATANI Ltd

Project: US/URT/02/117, FC/URT/04/118, SF/URT/05/119

Supplier/Manufacturer: BEB (Bio Energy Berlin GmbH)

Contract-No.: 16001023

Object/Plant part: AFTER STORAGE TANK

√ ☐ Installation √ ☐ Build up √ ☐ Performance ☐ Repair measure ☐ Rework

---

The object was jointly inspected on 6th August 2007 and checked out after the following criteria:

√ ☐ Visual Examination / Visual Inspection

√ ☐ Examination on completeness

Remarks: Build up and Installation - completed and it is operating though the stirrer has no moisture protection sensor.

No further defects were noticed. The object is regarded as passed. √ ☐ Yes ☐ No

Approval under reservation ☐ Yes ☐ No

Hale Eshete 13/8/2007
(Place / date)

Yan Zhiying BBB
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Signature Customer (TSB)

Signature User (KATANI Ltd)

KATANI LTD
P.O. BOX 123
TANGA

APPENDIX 2: Hand-over protocol

Hand Over Protocol for UNIDO Contract N0. 16001023 between UNIDO and the Contractor BEB, Project No. US/URT/02/117 – FC/URT/04/118 – SF/URT/05/119,

1. Type of Protocol

☒ Hand Over protocol

☐ Protocol for technical acceptance

2. Duration of Services:

The duration of the contract was from **29.05.2006 until 29.09.2007**

3. Contractual Obligations:

Provision of services and supply of equipment, materials and parts related to the design, construction, erection, training and commissioning of the pilot demonstration facility for the production, generation and distribution of electricity from biogas produced from sisal leaf waste.

4. Officers involved in the handing over:

This Handing over was carried out in the presence of:

Mr Odhiambo O. Wilson	Director General Tanzania Sisal Board
Mr Salum Shamte,	Managing Director Katani Limited
Mr. Guy Kabengele	Project Engineer Bio-Energy Berlin GmbH
Mr Omari Mduruma	Quality Assurance Manager Tanzania Sisal Board
Mr. Ulimbakisya Malasi	Quality Assurance Officer Tanzania Sisal Board
Lt Col C Rutta	Mechanical Engineer TATC
Ambassador Waziri Juma	Executive Secretary Sisal Association of Tanzania
Mr. Fred Lauwo	Consultant TEMDO
Mr. Francis Nkuba	National Project Coordinator
Mr. Gilead Kissaka	Project Engineer

5. Introductory Remarks:

This handing over does not make null and void the observations made in the technical acceptance report and any other requirements provided in the contract.

6. Guarantees and Claims:

6.1 Guarantee period for rectification of facility components is one year (12 months) from the date of Technical acceptance of 13th August 2007

6.2 The Client shall identify and notify the contractor in writing of the claim for uncompleted work or damage of any part of the facility within the guarantee period.

6.3 The contractor shall complete the works or correct the damage within the specified elimination period as agreed by both parties.

7. Performances check-up yielded following defects:

Please refer to the appendix attached

8. Defects that cannot be removed:

During the handing over no defects were considered to be unremovable.

9. Claims for defects

Claims for defects will be made according to the contract stipulations before expiry of the 12 months of guarantee starting from 13th August 2007

10. Revision of records/certificates/maintenance and instructions

- ☒ Layout and drawing plan
- ☒ Foundation completion certificate
- ☒ Trial test run
- ☒ Acceptance test
- ☒ Inspection and maintenance plan
- ☒ CHP performance certificate
- ☒ Checklist of plant components

The following records are missing and are to be enclosed the end bill
.....NONE.....

11. Contacts and Addresses of Equipment Suppliers

BEB agrees to submit to counterparts all addresses of the suppliers/manufacturers of all plant components and spares

12. Other

.....NOT APPLICABLE.....

13. Handing Over Status

☐ Handed over according to contract and terms of reference without reservations
☑ Handed over according to contract and terms of reference with reservations
☐ Cannot take place because of essential lacks and is put back until to the_____.

SIGNED:

CLIENT

TSB: .....
Signature

Name ODHIAMBO OWUR WILSON

Title DIRECTOR GENERAL

Date 29th September 2007

CONTRACTOR

BEB .....
Signature

Name KARENGELE

Title Mechanical engineer

Date 29.09.07

KATANI LTD.....
Signature

Name: SALUM SHAMTE

Title MANAGING DIRECTOR

Date 29TH SEPTEMBER, 2007

UNIDO.....
Signature

Name: FRANCIS NIUBA

Title NATIONAL PROJECT COORDINATOR

Date 29th SEPTEMBER 2007

TEMDO.....
Signature

Name: FRED LAUWO

Title CHIEF ENGINEER

Date 29-09-2007

APPENDIX

HAND OVER PROTOCOL PER UNIDO CONTRACT NO. 16001023 PROJECT US/URT/02/117, FC/URT/04/118, SF/URT/05/119

This detailed report forms part of the handing over Protocol (Clause 8 and 10)

During handing over of the pilot biogas plant per UNIDO Contract 16001023, the Contractor BEB and the Client/Counterparts TSB and Katani Limited, in the presence of the Sisal Association of Tanzania and TEMDO, agreed to the following:

1.0 GENERAL REMARKS

- Counterparts will seal all tank bottoms and provide gates on all tank ladders.

- Counterparts will regrind and repaint outer parts of all the tanks. Total cost of the paint and labour is estimated at Tsh. 3,000,000. BEB will pay Tsh. 1,500,000 and Counterpart Tsh. 1,500,000.

2.0 COLLECTION TANK

2.1 The Contractor BEB will supply another stirrer within 6 to 8 weeks from the date of handing over. It is recommended that BEB should buy a bigger stirrer to avoid downtime if the small one does not work properly.

2.2 If the new stirrer will not work perfectly BEB will be informed and replace

2.3 The new pump has shown some problems of clogging during pumping. It is yet to be confirmed whether is due to improper stirring or due to low capacity/design of the pump. BEB should supply a bigger pump to save time in case the present one will not work even with proper stirring.

2.0 HYDROLYSIS TANK

Rusting on the inner part of the tank is due to oxidation, which occurs as the tank has open pipes for breathing. It has to be repainted. BEB will buy coal tar and Counterparts will paint the two top plates of 125 square metres. A total of 42 litres of Amercoat paint is required. The time for starting this work will be communicated as soon as Guy discusses with Alexander Boitin. Counterparts at their cost will paint the other inner part of the tank.

3.0 CSTR DIGESTER

- Counterparts to provide a rough walkway to center of the dome.

- Counterparts to provide straps at the outer ring at the top of the tanks.

4.0 DESULPHURIC TOWER

Counterparts to install gas pipes for sample collection as long as the pipe is removed from the gas system during welding

5.0 GAS STORAGE TANK

BEB recommended the use of safety belts when working. Therefore the inner handrail on gas tank was considered not necessary.
The counterparts decided to install handrails and gates at their own cost. BEB agreed that Counterparts can do the work by prefabricating the handrails on the ground, drilling and fixing with bolts the prefabricated handrails.

6.0 WATER SYSTEM

- There is provision for two water hydrants but one is missing. BEB agreed to supply one water hydrant 6 to 8 weeks from the date of handing over.

- TEMDO recommended fire-fighting hoses be provided or mounted close to the water hydrant. They also recommended that expert advise be sought from the fire department on type of equipment required.

7.0 SAFETY FLARE

- BEB agreed to look for a supplier of plastic gas storage tanks and inform the counterparts about their availability and price so that excess gas can be used and not to burn with safety flare.

- Counterparts recommended the use of biogas for cooking at the corona area and if pressure allows use in workers houses close to the factory. BEB supported the idea but recommended the use of one-way water valve before it is supplied for safety of the plant.

8.0 CHP UNIT

BEB promised to find a device to measure and record electricity generated (kW) and consumed (kWh). It was felt important to provide a gas meter before the CHP to read consumption. Counterpart will procure the gas meter.

9.0 CONTROL SYSTEM

Installation of Windows 2000 English version could not be finalized for fear that it would interfere with the existing Chinese program. BEB recommended that Katani IT Officer Mr. Zanta Mnyani install in the computer the three CDs provided. BEB agreed that it was their responsibility to solve the control problem and if Mr. Zanta fails they will send somebody from the suppliers firm to reinstall the programme.

10. AFTER STORAGE TANK

- The stirrer is operating without moisture protection sensor. BEB will provide the sensor within 6 to 8 weeks from the date of handing over.

- As there is no spare stirrer, BEB has agreed to supply spare parts (coil) for stirrer within 6 to 8 weeks from the date of handing over.

- BEB agreed to send price of a new stirrer and purchase at Counterpart cost.

APPENDIX 3: Foundation certificate

TANZANIA SISAL BOARD

CONTRACT FOR CONSTRUCTION OF RAFT FOUNDATIONS FOR BIOGAS PILOT PROJECT AT HALE IN TANGA

CERTIFICATE OF STRENGTH FOR PLAIN AND REINFORCED CONCRETE RAFT FOUNDATIONS

CONTRACTOR:	M.P.INVESTMENT P.O. BOX 6011 TANGA
CONTRACT FOR:	CONSTRUCTION OF COLLECTOR TANK, GAS TANK,AFTER STORAGE TANK, PRESTORAGE TANK, GAS STORAGE TANK AND HYDROLYSIS TANK FOUNDATIONS.
CONSULTANT:	NYIPOLO INVESTMENT P.O.BOX 709 TANGA
MAJOR WORKS:	PLAIN CONCRETE 71M^3 REINFORECED CONRETE CLASS 20 148M^3
STEEL BARS :	16MM DIAMETER 21 METRIC TONES 12MM DIAMETER 1..50 METRIC TONES
CLIENT :	TANZANIA SISAL BOARD P.O.BOX 277 TANGA
PROJECT O. SEER:	KATANI LTD. P.O.BOX 277 TANGA.
PROJECT STATUS:	RAFT FOUNDATIONS WORKS COMPLETED SUCCSESSIFELY

PREPARED BY NYIPOLO INVESTMENT P.O. BOX 709 TANGA	CONSTRUCTION CARRIED BY M.P. INVESTMENT LTD. CIVIL & BUILDING CONTRACTOR P.O. Box 6011 TANGA
TITLE: CONSULTANT	TITLE : CONTRACTOR.....
NAME..NYIPOLO INVESTMENT.....	NAME : M. P. INVESTMENT LTD
SIGNATURE..... DATE..9/2/07	SIGNATURE..... DATE..8.2.2007

TANROADS
TANZANIA NATIONAL ROADS AGENCY

TANLAB

WORKING SHEET

Compressive Strength of Concrete Cubes/Blocks

Project. **Biogas Plant Hale**	Location. **Hale**	Contractor. M.P.INVESTMENT.
Client: **M.P.Investment Co Ltd**	Lab. No: **C 067**	Date: 24/11/06
Responsible Technician: JOEL	Checked: **B.U.Massawe**	Approved:

TEST METHOD CML TEST 2.13, ref. BS 1881: Part 116: 1983			
Construction part: **Foundation Base (Gas Tank)**			
Conditions of curing: SOAKED	Sampling		
Condition at testing: AIR DRY	Time	Date: **17/11/06**	Operator
Cement Type: **OPC**	Concrete Class: **20**		
Additive: **NIL**	Aggregate :**LIMESTONE**		
Method of Compaction: **TAMPING ROD**	MIX RATIO: **1:2:4**		

Cube Marking	Cube Size W x D x H (mm x mm x mm)	Mass of Cube (g)	Density (g/dm^3)	Test Load (KN)	Date Made	Date tested	Age of Cube (Days)	Cube Strength MPa	Type of failure
1.	150 x 150 x 150	8320	2465	351	17/11/06	24/11/06	7	15.6	Normal
2.	150 x 150 x 150	8240	2441	367	17/11/06	24/11/06	7	16.3	
3	150 x 150 x 150	8315	2464	335	17/11/06	24/11/06	7	14.9	
							Avg:15.6N/mm^2		

REMARKS: The avg. crushing strength of 15.6 for a class 20 Concrete for 7 days is acceptable.

Date: 24/11/2006

Signed by: .....

For: REGIONAL MANAGER
TANROADS – TANGA.

For: REGIONAL MANAGER
TANROADS
TANZANIA NATIONAL ROADS AGENCY
P. O. Box
TANGA

TANROADS
TANZANIA NATIONAL ROADS AGENCY

TANLAB

WORKING SHEET

Compressive Strength of Concrete Cubes/Blocks

Project: Biogas Plant Hale	Location: Hale	Contractor: M.P. Investiment
Client: M.P.Investiment Co. Ltd	Lab. No: C 067	Date: 22/11/06
Responsible Technician: Joel	Checked: B.U.Massawe	Approved:

TEST METHOD: CML TEST 2.13, ref. BS 1881: Part 116: 1983

Construction part: **Foundation Base (GasTanks)**

Conditions of curing: **SOAKED**	Sampling		
Condition at testing: **AIR DRY**	Time	Date: **24/12/06**	Operator
Cement Type: **OPC**	Concrete Class: **20**		
Additive: **NIL**	Aggregate : **Limestone**		
Method of Compaction: **TAMPING ROD**	MIX RATIO:		

Cube Marking	Cube Size W x D x H (mm x mm x mm)	Mass of Cube (g)	Density (g/dm^3)	Test Load (KN)	Date Made	Date tested	Age of Cube (Days)	Cube Strength MPa	Type of failure
1.	150 x 150 x 150	8490	2516	551	24/11/06	22/12/06	28	24.5	Normal
2.	150 x 150 x 150	8650	2563	565	24/11/06	22/12/06	28	25.1	
3	150 x 150 x 150	8290	2456	556	24/11/06	22/12/06	28	24.7	
								AVG: 24.8	

REMARKS: The avg. crushing strength of 24.8 MPa for a class 20 concrete cured for 28 is acceptable.

Date: 22/11/2006

Signed by:.....

For: REGIONAL MANAGER

For: REGIONAL MANAGER
TANROADS
TANZANIA NATIONAL ROADS AGENCY
P. O. Box 5021
TANGA

TANROADS

TANZANIA NATIONAL ROADS AGENCY

TANLAB

WORKING SHEET

Compressive Strength of Concrete Cubes/Blocks

Project: **Biogas Plant Hale**	Location: Hale	Contractor: **M.P. Investiment.**
Client: **M.P.Investiment Co. Ltd .**	Lab. No: C 067	Date: **09/11/06**
Responsible Technician: **Joel**	Checked: B.U.Massawe	Approved:

TEST METHOD CML TEST 2.13, ref. BS 1881: Part 116: 1983

Construction part: **BLINDING AFTER STORAGE TANK.**

Conditions of curing: **SOAKED**	Sampling		
Condition at testing: **AIR DRY**	Time	Date: **02/11/06**	Operator: **Joel**
Cement Type: **OPC**	Concrete Class: **10**		
Additive: **NIL**	Aggregate : **Limestone**		
Method of Compaction: **TAMPING ROD**	MIX RATIO: **1:4:8**		

Cube Marking	Cube Size W x D x H (mm x mm x mm)	Mass of Cube (g)	Density (g/dm^3)	Test Load (KN)	Date Made	Date tested	Age of Cube (Days)	Cube Strength MPa	Type of failure
1.	150 x 150 x 150	8490	2516	151	02/11/06	09/11/06	7	6.7	Normal
2.	150 x 150 x 150	8470	2510	178	02/11/06	09/11/06	7	7.9	
3	150 x 150 x 150	8530	2527	153	02/11/6	09/11/06	7	6.8	
								AVG: 7.1	

REMARKS: **The avg. crushing strength of 7.1 MPa for a class 10 concrete cured for 7 days meets requirement strength.**

Date: 09/11/2006

Signed by:.....

For: REGIONAL MANAGER

For: REGIONAL MANAGER
TANROADS
TANZANIA NATIONAL ROADS AGENCY
P. O. Box 5021
TANGA

TANROADS
TANZANIA NATIONAL ROADS AGENCY

TANLAB

WORKING SHEET

Compressive Strength of Concrete Cubes/Blocks

Project: Biogas Plant Hale.	Location: Hale	Contractor: **M.P. Investiment.**
Client: M.P.Investiment **Co. Ltd**	Lab. No: C 067	Date. **09/11/06**
Responsible Technician: **Joel**	Checked: B.U.Massawe	Approved:

TEST METHOD CML TEST 2.13, ref. BS 1881: Part 116: 1983

Construction part: **BLINDING AFTER STORAGE TANK.**

Conditions of curing: **SOAKED**	Sampling		
Condition at testing: **AIR DRY**	Time	Date: **02/11/06**	Operator: **Joel**
Cement Type: **OPC**	Concrete Class: **10**		
Additive: **NIL**	Aggregate : **Limestone**		
Method of Compaction: **TAMPING ROD**	MIX RATIO:		

Cube Marking	Cube Size W x D x H (mm x mm x mm)	Mass of Cube (g)	Density (g/dm^3)	Test Load (KN)	Date Made	Date tested	Age of Cube (Days)	Cube Strength MPa	Type of failure
1.	150 x 150 x 150	8320	2465	286	02/11/06	30/11/06	28	12.7	Normal
2.	150 x 150 x 150	8420	2495	294	02/11/06	30/11/06	28	13.1	
							Avg. 12.9		

REMARKS: The avg. crushing strength of 12.9MPa for a class 10 concrete cured for 28days is acceptable.

Date:

Signed by:.....

For: REGIONAL MANAGER
TANROADS – TANGA.

For: REGIONAL MANAGER
TANROADS
TANZANIA NATIONAL ROADS AGENCY
P. O. Box 5001
TANGA

...terials Laboratory	Biogas Plant at Hale Estate	TANROADS

SIZE:(mm) Aggregate 20mm | Sample. Agg 34 | DATE. 28/11/2006

CLIENT: MP Investment Ltd

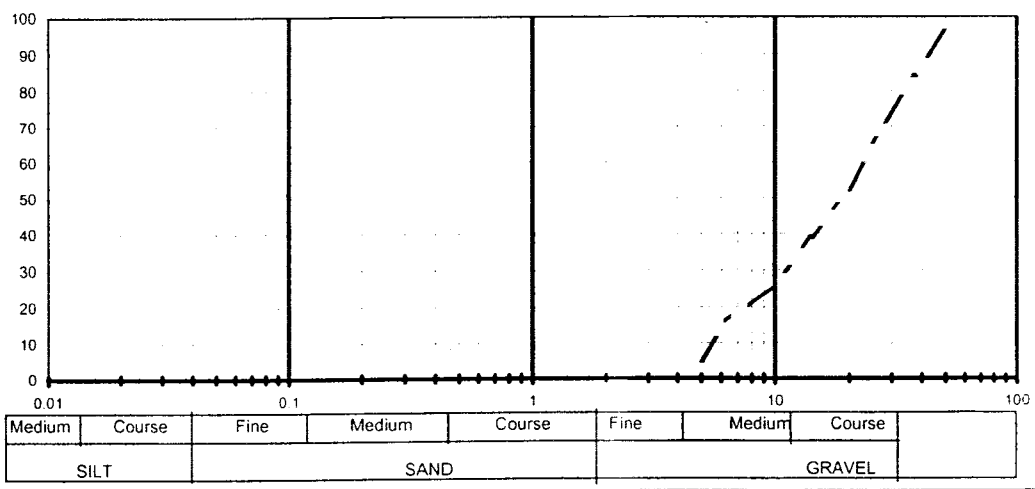
LOCATION: Amboni Quarry | **Name of Operator:** Alo...

Data entry

sieve size(mm)	Passing	Grading Requirement High	Grading Requirement Low
50			
37 5			
28	100		
20	96		
14	84		
10	71		
6 3	52		
5	39		
2 36	26		
0 425	16		
0.075	5		

Fakiness Index	19.8
TFV 10% Fines	

Particle Size Analysis



REMARKS: The aggregates meet requirement of BS 882:1992

Date: 28/11/2006

Signed by: .....

For: REGIONAL MANAGER
TANROADS - TANGA

For: REGIONAL ...
TANROADS
TANZANIA NATIONAL ROADS AGENCY
P. O. Box 5021
TANGA

Materials Laboratory	Biogas Plant at Hale Estate	TANROADS

SIZE:(mm) Aggregate 5mm | Sample. **Agg 34** | DATE: 28/11/2006

CLIENT: MP Investment Ltd

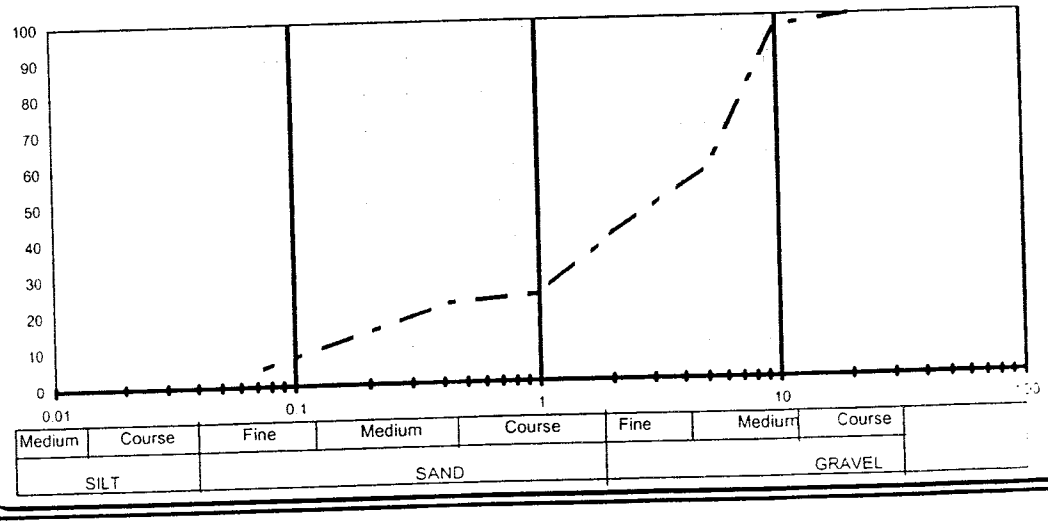
LOCATION: Amboni River Sand | Name of Operator: Joel

Data entry

sieve size(mm)	%passing	Grading Requirement High	Grading Requirement Low
50			
37 5			
28			
20	100		
10	97		
5	58		
2	40		
1	24		
0 425	22		
0.075	5		

Liquid Limit	NP
Plastic Limit	NP
Plasticicity Index %	NP
Linear Shrinkage%	
Flakiness Index %	
TFV 10% Fines	

Particle Size Analysis



REMARKS:

Date: 28/11/2006

Signed by: .....

For: REGIONAL MANAGER
TANROADS - TANGA

For: REGIONAL MANAGER
TANROADS
TANZANIA NATIONAL ROADS AGENCY
P. O. Box 5..
TANGA

TANROADS TANZANIA NATIONAL ROADS AGENCY TANLAB	WORKING SHEET Flakiness Index - FI Average Least Dimension - ALD Crushed Stone base

Project: Biogas Plant Hale	Location: Amboni Quarry	Depth:
Client: MP Investment Ltd	Lab. No. AGG 34	Date: 29/11/2006
Responsible Technician: Joel	Checked: B. U. Masawe	Approved:

TEST METHOD	CML TEST 2.4, ref. BS 812 : Section 105. 1 : 1989

		Fraction Gauged						
Passing sieve	mm	63	50	37.5	28	20	14	10
Retained on sieve	mm	56	37.5	28	20	14	10	6.3
Slots width	mm	33.9	26.3	19.7	14.4	10.2	7.2	4.9
Fraction Gauged	x				**516.99**	**855.53**	**266.52**	**34.97**

Before Gauging								
Mass of tray + Aggregate fraction	g							
Mass of tray	g							
Mass of Aggregate fraction M_o	g				653.07	1017.5	318.4	43.92
Individual percentage $M_o/M_1 \times 100$	%				32.13	50.05	15.66	2.16
Sum of Aggregates mass M_1	g	2032.89						
Sum of fractions less than 5% of M_1	g	2.16						
Remaining sum of Aggregate mass M_2	g	1816.89						

After Gauging		
Mass of tray + Sum of Aggregate passing slots	g	
Mass of tray	g	
Sum of Aggregate mass passing slots M_3	g	359.88
Flakines Index FI **= $M_3/M_2 \times 100$**	%	19.8

Average Least Dimension		
Median size (the sieve size through which 50% pass)	mm	
Average Least Dimension - ALD (determined from nomograph)	mm	

29/11/2006
Date

INCHARGE - TANLAB

For: REGIONAL MANAGER
TANROADS
TANZANIA NATIONAL ROADS AGENCY
P. O. Box 9021
TANGA

APPENDIX 3: Foundation certificate

TANZANIA SISAL BOARD

CONTRACT FOR CONSTRUCTION OF RAFT FOUNDATIONS FOR BIOGAS PILOT PROJECT AT HALE IN TANGA

CERTIFICATE OF STRENGTH FOR PLAIN AND REINFORCED CONCRETE RAFT FOUNDATIONS

CONTRACTOR:	M.P.INVESTMENT P.O. BOX 6011 TANGA
CONTRACT FOR:	CONSTRUCTION OF COLLECTOR TANK, GAS TANK,AFTER STORAGE TANK, PRESTORAGE TANK, GAS STORAGE TANK AND HYDROLYSIS TANK FOUNDATIONS.
CONSULTANT:	NYIPOLO INVESTMENT P.O.BOX 709 TANGA
MAJOR WORKS:	PLAIN CONCRETE 71M^3 REINFORECED CONRETE CLASS 20 148M^3
STEEL BARS :	16MM DIAMETER 21 METRIC TONES 12MM DIAMETER 1..50 METRIC TONES
CLIENT :	TANZANIA SISAL BOARD P.O.BOX 277 TANGA
PROJECT O. SEER:	KATANI LTD. P.O.BOX 277 TANGA.
PROJECT STATUS:	RAFT FOUNDATIONS WORKS COMPLETED SUCCSESSIFELY

PREPARED BY NYIPOLO INVESTMENT P.O. BOX 709 TANGA	CONSTRUCTION CARRIED BY M.P. INVESTMENT LTD. CIVIL & BUILDING CONTRACTOR P.O. Box 6011 TANGA
TITLE: CONSULTANT	TITLE : CONTRACTOR.....
NAME..NYIPOLO INVESTMENT.....	NAME : M. P. INVESTMENT LTD
SIGNATURE..... DATE..9/2/07	SIGNATURE..... DATE..8.2.2007

TANROADS
TANZANIA NATIONAL ROADS AGENCY

TANLAB

WORKING SHEET

Compressive Strength of Concrete Cubes/Blocks

Project. **Biogas Plant Hale**	Location. **Hale**	Contractor. M.P.INVESTMENT.
Client: **M.P.Investment Co Ltd**	Lab. No: **C 067**	Date: 24/11/06
Responsible Technician: JOEL	Checked: **B.U.Massawe**	Approved:

TEST METHOD CML TEST 2.13, ref. BS 1881: Part 116: 1983			
Construction part: **Foundation Base (Gas Tank)**			
Conditions of curing: SOAKED	Sampling		
Condition at testing: AIR DRY	Time	Date: **17/11/06**	Operator
Cement Type: **OPC**	Concrete Class: **20**		
Additive: **NIL**	Aggregate :**LIMESTONE**		
Method of Compaction: **TAMPING ROD**	MIX RATIO: **1:2:4**		

Cube Marking	Cube Size W x D x H (mm x mm x mm)	Mass of Cube (g)	Density (g/dm^3)	Test Load (KN)	Date Made	Date tested	Age of Cube (Days)	Cube Strength MPa	Type of failure
1.	150 x 150 x 150	8320	2465	351	17/11/06	24/11/06	7	15.6	Normal
2.	150 x 150 x 150	8240	2441	367	17/11/06	24/11/06	7	16.3	
3	150 x 150 x 150	8315	2464	335	17/11/06	24/11/06	7	14.9	
							Avg:15.6N/mm^2		

REMARKS: The avg. crushing strength of 15.6 for a class 20 Concrete for 7 days is acceptable.

Date: 24/11/2006

Signed by: .....

For: REGIONAL MANAGER
TANROADS – TANGA.

For: REGIONAL MANAGER
TANROADS
TANZANIA NATIONAL ROADS AGENCY
P. O. Box
TANGA

TANROADS
TANZANIA NATIONAL ROADS AGENCY

TANLAB

WORKING SHEET

Compressive Strength of Concrete Cubes/Blocks

Project: Biogas Plant Hale	Location: Hale	Contractor: M.P. Investiment
Client: M.P.Investiment Co. Ltd	Lab. No: C 067	Date: 22/11/06
Responsible Technician: Joel	Checked: B.U.Massawe	Approved:

TEST METHOD: CML TEST 2.13, ref. BS 1881: Part 116: 1983

Construction part: **Foundation Base (GasTanks)**

Conditions of curing: **SOAKED**	Sampling		
Condition at testing: **AIR DRY**	Time	Date: **24/12/06**	Operator
Cement Type: **OPC**	Concrete Class: **20**		
Additive: **NIL**	Aggregate : **Limestone**		
Method of Compaction: **TAMPING ROD**	MIX RATIO:		

Cube Marking	Cube Size W x D x H (mm x mm x mm)	Mass of Cube (g)	Density (g/dm^3)	Test Load (KN)	Date Made	Date tested	Age of Cube (Days)	Cube Strength MPa	Type of failure
1.	150 x 150 x 150	8490	2516	551	24/11/06	22/12/06	28	24.5	Normal
2.	150 x 150 x 150	8650	2563	565	24/11/06	22/12/06	28	25.1	
3	150 x 150 x 150	8290	2456	556	24/11/06	22/12/06	28	24.7	
								AVG: 24.8	

REMARKS: The avg. crushing strength of 24.8 MPa for a class 20 concrete cured for 28 is acceptable.

Date: 22/11/2006

Signed by:.....

For: REGIONAL MANAGER

For: REGIONAL MANAGER
TANROADS
TANZANIA NATIONAL ROADS AGENCY
P. O. Box 5021
TANGA

TANROADS

TANZANIA NATIONAL ROADS AGENCY

TANLAB

WORKING SHEET

Compressive Strength of Concrete Cubes/Blocks

Project: **Biogas Plant Hale**	Location: Hale	Contractor: **M.P. Investiment.**
Client: **M.P.Investiment Co. Ltd .**	Lab. No: C 067	Date: **09/11/06**
Responsible Technician: **Joel**	Checked: B.U.Massawe	Approved:

TEST METHOD CML TEST 2.13, ref. BS 1881: Part 116: 1983

Construction part: **BLINDING AFTER STORAGE TANK.**

Conditions of curing: **SOAKED**	Sampling		
Condition at testing: **AIR DRY**	Time	Date: **02/11/06**	Operator: **Joel**
Cement Type: **OPC**	Concrete Class: **10**		
Additive: **NIL**	Aggregate : **Limestone**		
Method of Compaction: **TAMPING ROD**	MIX RATIO: **1:4:8**		

Cube Marking	Cube Size W x D x H (mm x mm x mm)	Mass of Cube (g)	Density (g/dm^3)	Test Load (KN)	Date Made	Date tested	Age of Cube (Days)	Cube Strength MPa	Type of failure
1.	150 x 150 x 150	8490	2516	151	02/11/06	09/11/06	7	6.7	Normal
2.	150 x 150 x 150	8470	2510	178	02/11/06	09/11/06	7	7.9	
3	150 x 150 x 150	8530	2527	153	02/11/6	09/11/06	7	6.8	
								AVG: 7.1	

REMARKS: **The avg. crushing strength of 7.1 MPa for a class 10 concrete cured for 7 days meets requirement strength.**

Date: 09/11/2006

Signed by:.....

For: REGIONAL MANAGER

For: REGIONAL MANAGER
TANROADS
TANZANIA NATIONAL ROADS AGENCY
P. O. Box 5021
TANGA

TANROADS
TANZANIA NATIONAL ROADS AGENCY

TANLAB

WORKING SHEET

Compressive Strength of Concrete Cubes/Blocks

Project: Biogas Plant Hale.	Location: Hale	Contractor: **M.P. Investiment.**
Client: M.P.Investiment **Co. Ltd**	Lab. No: C 067	Date. **09/11/06**
Responsible Technician: **Joel**	Checked: B.U.Massawe	Approved:

TEST METHOD CML TEST 2.13, ref. BS 1881: Part 116: 1983

Construction part: **BLINDING AFTER STORAGE TANK.**

Conditions of curing: **SOAKED**	Sampling		
Condition at testing: **AIR DRY**	Time	Date: **02/11/06**	Operator: **Joel**
Cement Type: **OPC**	Concrete Class: **10**		
Additive: **NIL**	Aggregate : **Limestone**		
Method of Compaction: **TAMPING ROD**	MIX RATIO:		

Cube Marking	Cube Size W x D x H (mm x mm x mm)	Mass of Cube (g)	Density (g/dm^3)	Test Load (KN)	Date Made	Date tested	Age of Cube (Days)	Cube Strength MPa	Type of failure
1.	150 x 150 x 150	8320	2465	286	02/11/06	30/11/06	28	12.7	Normal
2.	150 x 150 x 150	8420	2495	294	02/11/06	30/11/06	28	13.1	
							Avg. 12.9		

REMARKS: The avg. crushing strength of 12.9MPa for a class 10 concrete cured for 28days is acceptable.

Date:

Signed by:.....

For: REGIONAL MANAGER
TANROADS – TANGA.

For: REGIONAL MANAGER
TANROADS
TANZANIA NATIONAL ROADS AGENCY
P. O. Box 5001
TANGA

...terials Laboratory	Biogas Plant at Hale Estate	TANROADS

SIZE:(mm) Aggregate 20mm | Sample. Agg 34 | DATE. 28/11/2006

CLIENT: MP Investment Ltd

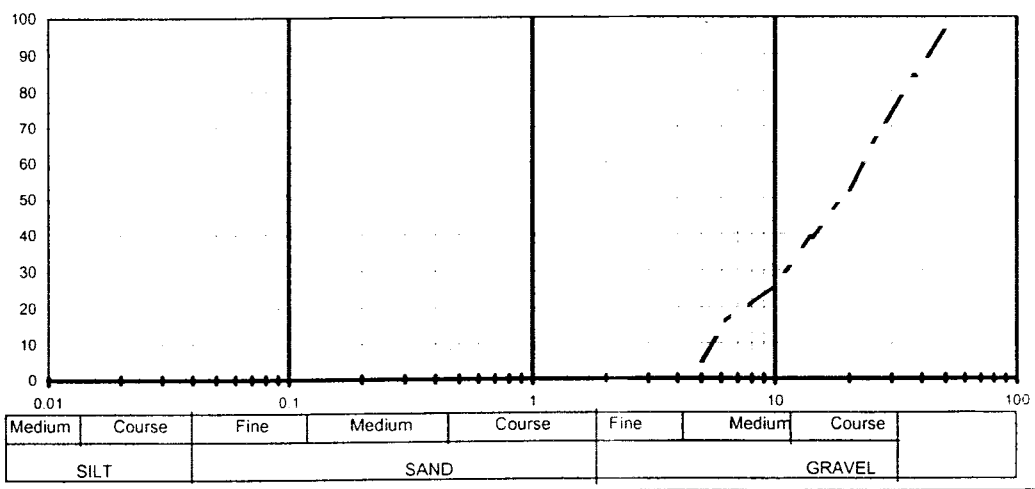
LOCATION: Amboni Quarry | **Name of Operator:** Alo...

Data entry

sieve size(mm)	Passing	Grading Requirement High	Grading Requirement Low
50			
37 5			
28	100		
20	96		
14	84		
10	71		
6 3	52		
5	39		
2 36	26		
0 425	16		
0.075	5		

Fakiness Index	19.8
TFV 10% Fines	

Particle Size Analysis



REMARKS: The aggregates meet requirement of BS 882:1992

Date: 28/11/2006

Signed by: .....

For: REGIONAL MANAGER
TANROADS - TANGA

For: REGIONAL ...
TANROADS
TANZANIA NATIONAL ROADS AGENCY
P. O. Box 5021
TANGA

Materials Laboratory	Biogas Plant at Hale Estate	TANROADS

SIZE:(mm) Aggregate 5mm | Sample. **Agg 34** | DATE: 28/11/2006

CLIENT: MP Investment Ltd

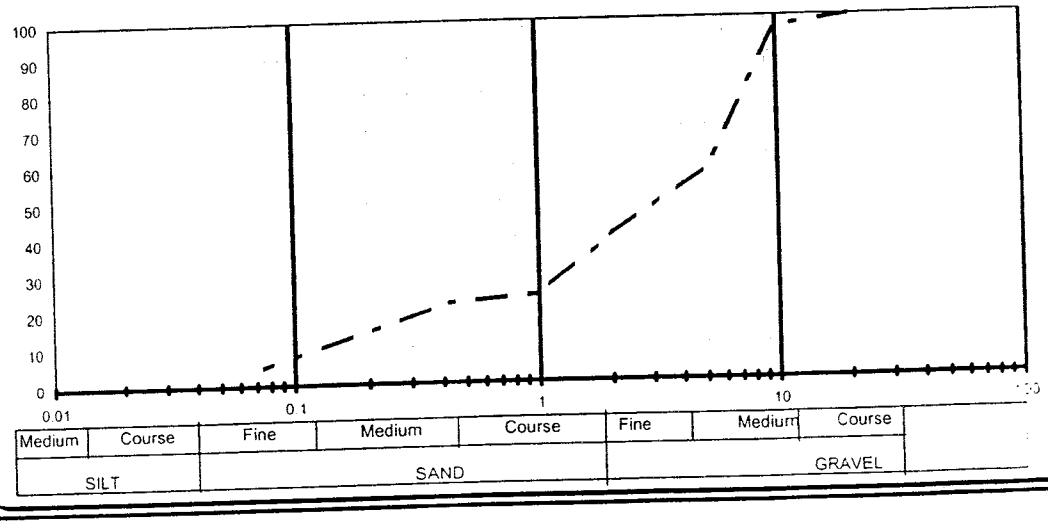
LOCATION: Amboni River Sand | Name of Operator: Joel

Data entry

sieve size(mm)	%passing	Grading Requirement High	Grading Requirement Low
50			
37 5			
28			
20	100		
10	97		
5	58		
2	40		
1	24		
0 425	22		
0.075	5		

Liquid Limit	NP
Plastic Limit	NP
Plasticicity Index %	NP
Linear Shrinkage%	
Flakiness Index %	
TFV 10% Fines	

Particle Size Analysis



REMARKS:

Date: 28/11/2006

Signed by: .....

For: REGIONAL MANAGER
TANROADS - TANGA

For: REGIONAL MANAGER
TANROADS
TANZANIA NATIONAL ROADS AGENCY
P. O. Box 5..
TANGA

TANROADS TANZANIA NATIONAL ROADS AGENCY TANLAB	WORKING SHEET Flakiness Index - FI Average Least Dimension - ALD Crushed Stone base

Project: Biogas Plant Hale	Location: Amboni Quarry	Depth:
Client: MP Investment Ltd	Lab. No. AGG 34	Date: 29/11/2006
Responsible Technician: Joel	Checked: B. U. Masawe	Approved:

TEST METHOD	CML TEST 2.4, ref. BS 812 : Section 105. 1 : 1989

		Fraction Gauged						
Passing sieve	mm	63	50	37.5	28	20	14	10
Retained on sieve	mm	56	37.5	28	20	14	10	6.3
Slots width	mm	33.9	26.3	19.7	14.4	10.2	7.2	4.9
Fraction Gauged	x				**516.99**	**855.53**	**266.52**	**34.97**

Before Gauging								
Mass of tray + Aggregate fraction	g							
Mass of tray	g							
Mass of Aggregate fraction M_o	g				653.07	1017.5	318.4	43.92
Individual percentage $M_o/M_1 \times 100$	%				32.13	50.05	15.66	2.16
Sum of Aggregates mass M_1	g	2032.89						
Sum of fractions less than 5% of M_1	g	2.16						
Remaining sum of Aggregate mass M_2	g	1816.89						

After Gauging		
Mass of tray + Sum of Aggregate passing slots	g	
Mass of tray	g	
Sum of Aggregate mass passing slots M_3	g	359.88
Flakines Index FI **= $M_3/M_2 \times 100$**	%	19.8

Average Least Dimension		
Median size (the sieve size through which 50% pass)	mm	
Average Least Dimension - ALD (determined from nomograph)	mm	

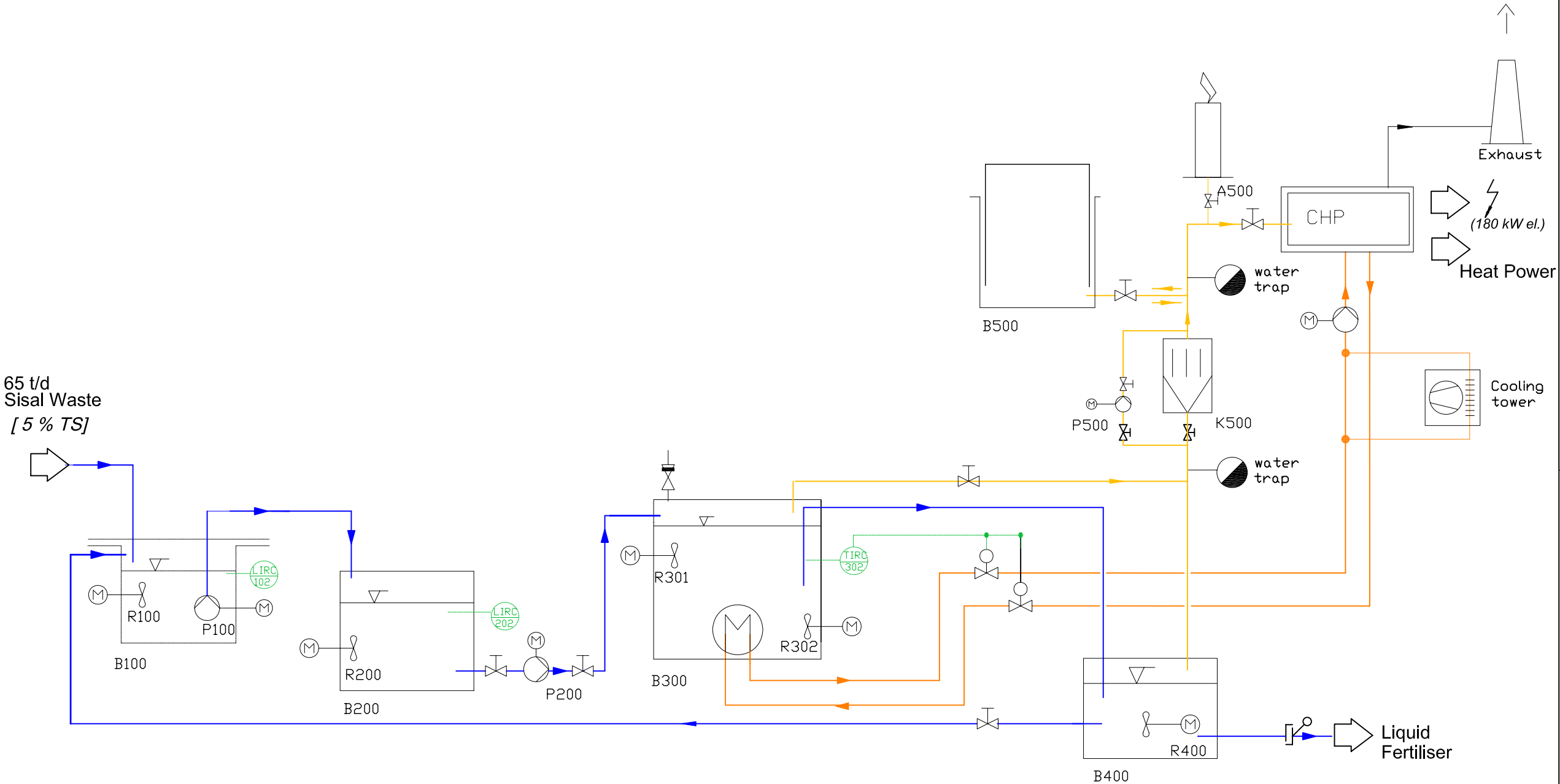
29/11/2006
Date

INCHARGE - TANLAB

For: REGIONAL MANAGER
TANROADS
TANZANIA NATIONAL ROADS AGENCY
P. O. Box 9021
TANGA

APPENDIX 4: Design and Drawings

- Process flow scheme
- Layout plan with pipeline
- Layout plan with levelling
- Collection tank (B100) – layout
- Pre-storage a. Hydrolise tank (B200) – layout
- CSTR digester tank (B300) – layout
- After storage tank (B400) – layout
- Gasstorage tank (B500) – layout
- Desulphruric tower (K500) – layout
- CHP Unit - layout



Legende

B100	Collection Tank
B200	Prestorage & Hydrolisetank
B300	Digester Tank
B400	After storage Tank
K500	Desulphuric Tower
A500	Gasflare
P100	Substrat pump
P200	Substrat pump
P500	Water pump
R100	Stirrer B100
R200	Stirrer B200
R301	Stirrer B300
R302	Stirrer B300
R400	Stirrer B400

EQUIPMENT NUMMER		B100	B200	B300	B400	B500	K500	CHP	A500	P100	P200	P500	R100	R200	R301	R302	R400
DESIGNATION		Collection-tank	Pre-storage a Hydrolisetank	Digester tank	After sto-rage tank	Gasstorage tank	Desulphuric tower	Modul	Gasflare	Submerble pump	Excentric-pump	water-pump	Stirrer Collecting	Stirrer Prestorage	Stirrer Digester		Stirrer After storage
TECHNICAL SPEZIFICATION	m	Ø5 x 2.5	Ø8 x 6	Ø16,9x 7,5	Ø10,5 x 6	Ø10,5 x 6,5	Ø1,6x6	4,3 x 2,1 x 3	1,5 x 1,5x4	/	/	/	/	/	/		/
	m³	50	300	1700	500	350	12	/	350	/	/	/	/	/	/		/
	m³/h		/	/	/	/	/	/	/	15	15	3	/	/	/		/
	kW		/	/	/	/	/	180 el.	/	4	4	0,5	4	15	15		15
RENTENTION TIME	Day		5	28	15	1	1	/	1	/	/	/	/	/	/		/
ALLOWED OVERPRESSURE	bar		0,035	0,035	0,035	0,035	/	/	0,035	3	10	1	Atm.	Atm.	Atm.		Atm.
ALLOWED WORK. TEMP.	°C		50	60	60	60	Atm.	/	60	50	50	50	0-60	0-60	0-60		0-60
MATERIAL		Concret	St.	St.	St.	St.	St.	St.	St.	casting	casting / St.	St. / VA	St. / VA	St. / VA	St. / VA		St. / VA

Projectname:

Cleaner Integral Utilisation of Sisal Waste
f. Biogas a. Biofertilizers

Drawingsname:

Biogas Plant at Hale Estate
PEFS- Scheme (Update- Final report)

BioEnergyBerlin
Köpernicker Str. 325
Germany-12555 Berlin
Tel. +4930-65763254
Fax +4930-65763256

Contractor:

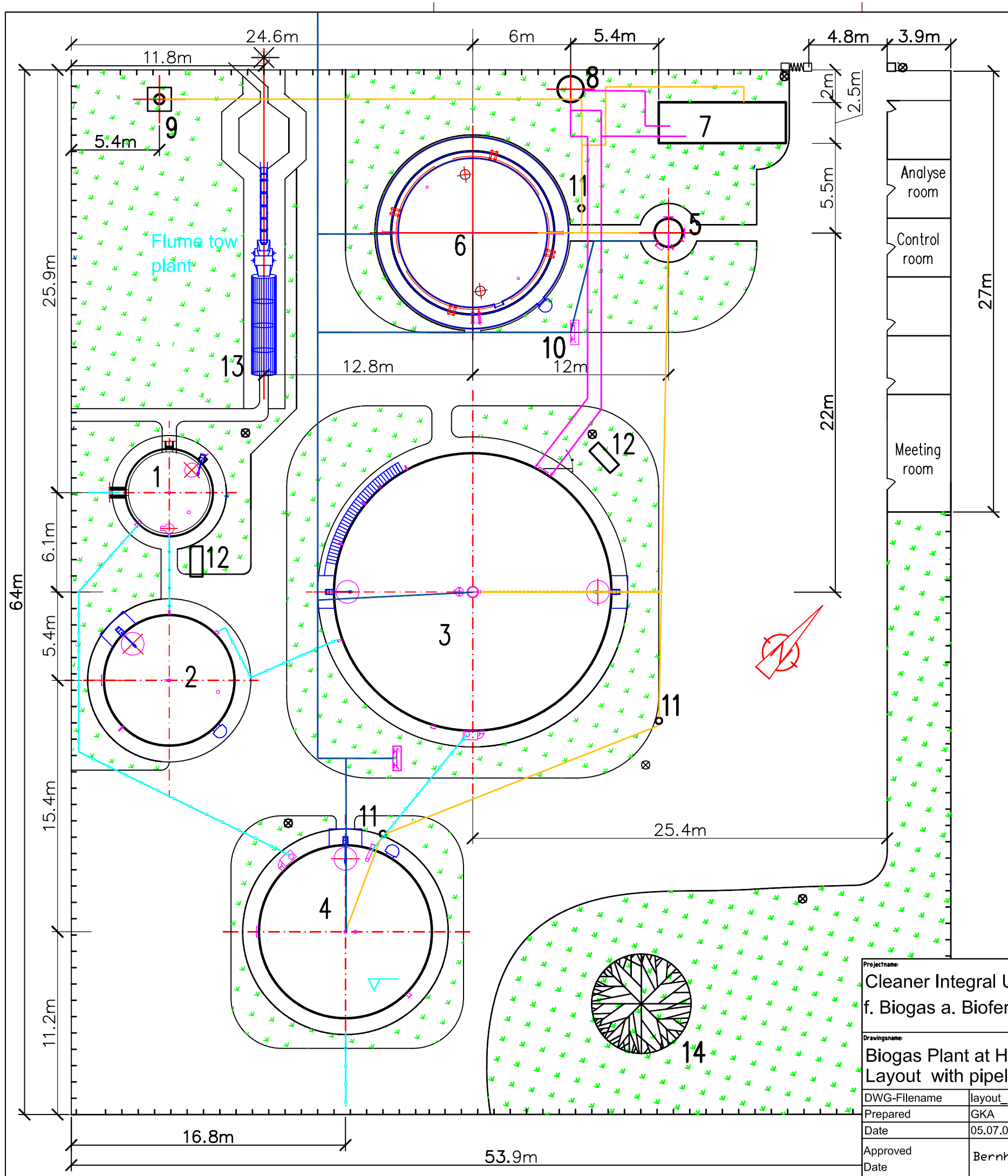
UNIDO
Wagramer Str. 5 A-1220 Vienna

DWG-Filename	Flow Scheme_update.dwg	Contract Nr.: 16001023	Project-Nr.: 06.026
Prepared	GKA	Modified	GKA
Date	06.07.2006	Date	29.09.2007
Approved		Revision-Nr.	
Date		Old DWG-Filename	

Drawing-Nr.

Size DIN A3

Scale



Legend

- Substrate Pipe
- Gas Pipe
- Heating Pipe
- Water Pipe

POS.	EQUIPMENT NUMBER	DESIGNATION	TECHNICAL SPEZIFICATION	
			m	m³
1	B100	Collection-tank	Ø5x2.5	50
2	B200	Pre-storage a. Hydrolisetank	Ø8 x 6	300
3	B300	Methanizer tank	Ø16,9x 7,5	1700
4	B400	Outlet storage tank	Ø10,5 x 6	500
5	K500	Desulphic tower	Ø1,6 x 6,0	
6	B500	Gasstorage	Ø10,5 x 6,7	350
7	CHP	Modul in Container	1,77x 1,14 x 1,35	
8		Water cooling tower for CHP		
9		Safety flare		
10		Fire Block		
11		Condensate pit		
12		Outdoor panel switch		
13		Flume tow plant		
14		Tree a. Stony area		

Projectname:
Cleaner Integral Utilisation of Sisal Waste
f. Biogas a. Biofertilizers

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Germany-12555 Berlin
Tel. +4930-65763254
Fax +4930-65763256

Drawingsname:
Biogas Plant at Hale Estate
Layout with pipeline System (Update Final report)

Contractor:
UNIDO
Wagramer Str. 5 A-1220 Vienna

DWG-Filename	layout_piping_system_bga_tansania.dwg		
Prepared	GKA	Modified	GKA
Date	05.07.06	Date	12.10.07
Approved	Bernhardt	Revision-Nr.	
Date		Old DWG-Filename	

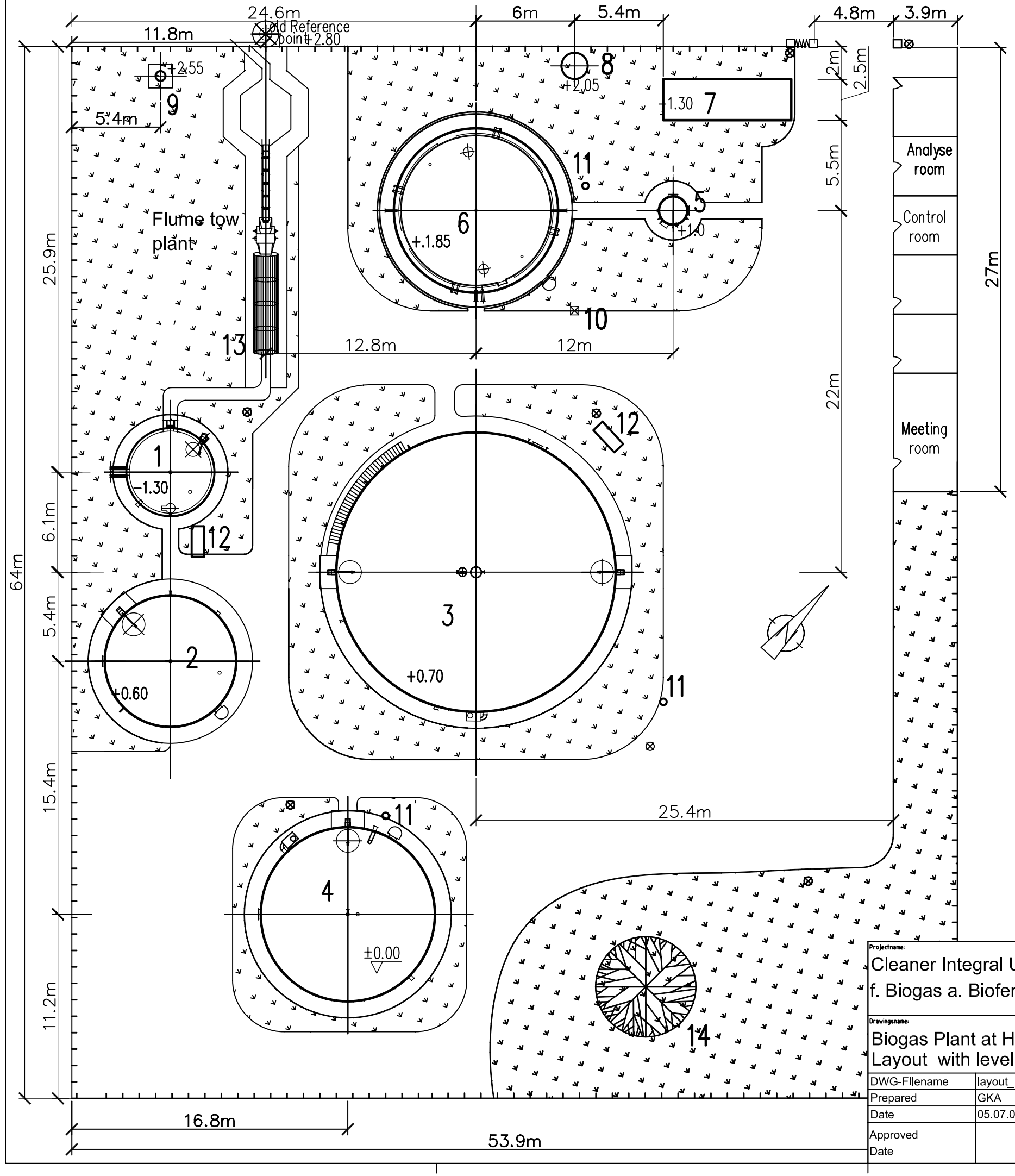
Contract Nr.: 16001023

Project-Nr.: 06.026

Drawing-Nr. 02_0621_update

Size DIN A 3

Scale 1:500



POS.	EQUIPMENT NUMBER	DESIGNATION	TECHNICAL SPEZIFICATION	
			m	m³
1	B100	Collection-tank	Ø5x2.5	50
2	B200	Pre-storage a. Hydrolisetank	Ø8 x 6	300
3	B300	Methanizer tank	Ø16,9x 7,5	1700
4	B400	Outlet sto-rage tank	Ø10,5 x 6	500
5	K500	Desulphic tower	Ø1,6 x 6,0	
6	B500	Gasstorage	Ø10,5 x 6,7	350
7	CHP	Modul in Container	1,77x 1,14 x 1,35	
8		Water cooling tower for CHP		
9		Safety flare		
10		Fire Block		
11		Condensate pit		
12		Outdoor panel switch		
13		Flume tow plant		
14		Tree a. Stony area		

Projectname:
Cleaner Integral Utilisation of Sisal Waste
f. Biogas a. Biofertilizers

Drawingsname:
Biogas Plant at Hale Estate
Layout with levelling (Update Final Report)

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Tel. +4930-65763254
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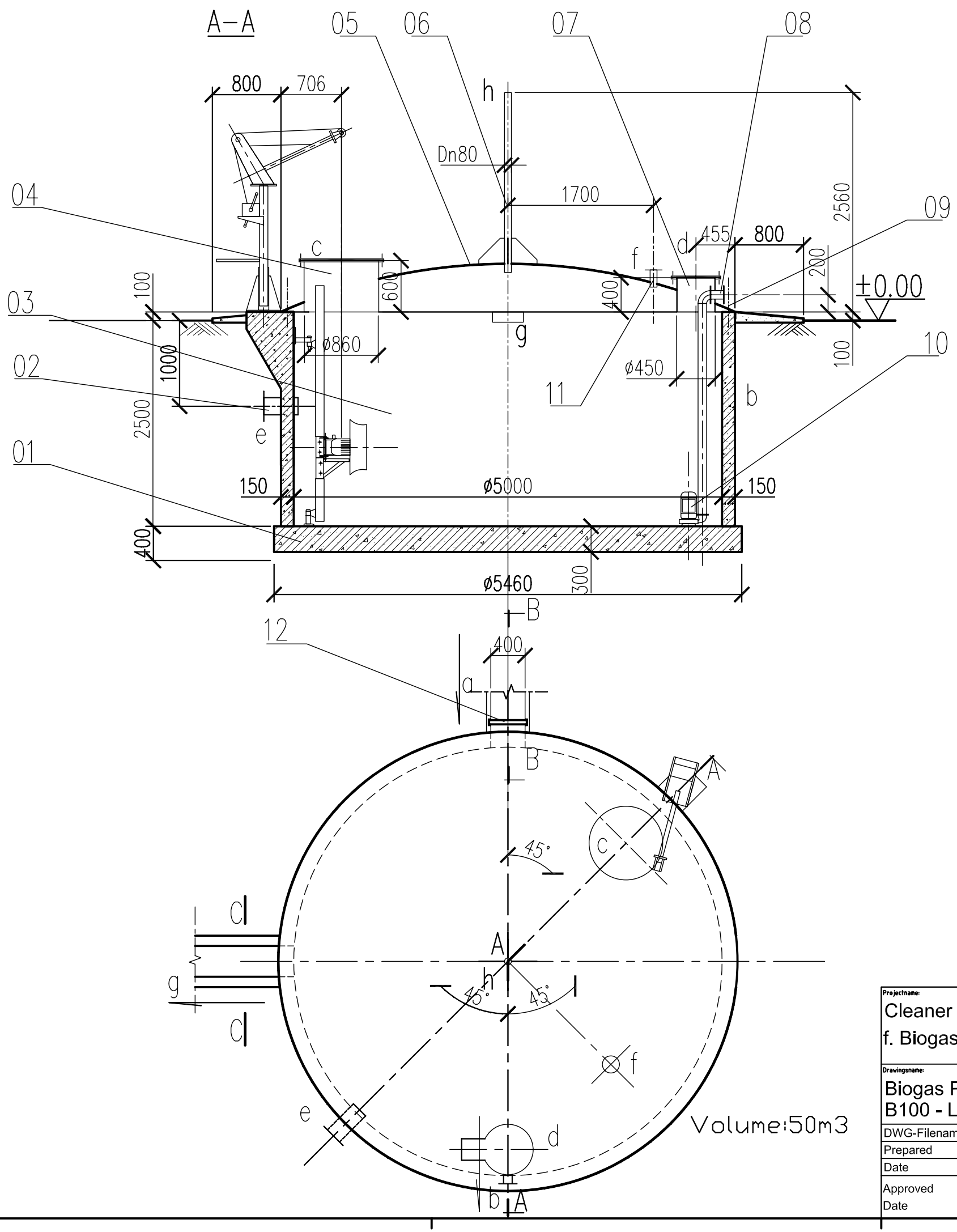
Contractor:
UNIDO
Wagramer Str. 5 A-1220 Vienna

DWG-Filename	layout_levelling_bga_tansania_revised.dwg		
Prepared	GKA	Modified	GKA
Date	05.07.06	Date	12.10.07
Approved		Revision-Nr.	
Date		Old DWG-Filename	

Contract Nr.: 16001023
Project-Nr.: 06.026
Drawing-Nr. 02_0621_update
Size DIN A3
Scale 1:500



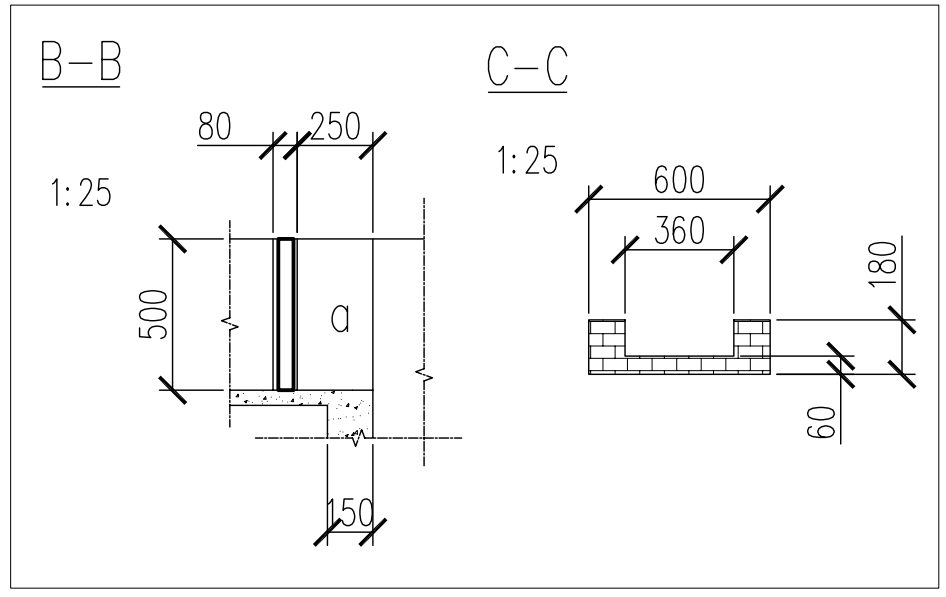
Design Description

1. Designed temperature: -20° – 90 °C;
2. Designed input material weight: 1.05 t/m³;
3. Designed pressure of gas room: 0 Pa;
4. Designed aseismatic grade: > 7;
5. The design including: protection measures for electrical pressure and thunder;
6. The bottom and walls of the tank should use steel bar concrete, and the walls can also use brick structure. The cover is steel material, which connect with walls using expanding bolts. The distance of plates spell is bot smaller than 300 mm.
7. The bottom and walls have to do waterproof treatment. The cover with steel material have to do antirust and anticorrosion treatment.

Nozzle Table

No.	Size	interlink standard	interlink	function
a	400x500			input
b	Dn100	HG5010	plane	output
c	Dn860	JB577-64-37	plane	manhole
d	Dn450	JB577-64-37	plane	manhole
e	Dn200	HG5010	plane	Return
f	Dn80	HG5010	plane	air
g	360x120			sample tap
h	Dn80	HG5010		Exhaust

No.	name	size	material	unit	amount
12	gridiron	440x500	A3F	piece	1
11	sampling pipe	Dn80	A3F	piece	1
10	underwater pump	WQ25-14-2.2	unit	set	1
09	inflated bolt	M16	A3	set	8
08	effluent pipe	Dn100	A3F	piece	1
07	underwater pump manhole	Dg450	A3F	piece	1
06	vent-pipe	Dn80	A3F	piece	1
05	coping	δ=4mm	A3F	piece	1
04	blender manhole	Dn860	A3F	piece	1
03	blender	QJB4/6-400/3-980	unit	set	1
02	backwater pipe	Dn200	A3F	piece	1
01	concrete cistern		concrete	piece	1



Projectname:
Cleaner Integral Utilisation of Sisal Waste
f. Biogas a. Biofertilizers

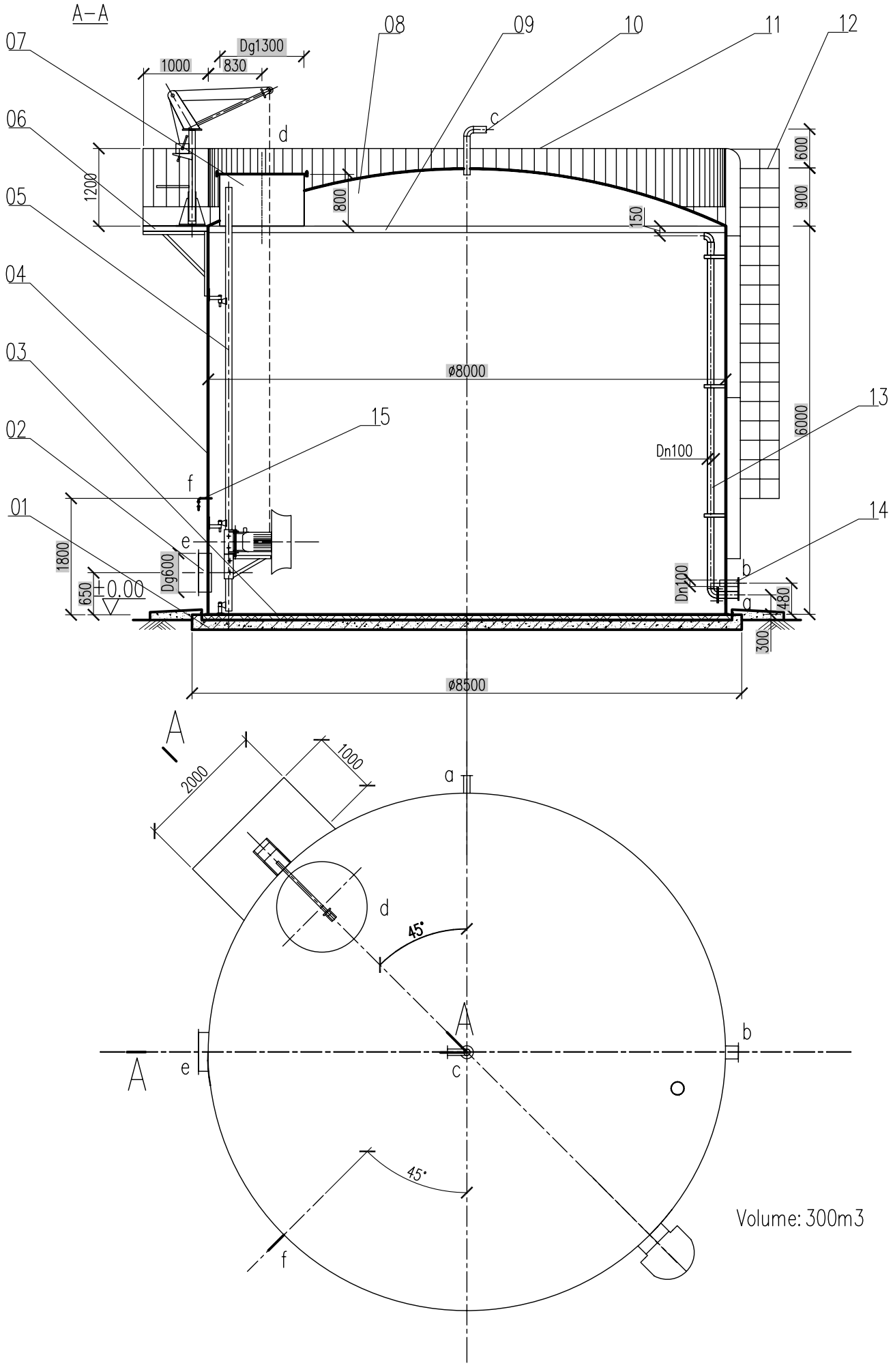
Drawingsname:
Biogas Plant at Hale Estate - Collection Tank
B100 - Layout (Update final Report)

BioEnergyBerlin
Köpernicker Str. 325
Germany-12555 Berlin
Tel. +4930-65763254
Fax +4930-65763256

Contractor:
UNIDO
Wagramer Str. 5 A-1220 Vienna

DWG-Filename	B100-00-0725.dwg		
Prepared	GKA	Modified	GKA
Date	27.07.06	Date	12.10.07
Approved		Revision-Nr.	
Date		Old DWG-Filename	

Contract Nr.: 16001023
Project-Nr.: 06.026
Drawing-Nr. B100-00-0725
Size DIN A 3
Scale 1:50



Design Description

1. Designed temperature: -20 – 90 °C;
2. Designed input material weight: 1.05 t/m³;
3. Designed pressure of gas room: 3000 Pa;
4. Designed aseismatic grade: > 7;
5. The design including: protection measures for electrical pressure and thereunder;
6. The tank uses arc welding, welding line is T 422. The distance of plates spell is not smaller than 300 mm;
7. Tang inner layer with antirust treatment , and out layer with antirust and anticorrosion treatment.

pipe parameters

No	name	parameters	flange mode	use
a	Dn100	HG5010	plane	input
b	Dn100	HG5010	"	output
c	Dn100	HG5010		gas
d	Dg1300	JB577-64-37		manhole
e	Dg600	JB577-64-37		manhole
f	Dn25	HG5010	whorl	sample

15	sample tie-in	Dn25	A3F	piece	1
14	effluent pipe	Dn100	A3F	piece	1
13	influent pipe	Dn100	A3F	"	1
12	ladder	Dn40/Dn20	A3F	"	1
11	balustrade	Dn40/Dn20	A3F	"	1
10	gas pipe	Dn100	A3F	"	1
09	corner steel	L100x100x10	A3F	"	1
08	tank roof	δ=8.6	A3F	"	1
07	manhole	Dg1300	A3F	"	1
06	flat roof	QJB$\frac{10}{12}\frac{615}{3}$-480	A3F	"	1
05	stirrer	QJB15	unit	set	1
04	wall board	δ=8.6	A3F	piece	1
03	bottom board	δ=8	A3F	"	1
02	manhole	Dg600	A3F	"	1
01	foundation		concrete	"	1
No.	name	size	material	unit	amount

Projectname:
Cleaner Integral Utilisation of Sisal Waste
f. Biogas a. Biofertilizers

Drawingsname:
Biogas Plant at Hale Estate - Prestorage a. Hydrolise Tank
B200 - Layout (Update Final Report)

BioEnergyBerlin
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Germany-12555 Berlin
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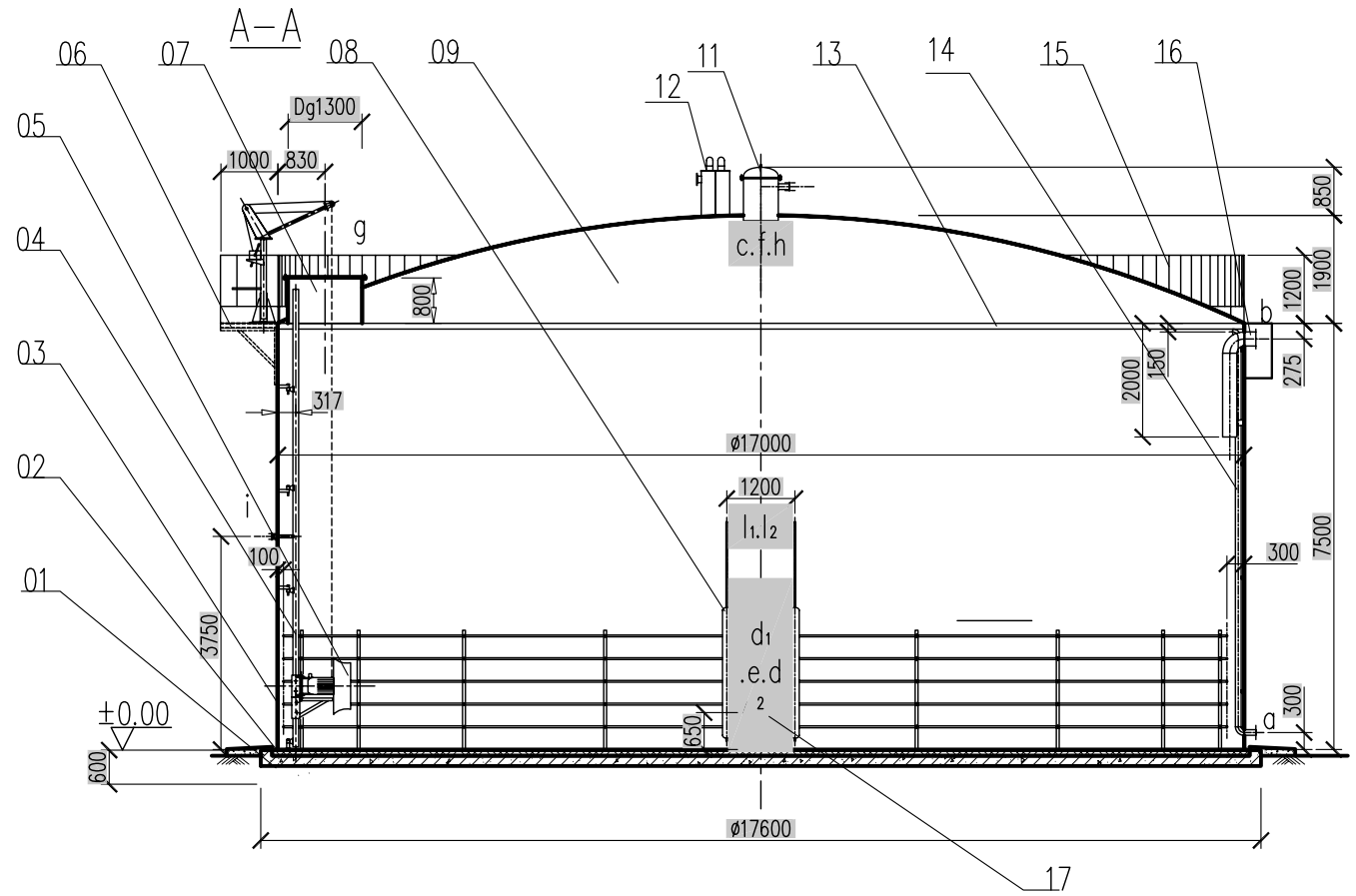
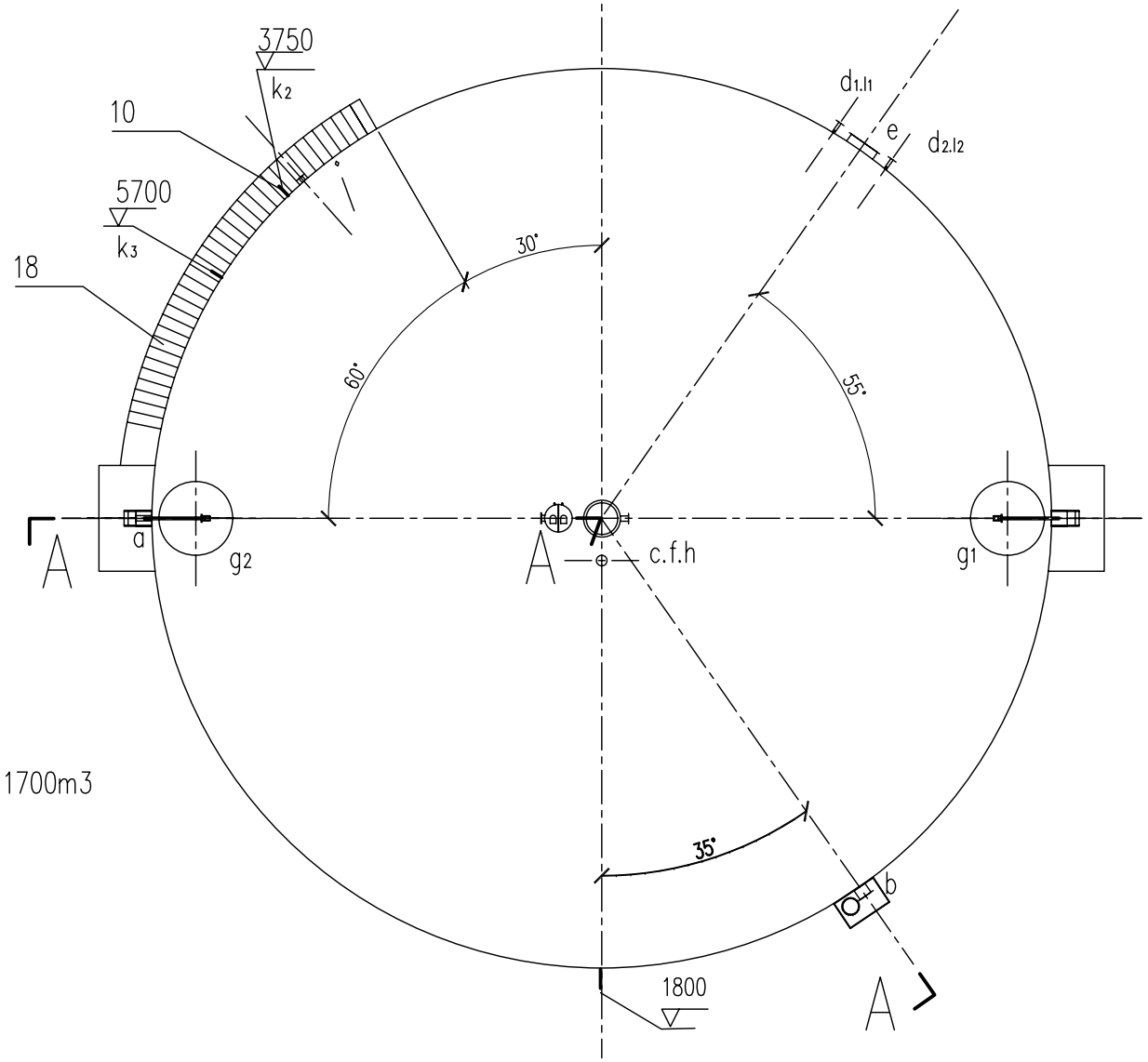
Contractor:
UNIDO
Wagramer Str. 5 A-1220 Vienna

DWG-Filename	B200-00-0725.dwg			Contract Nr.: 16001023	Project-Nr.: 06.026
Prepared	GKA	Modified	GKA		
Date	27.07.06	Date	12.10.07		Drawing-Nr. B200-00-0725
Approved		Revision-Nr.			Size DIN A 3
Date		Old DWG-Filename			Scale 1:75





Volume: 1700m3

Design Description

1. Designed temperature: -20 – 90 °C;
2. Designed input material weight: 1.05 t/m³;
3. Designed pressure of gas room: 3000 Pa;
4. Designed aseismatic grade: > 7;
5. The design including: protection measures for electrical pressure and thereunder;
6. The tank uses arc welding, welding line is T 422. The distance of plates spell is not smaller than 300 mm;
7. Tang inner layer with antirust treatment , and out layer with antirust and anticorrosion treatment.

pipe parameters

No.	name	parameters	flange mode	use
a	Dn100	HG5010	plane	influent
b	Dn250	HG5010	"	effluent
c	Dn100	HG5010	"	gas output
d	Dn80	HG5010	"	heating system
e	Dg600	JB577-64-37	"	manhole
f	Dg600	JB577-64-37	"	manhole
g	Dg1300	JB577-64-37	"	manhole
h	Dn25	HG5010	"	shower water
i	Dn50	HG5010	"	sensor
j	Dn50	HG5010	whorl	air realise
l	Dn25	HG5010	whorl	sample

No.	name	size	material	unit	amount
18	ladder		A3F	piece	1
17	manhole	Dg600	A3F	"	1
16	effluent pipe	Dn250	A3F	"	1
15	balustrade	Dn40/Dn20	A3F	"	1
14	influent pipe	Dn100	A3F	"	1
13	corner steel	L100x100x10	A3F	"	1
12	over pressure savety		A3F	"	1
11	manhole	Dg600	A3F	"	1
10	tank roof	δ=6	A3F	"	1
09	sampling tie-in	Dn50	A3F	"	3
08	heating system		A3F	"	1
07	manhole	Dg1300	A3F	"	2
06	roof plate	QJB$^{10\,515}_{12\,3}$-480	A3F	piece	2
05	stirrer	QJB15	set	set	2
04	transmission pipe	Dn50	A3F	piece	1
03	wall board	δ=10.8	A3F	"	1
02	bottom board	δ=10.8	A3F	"	1
01	foundation		concrete	"	1

Projectname:
Cleaner Integral Utilisation of Sisal Waste
f. Biogas a. Biofertilizers

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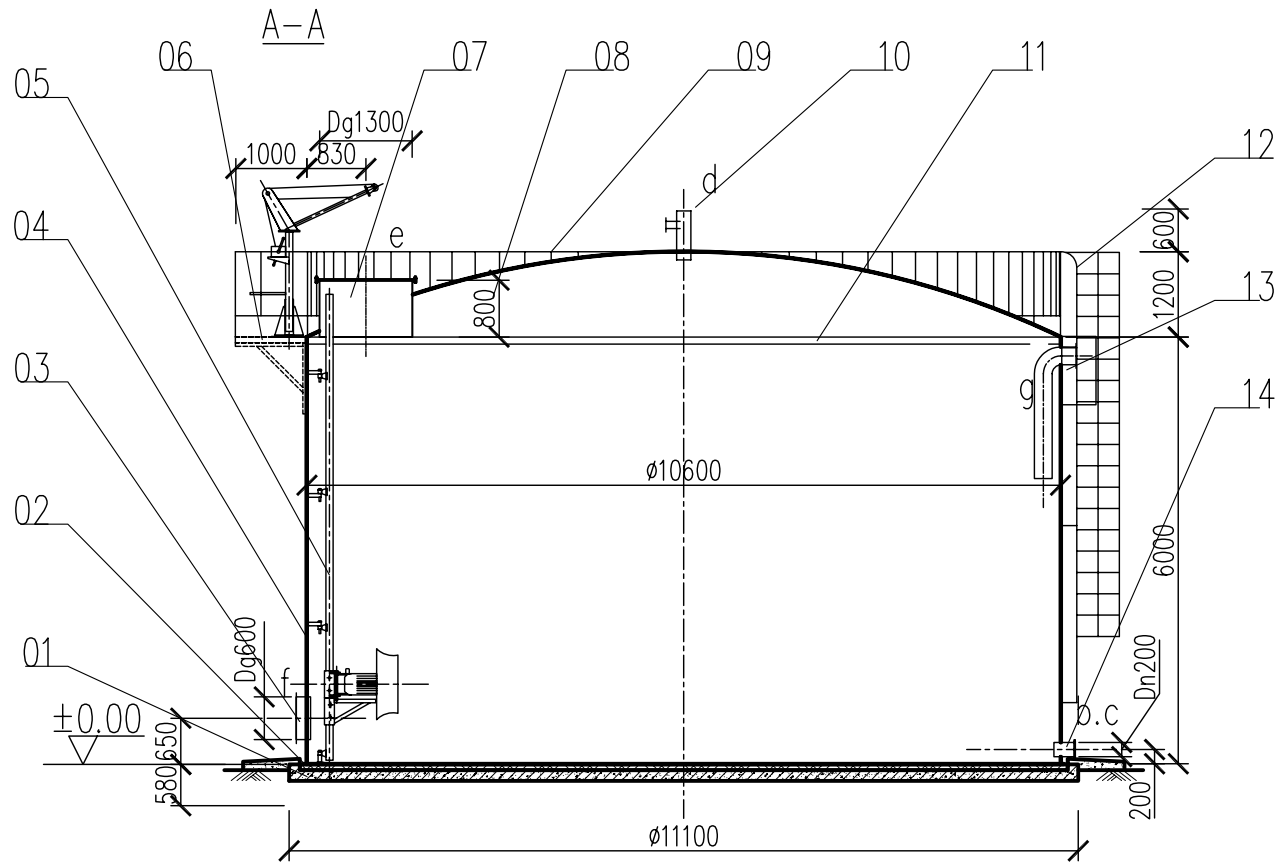
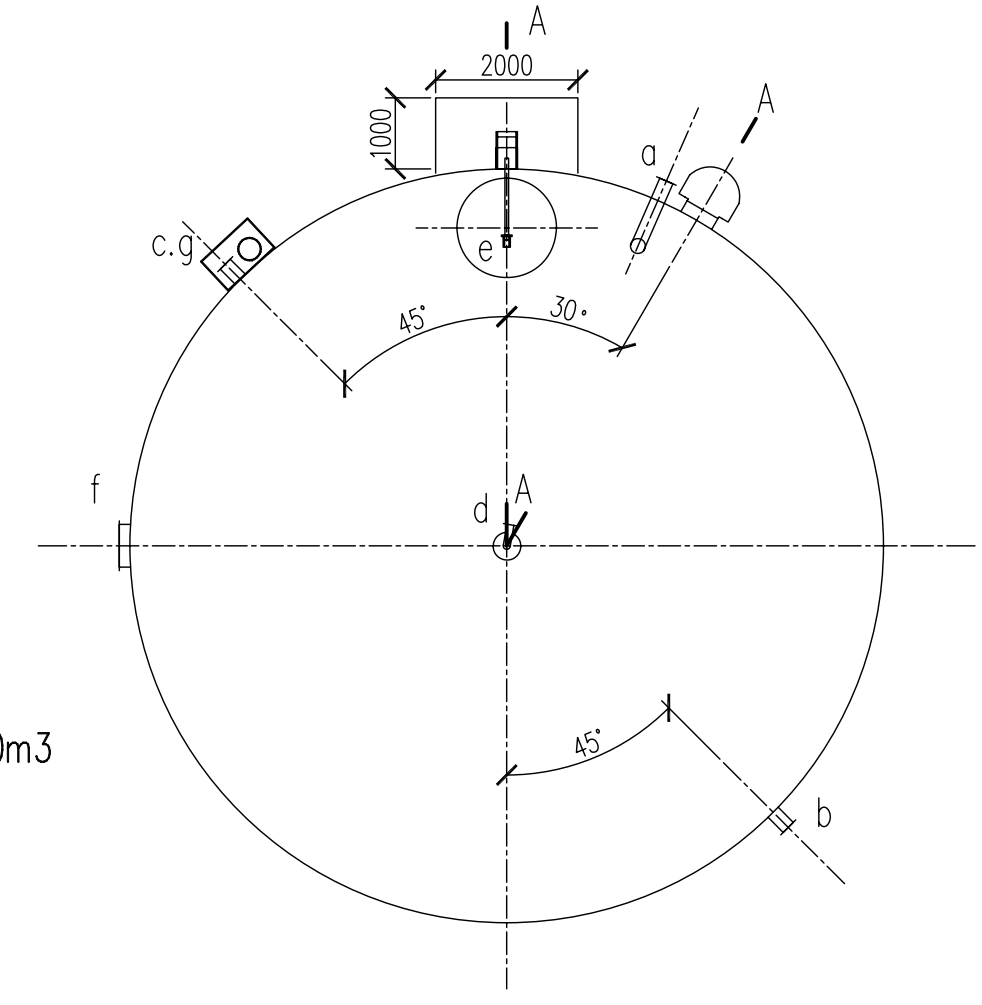
Tel. +4930-65763254
Fax +4930-65763256

Drawingsname:
Biogas Plant at Hale Estate - CSTR Digester Tank
B300 - Layout (Update Final Report)

Contractor:
UNIDO
Wagramer Str. 5 A-1220 Vienna

DWG-Filename	B300-00-0725.dwg			Contract Nr.: 16001023	Project-Nr.: 06.026
Prepared	GKA	Modified	GKA		Drawing-Nr. B300-00-0725
Date	27.07.06	Date	12.10.07		Size DIN A 3
Approved		Revision-Nr.			Scale 1:125
Date		Old DWG-Filename			





Volume: 500m3

Design Description

1. Designed temperature: -20 – 90 °C;
2. Designed input material weight: 1.05 t/m³;
3. Designed pressure of gas room: 3000 Pa;
4. Designed aseismatic grade: > 7;
5. The design including: protection measures for electrical pressure and thereunder;
6. The tank uses arc welding, welding line is T 422. The distance of plates spell is not smaller than 300 mm;
7. Tang inner layer with antirust treatment , and out layer with antirust and anticorrosion treatment.
8. The tank have to do test operation with water.

pipe parameters

No.	name	parameters	flange mode	use
a	Dn200	HG5010	plane	inffluent
b	Dn200	HG5010	"	effluent
c	Dn200	HG5010	"	return
d	Dn50	HG5010	"	gas output
e	Dg1300	JB577-64-37	"	manhole
f	Dg600	JB577-64-37	"	manhole
g	Dn200	HG5010	"	overflow

14	effluent pipe	Dn200	A₃F	piece	3
13	influent pipe	Dn200	A₃F	piece	1
12	ladder		A₃F	piece	1
11	corner steel	L100x100x10	A₃F	piece	1
10	gas output pipe	Dn100	A₃F	piece	1
09	balustrade	Dn40/Dn20	A₃F	piece	1
08	tank roof	δ=6	A₃F	piece	1
07	manhole	Dg1300	A₃F	piece	1
06	roof plate		A₃F	piece	1
05	stirrer	$QJB\frac{10.615}{12-3}$-480	unit	set	1
04	wall board	δ=10.8	A₃F	piece	1
03	manhole	Dg600	A₃F	piece	1
02	bottom board	δ=10.8	A₃F	piece	1
01	foundation		concrete	"	1
No.	name	size	material	unit	amount

Projectname:
Cleaner Integral Utilisation of Sisal Waste
f. Biogas a. Biofertilizers

BioEnergyBerlin

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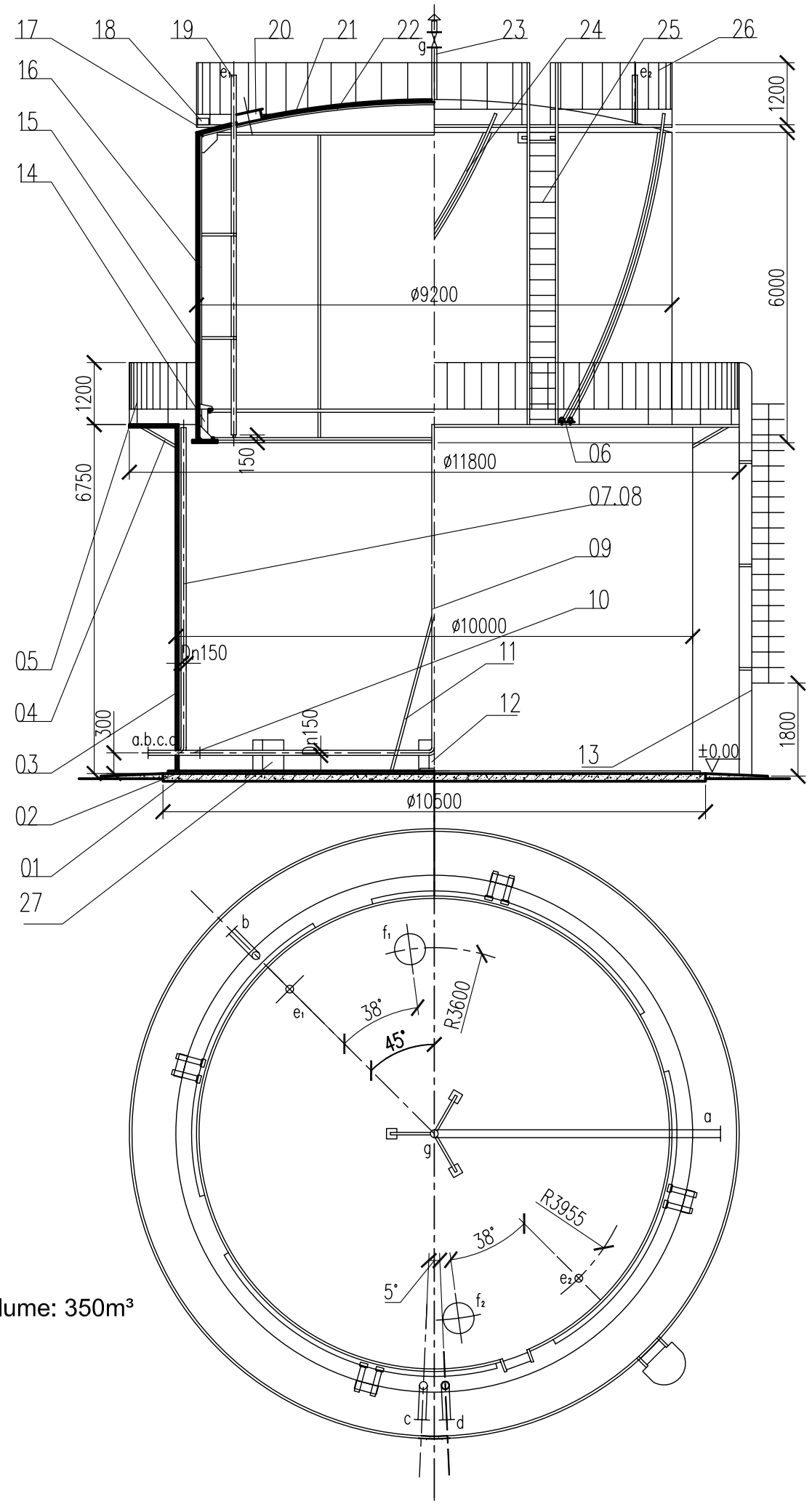
Drawingsname:
Biogas Plant at Hale Estate - After Storage Tank
B400 - Layout (Update Final Report)

Contractor:
UNIDO
Wagramer Str. 5 A-1220 Vienna

DWG-Filename	B400-00-0725.dwg			Contract Nr.: 16001023	Project-Nr.: 06.026
Prepared	GKA	Modified	GKA		Drawing-Nr. B400-00-0725
Date	27.07.06	Date	12.10.07		
Approved		Revision-Nr.			Size DIN A 3
Date		Old DWG-Filename			Scale 1:100



Volume: 350m³

Design Description

1. Designed temperature: -20 – 90 °C;
2. Designed input material weight: 1.05 t/m³;
3. Designed pressure of gas room: 3000 Pa;
4. Designed aseismatic grade: > 7;
5. The design including: protection measures for electrical pressure and thereunder;
6. The tank uses arc welding, welding line is T 422. The distance of plates spell is not smaller than 300 mm;
7. Tang inner layer with antirust treatment , and out layer with antirust and anticorrosion treatment.

technical parameters

No.	name	parameters
1	substrate	biogas
2	oper. pres.	<400mm H_2O
3	oper. temp.	<80°C
4	volume	350M³
5	eq. grade	un-standard

pipe parameters

No.	name	parameters	flange mode	use
a	Dn150	HG5010	plane	gas output
b	Dn150	HG5010	"	water input
c	Dn150	HG5010	"	overflow
d	Dn150	HG5010	"	drainage
e	Dn100	HG5010	"	safety
f	Dg500	JB577-64-37	"	manhole
g	Dn100	HG5010	"	empty

No.	name	size	material	unit	amount
27	fixing block	50x500x500	A3F	piece	8
26	above balustrade	Dn40/Dn20	A3F	piece	1
25	above ladder	Dn40/Dn20	A3F	"	1
24	trail	□□ 15	A3F	"	4
23	empty pipe	Dn100	A3F	"	1
22	joist		A3F	"	1
21	cover top	δ=4.5□3	A3F	"	1
20	manhole	Dg500	A3F	"	2
19	auto. empty pipe	Dn100	A3F	"	2
18	aggravation	450x220x2	unit		30
17	aggravation support		A3F	"	1
16	steel frame		A3F	"	1
15	cover wall	δ=4.5	A3F	"	1
14	under aggravation		HT12-28	"	76
13	under ladder	Dn40/Dn20	A3F	"	1
12	pipe seat		A3F	"	2
11	pipe bracket	L50x50x5	A3F	"	1
10	drainage	Dn150	A3F	"	1
09	gas input pipe	Dn150	A3F	"	1
08	water supply pipe	Dn150	A3F	"	1
07	overflow pipe	Dn100	A3F	"	1
06	idler pulley		unit	"	4
05	under balustrade	Dn40/Dn20	A3F	"	1
04	roof plate		A3F	"	1
03	wall board	δ=10□8	A3F	"	1
02	bottom board	δ=10□8	A3F	"	1
01	foundation		concrete	"	1

Projectname:
Cleaner Integral Utilisation of Sisal Waste
f. Biogas a. Biofertilizers

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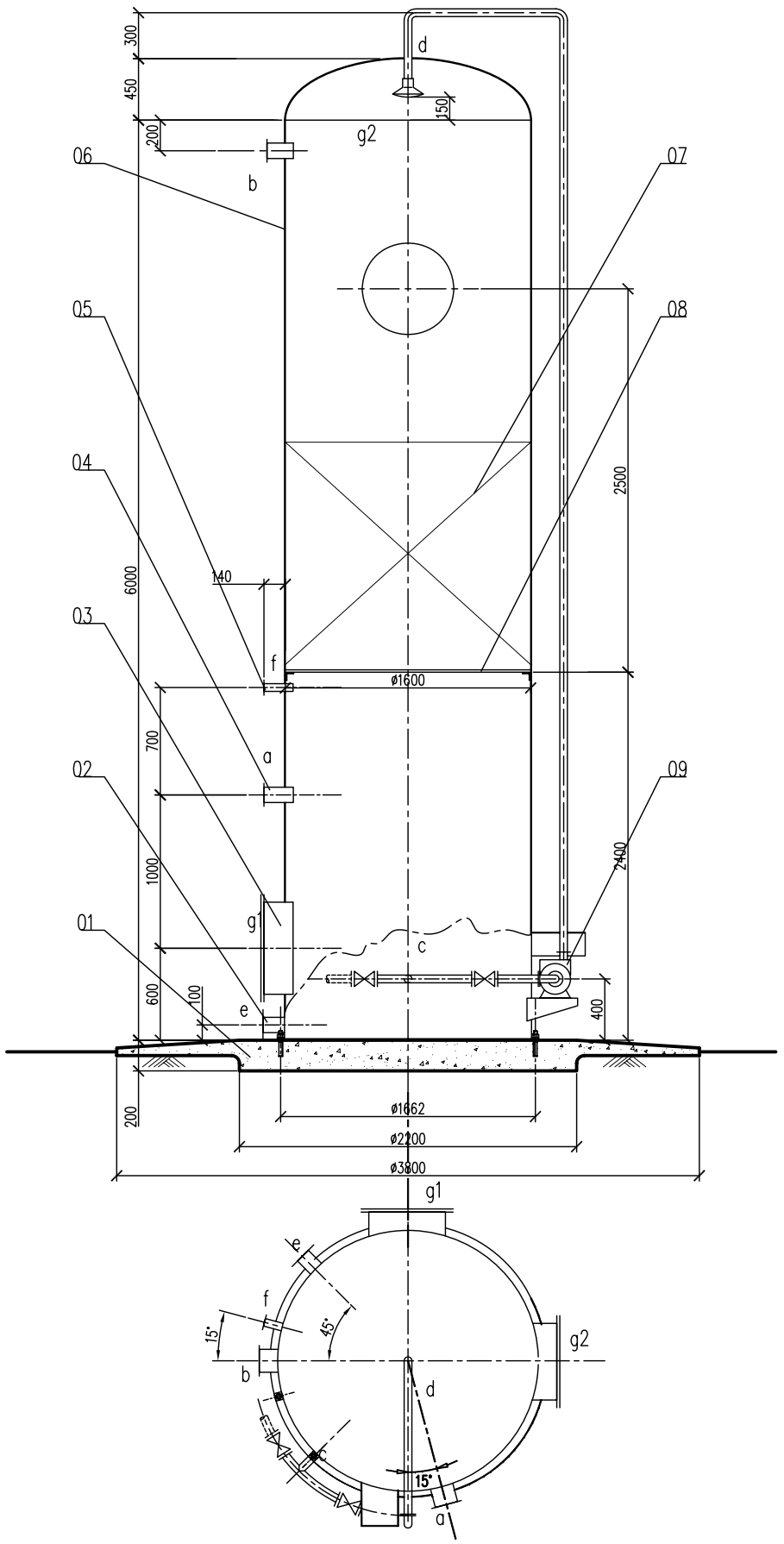
Drawingsname:
Biogas Plant at Hale Estate - Gasstorage Tank
B500 - Layout (Update Final Report)

Contractor:
UNIDO
Wagramer Str. 5 A-1220 Vienna

DWG-Filename	B500-00-0725.dwg	Contract Nr.: 16001023	Project-Nr.: 06.026
Prepared	GKA / Modified GKA		Drawing-Nr. B500-00-0725
Date	27.07.06 / Date 12.10.07		Size DIN A 3
Approved / Date	Revision-Nr. / Old DWG-Filename		Scale 1:100



Design Description

1. Designed temperature: -20 – 90 °C;
2. Designed input material weight: 1.05 t/m³;
3. Designed pressure of gas room: 3000 Pa;
4. Designed aseismatic grade: > 7;
5. The design including: protection measures for electrical pressure and thereunder;
6. The tank uses arc welding, welding line is T 422. The distance of plates spell is not smaller than 300 mm;
7. Tang inner layer with antirust treatment , and out layer with antirust and anticorrosion treatment.

pipe parameters

No.	name	parameters	flange mode	use
a	Dn100	HG5010	plane	gas input
b	Dn100	HG5010	„	gas output
c	Dn50	HG5010	„	water recycling
d	Dn50	HG5010	„	water recycling
e	Dn100	HG5010	„	water output
f	Dn50	HG5010	„	hand hole
g	Dg600	JB577-64-37	„	manhole

No.	name	size	material	unit	amount
09	water recycling			piece	1
08	grid		A₃F	piece	1
07	packing material	Dn150		m³	3
06	tower body	δ=6	A₃F	piece	1
05	pipe	Dn50	A₃F	piece	1
04	gaspipe	Dn150	A₃F	piece	2
03	manhole	Dg600	A₃F	piece	2
02	drain pipe	Dn100	A₃F	piece	1
01	foundation			concrete	1

Projectname:
Cleaner Integral Utilisation of Sisal Waste
f. Biogas a. Biofertilizers

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Drawingsname:
Biogas Plant at Hale Estate - Desulphic Tower K500 - Layout (Update Final Report)

Contractor:
UNIDO
Wagramer Str. 5 A-1220 Vienna

DWG-Filename	B600-00-0725.dwg	Contract Nr.: 16001023	Project-Nr.: 06.026
Prepared	GKA / Modified GKA		Drawing-Nr. B600-00-0725
Date	27.07.06 / Date 12.10.07		
Approved / Date	Bernhardt / Revision-Nr. / Old DWG-Filename		Size DIN A 3
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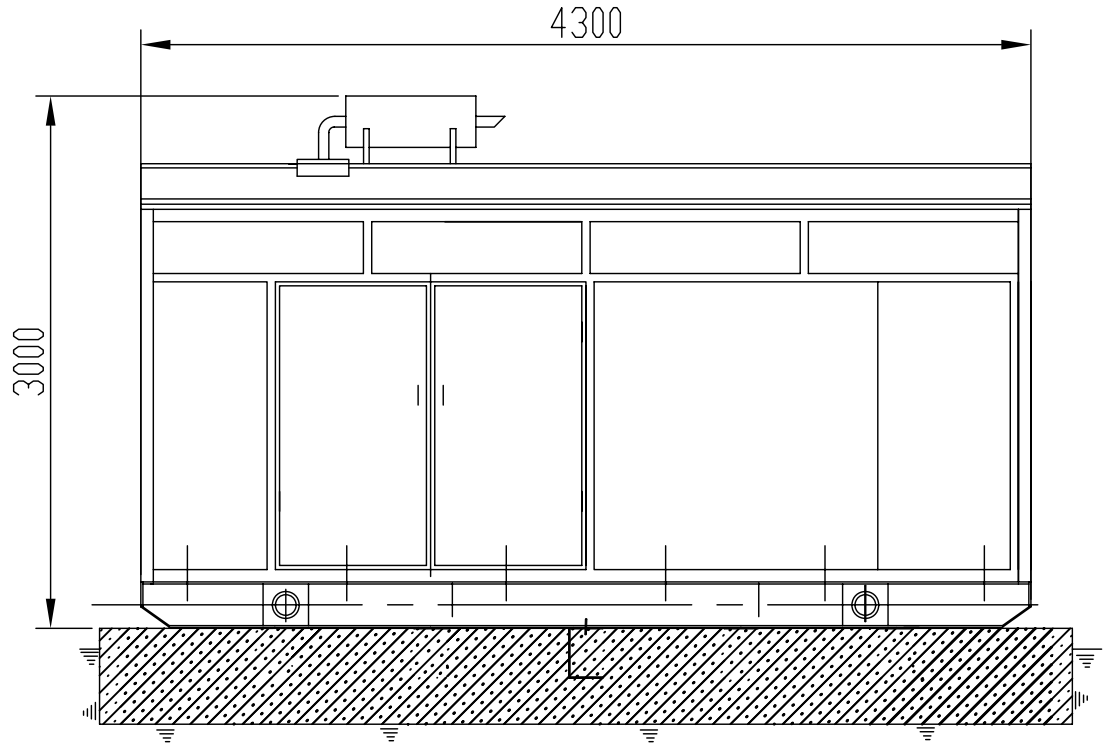

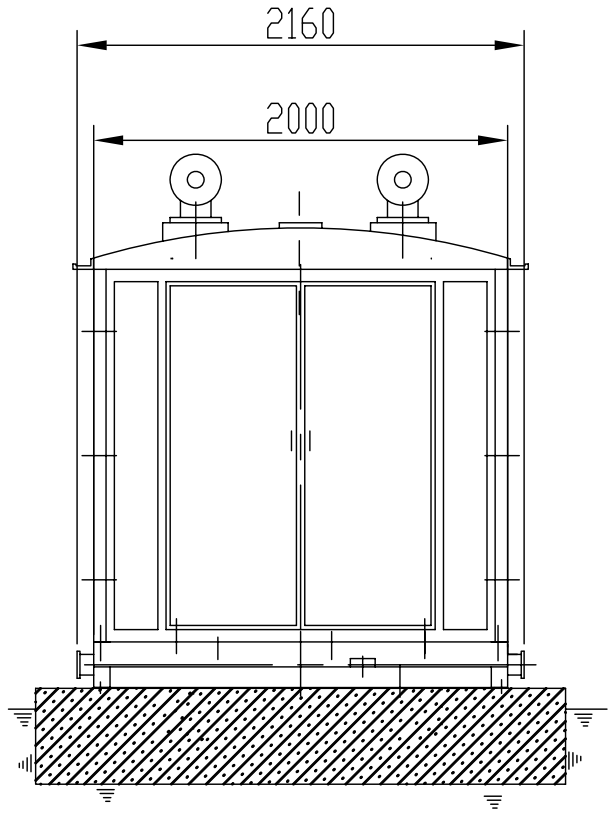

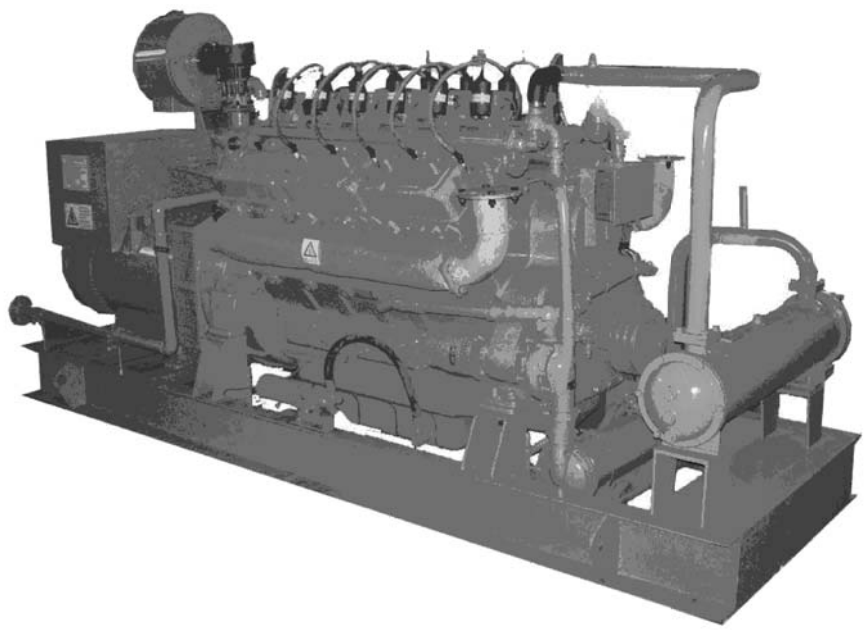

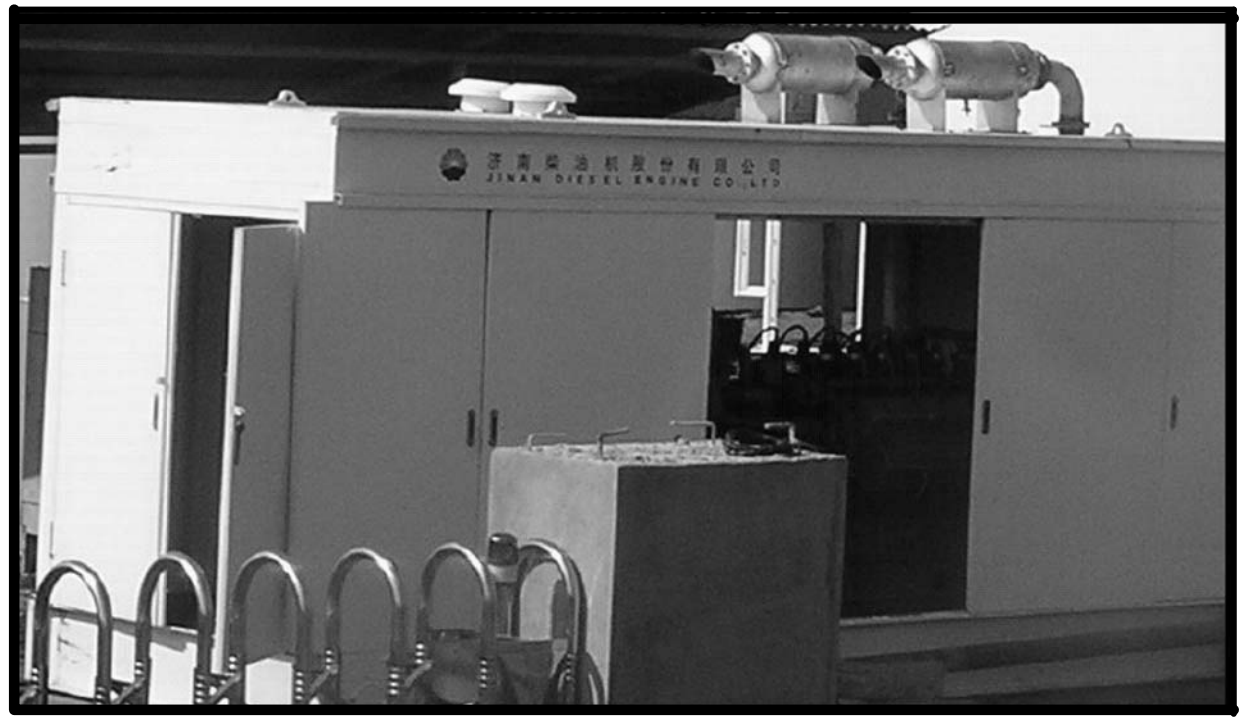

Description:

1. Foundation structure of power generator unit shall be determined according to site soil structure. Under normal conditions, foundation depth is 0.5—1.0m, foundation length shall be 0.3—0.5m longer than common chassis of generator unit, foundation width shall be 0.3—0.5m wider than common chassis of generator unit, foundation shall be 0.1m higher than ground.
2. Foundation bottom shall be tamped and reserved hole opening according to position of fixing holes for fixing foundation bolts.
3. Bearing capacity of foundation shall not be less than 6 tons.

Projectname:
Cleaner Integral Utilisation of Sisal Waste
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Drawingsname:
Biogas Plant at Hale Estate
CHP Unit - Layout (Update Final Report)

Contractor:
UNIDO
Wagramer Str. 5 A-1220 Vienna

DWG-Filename	B800-00-0613.dwg	Contract Nr.: 16001023	Project-Nr.: 06.026
Prepared	GKA	Modified	GKA	Drawing-Nr. B800-00-0613
Date	27.07.06	Date	12.10.2007	
Approved		Revision-Nr.		Size DIN A 3
Date		Old DWG-Filename		Scale 1:750

APPENDIX 5: Manual and maintenance handbook

Project No. US/URT/02/117, FC/URT/04/118, SF/URT/05/119-

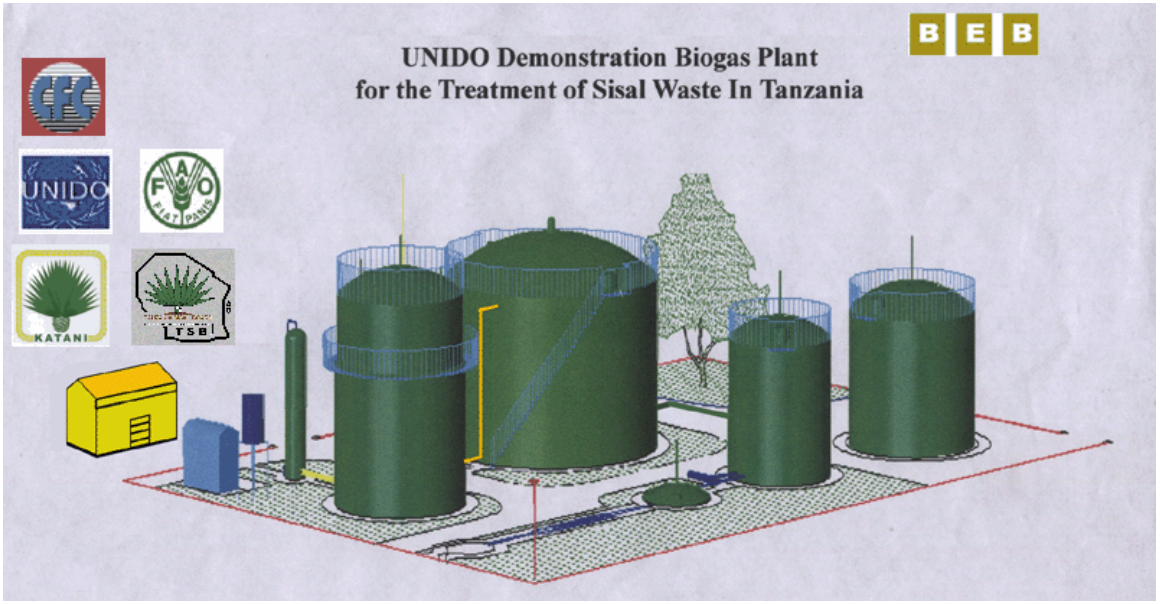
UNIDO Contractor no.: 16001023

Design, Construction, Erection, Installation, Training and Commissioning of a Pilot Demonstration Facility

for the

Production, Generation and Distribution of Electricity from biogas produced from sisal leaf waste in Tanzania

Guidebook and Maintenance Map



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1 PROJECT DESCRIPTION

1.1 TECHNICAL DESCRIPTION

1.1.1 Introduction

The sisal fibre production generates a huge amount of waste material, which consists of more than 96% of vegetative waste material and process waste water. This waste material is deposited in land or surface area around the fibre decorticating units, thus causing major environmental damage. So the current project will now aim at establishing the technical parameters for commercial biogas production based on sisal waste.

This kind of waste consists of a high percentage of organic matter and is relatively easy to digest. Therefore, an optimal biological way of treat these wastes is the anaerobic digestion process. Anaerobic digestion of this waste represents an alternative treatment to conventional methods of disposal. During the digestion process biogas, a liquid and a dry residue are produced. Biogas can be used to generate heat and electric power and the liquid and dry residues can be used as high quality bio-fertiliser for commercial farming.

Others biogas utilisation could be the delivery to houses for cooking and lightning or extraction from the biogas of the methane which can be used in tractors or cars.

1.1.2 Biogas production from Sisal waste

Biogas is produced during the anaerobic digestion of organic material (human, animal and plant wastes) and the gas consists of methane (65-70%) and carbon dioxide (30 - 35%). The most profound benefit of anaerobic digestion is the production of biogas which can be converted into heat and electricity. For sisal waste a production rate of 400 l CH4/kg VS has been observed according to the result of BEB laboratory test and some other researchers. This means that for every tonne (t) of undiluted sisal waste ca. 50 m^3 of biogas will be produced. With an average inflow of 65t of diluted waste with 6 % TS content per day, a biogas production of 1,800 – 2,000 m^3/day will be possible. It is a biogas amount for a 140 – 150 kWele. CHP unit. Anaerobic digestion does also have some environmental advantages. During anaerobic digestion most of the organic pollutants are removed, which will reduce the present water pollution around the sisal companies. Another environmental advantage is the reduction of greenhouse emissions. Through the anaerobic digestion of the sisal waste, the methane emissions can be reduced.

The results of biogas producing rate for sisal waste was 0.40 m^3 biogas/kgvs with ca. 65%

CH_4 contents in laboratory case. Here we have choose the biogas production rate with 0,3 m³/kgvs (75% transfer rate to large scale plant from laboratory result) as our design parameter, so we can grantee the biogas production amount and the CHP output

1.1.3 Technical process choice

The anaerobic treatment process is the most important step in the overall system where the actual anaerobic digestion of organic matter takes place and biogas is generated. In order to choose an optimal anaerobic treatment process and satisfying the requested power output TOR for the treatment of sisal waste in the Tanzania biogas project, a selection of CSTR reactor option is offered for the design. The decision is considered to be appropriate in yielding enough biogas to achieve the required 140 -150 kW (in the TOR) and use the original sisal waste directly. In this process, original crushed sisal waste will be stored in a pre-storage tank, which is also serving as a hydrolysis tank. After that the hydrolysed substrate is fed directly from the storage tank into the CSTR reactor as an anaerobic fermentation without any pre- solid/liquid separation. After the CSTR step, the effluent from CSTR reactor will be pumped into a tank serving as storage for the effluent. The advantage of this option is the increase in biogas production. With increase in biogas production the amount of energy that can be produced also increases.

1.1.4 The process and procedure

The key step of the total system is a highly efficient two-step anaerobic digestion which includes hydrolyzer and methanizer. The crushed sisal waste as input material for the two-step anaerobic digestion will flow into the pre-storage/hydrolyse tank, where the substrate will be collected, stored, stirred and hydrolysed. A first diving guts pump, which is hanging in the tank will pump the substrate through a pipeline to the bio-digester. After the anaerobic fermentation process, the digested substrate will be pumped into the after-storage tank. The hydrolyse effect be achieved in a retention time of approx. 5 days.

The substrate will be heated up to 37 °C through a heat exchanger before it flows into the bio-digester. The heat exchanger will be installed in the pipeline between the pre-storage/hydrolyse tank and the bio-digester and the effluent from the methaniser which is operated at a higher temperature will act as the heating medium.

The bio-digester is a Continuously Stirred Tank Reactor (CSTR) with a total volume of 859 m³. The CSTR-reactor is stirred mechanically by means of a mixer. Due to the homogeneous character of the content of the digester, there is a good contact between the produced Biogas, the substrate and the methanogeneous microbes responsible for the production of the Biogas. A decrease in the concentration of bacteria in the reactor would adversely affect the process efficiency and stability. For effective treatment, the CSTR requires an extended hydraulic retention time (HRT approximately 15 days). Gentle stir-

ring of the substratum is guaranteed by a mechanical mixer. Owing to the special wall-heating system, the distribution of temperature in the digestion tank is optimal and even. The CSTR – reactor is a Combine Bio-reactor with integrated gas storage (ca. 500 m³ gas storage capacities).

The produced biogas will be collected in a non pressure gas bag installed above the CSTR -reactor. The biogas with a methane content of 60 – 65% will be used to produce heat and electric power in a combined heat and power generation unit. This CHP unit (140 - 150 kW) will be delivered as turn key modules in standard transportation containers including all necessary instruments and connection to external units.

The excess heat energy will be used as drying energy for the factory (corona and Hammer mill). As the second CHP can increase the output to 350KW the national Distribution Network (Tanesco) is able to trying the connection to the grind.

The treated substrate will be pumped into an after-storage tank with 590 m³ capacity and will be used as agriculture bio-fertiliser. The storage tank has a discharge connection flange for flexible tube connection to tank Lorries.

1.1.5 Input material

The process is designed for treatment of the total sisal waste with a mount of 65 Tone per day from the sisal production industry. The total solid content after the treatment of crushing unit shall be approximately 10% and VS in TS around 85%.

Substrate	Total N (Vol-%)	Total P (Vol-%)	TS (Vol-%)	VS (% in TS)
Sisal waste	0,82%	1,0%	5-8	85

1.1.6 Hydrolysation step

The Hydrolyser is a semi anaerobic reactor and loaded with the mixture of pre-treated sisal waste and the effluent from after-treatment tank. It is operated at a temperature of 30 – 40°C. In this step the high molecular components of the organic waste like proteins, carbohydrates and fats are broken down by hydrolytic and acid-forming bacteria. Hydrolysis of polymers and acidification of compounds take place in the first step, yielding soluble small organic matters such as glucose and volatile fatty acids.

The main operating parameters of the hydrolyzer are:

- Hydraulic retention time (HRT): 5 - 8 d
- TS – influent: 110 %

- PH in reactor: 5 - 6
- TS – loading rate: 3 - 6 Kg TS / m³.d
- VS – removal rate: ca. 20%

1.1.7 Methanization step

1.1.7.1 CSTR – Reactor Introduction

The Continuously Stirred Tank Reactor (CSTR) is a regular mixing reactor by mechanical stirrers, biogas-or substrate-circulation with the effect of homogeneous re-actor content and good access of microbes to substrate. The outflow from the reactor is limited by the growth rate of the bacteria because bacteria are always discharged with the treated waste water. A decrease of bacteria concentration in the reactor would adversely affect the process efficiency and stability. For effective treatment the CSTR requires an extended hydraulic retention time (HRT approximately several days).

CSTR is able to process waste water with high concentrations of suspended solids (SS > 5,000 mg/l) and very high COD-loads (> 50.000 mg COD/l). The solid/liquid separation is not necessary. A pre-treatment of the input materials (mostly crushing) should be considered in most cases.

1.1.7.2 Methanization phase

After a hydraulic retention time of approx. 5 – 8 days in hydrolyzer, the effluent feeds into the methanizer (bioreactor). The methanizer is a continuously Stirred Tank Reactor (CSTR) with an integrated biogas storage bag.

Treatment in CSTR reactor, with the aid of anaerobic technology, via the breaking down of micro-organisms, organic waste is converted into biogas which can be used for the production of electrical energy and heat. Via fermentation the homogeneity of the substrate is improved and the odour and CO2 emissions are reduced.

The methanogenic bacteria transform the volatile fatty acids directly into biogas. The biogas with 60 - 65% methane content contains very small amounts of hydrosulphide (H2S).

The two-step BEB-process for treatment of high concentrations of organic wastes is highly effective for VS removal and bio-energy recovery. This process is highly stable and able to withstand high peak loading. Moreover, the two-step process permits high conversion efficiencies and more than 80% of volatile solids may be converted to biogas.

The main operating parameters in the methanizer are:

- Hydraulic retention time (HRT): 15 - 20 d

- PH in reactor: 7.0 - 8.0
- TS – loading rate: 2 - 3 Kg ts/m³.d
- VS – removal rate: 80 - 85%
- CH4 – production rate: 0.2 - 0.25 m³ CH4 / kg VS*d
- CH4 – content in biogas: 60 - 65%

1.1.8 Control System

The whole system is controlled by an automatic control system (PCL). Pumps and other electrical units will be triggered by automated control and additional hand control facilities. Measured data like temperatures, pressure, flow rate or pH value are shown on the screen and stored in the internal data storage for process documentation.

This control system allows a automatic operation of the biogas plant. All process data and parameters of the system can by checked by process visualisation and can be changed by using a special code. A manual operation of the units is possible in case of blackout failure of the control system.

1.1.9 Power output of the biogas plant

For calculation of the biogas production that we guaranty, we suppose an input of 65 tons per day. Additionally we suppose a main value of the “TS” and “VS” parameters in the input material with 5-8% (TS) and 85% (VS) in TS. If the plant operates with the input material mentioned above, the total biogas production daily will reach around 1650 m³/d with approximately 60–65% methane content. Also the CHP units and their electric power output are calculated on the named predictions. Under these circumstances the electric power output of the CHP will reach 140 - 150 kW electrical power. The electrical voltage output is 400 V at a Frequency of 50 Hz or 480 V at a frequency of 60 Hz on a 3 phase system.

Corresponding to an electric power output of 150 kW the heat power output will be 200 kW. Heat energy can be delivered as hot water with an output temperature of 80°C. It is possible to get more heat energy from the exhaust gas from the machine, if the machine is equipped with an additional heat exchanger for the exhaust gas. All necessary installations for this additional heat output are not part of this offer.

If no heat energy is required from outside, the internal emergency cooling unit cools down the CHP machines.

Of course, the different organic materials with different total solid content (TS) and volatile solid content (VS) produce different biogas yield. For the liquid phase from sisal waste will be expected:

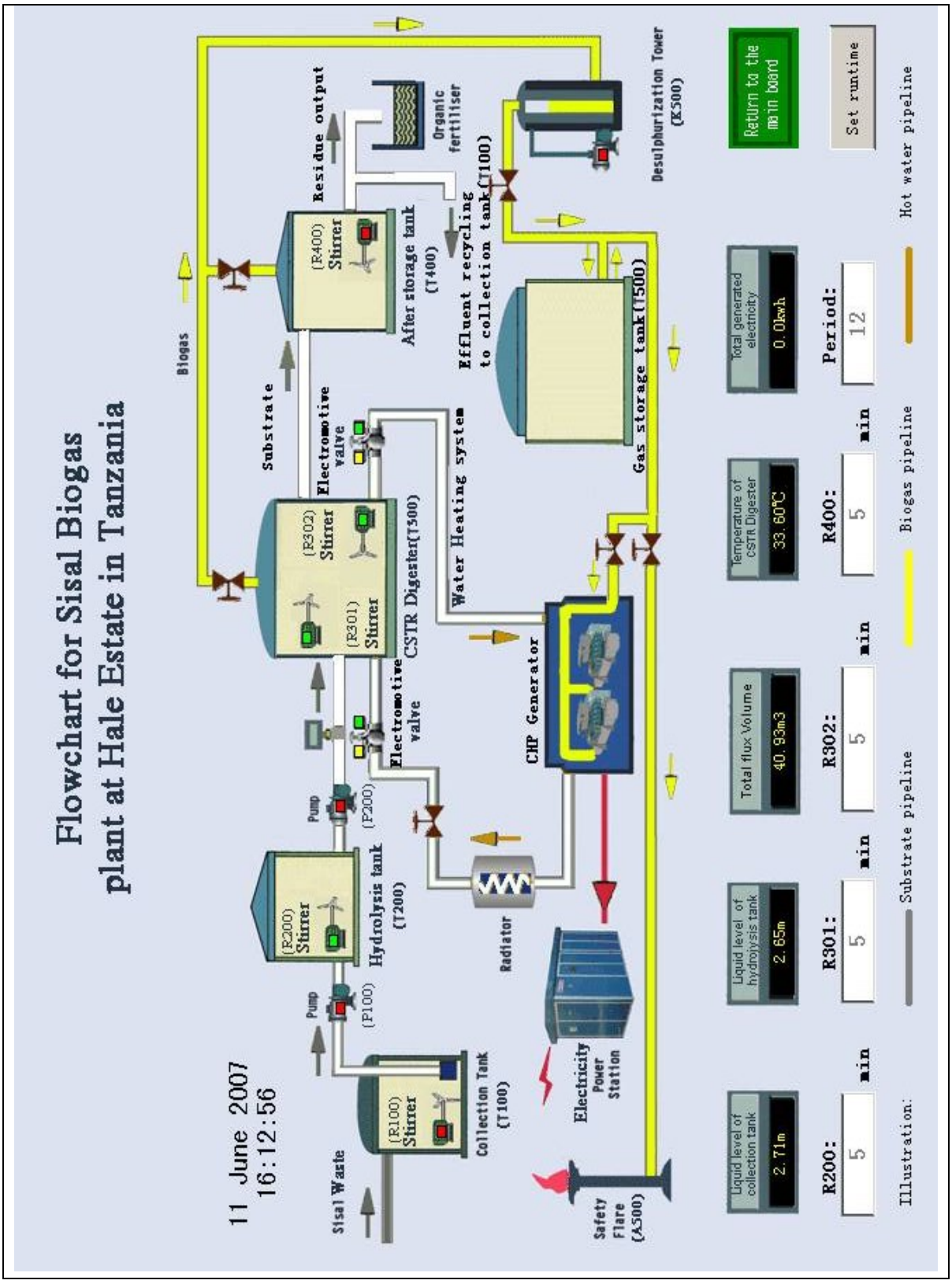
Substrate	Amount [t/a]	Amount [t/d]	Amount [m³/d]	Quantity of Energy [kWh/m³]	Quantity of Energy [kWh/a]
Sisal waste	20.075	65,0	65,0	150	3.900.000

1.1.10 General provisions

- Concerning the input material there are some restrictions: The input material has to be free of disturbing coarse pieces made of metallic or mineral material. Also any other disturbing material like plastic bags and long fibres has to be separated from the input material before into hydrolysis tank. The amount of input materials have to be guaranteed with at least 65 t/d with TS content of ca.5-8%. Otherwise the amount of biogas production can not be guaranteed.
- The output material will be stored in an after-storage tank with pipe connection for sucking out by a truck and an external pump. The dispatch via conveyor belt or truck.
- The electric power will be produced on a low voltage range. In the calculations the standard output voltage is 400 V at a frequency of 50 Hz according to German Standard, or 480 V at a frequency of 60 Hz.
- The produced heat power will be delivered as hot water with a temperature of 80°C. A hot water connection in the CHP container is be installed. An emergency cooling unit (blower) is in the CHP container in case the water cooling system fail.
- Operation management personnel shall be familiar with the treatment process of the biogas plant and requirements on the operation and technical indexes of the facilities and equipment.
- The operating personnel shall be technically trained and qualified before going on duty.
- Operators at each post shall exactly complete necessary operation records in a timely manner. Operation management personnel shall regularly inspect the original records.
- Operation management personnel and operators shall go around and inspect the operating conditions of the facilities, equipment, electric apparatuses and instruments, from time to time, according to the process and management requirements.

- In case of any abnormality discovered, corresponding measures shall be timely taken and the competent department of the upper level shall be reported.
- Before starting up any equipment, comprehensive inspection and complete preparation shall be preformed.
- All the facilities and equipment shall be kept clean all the time, avoiding any leakage of water, substrate or biogas.

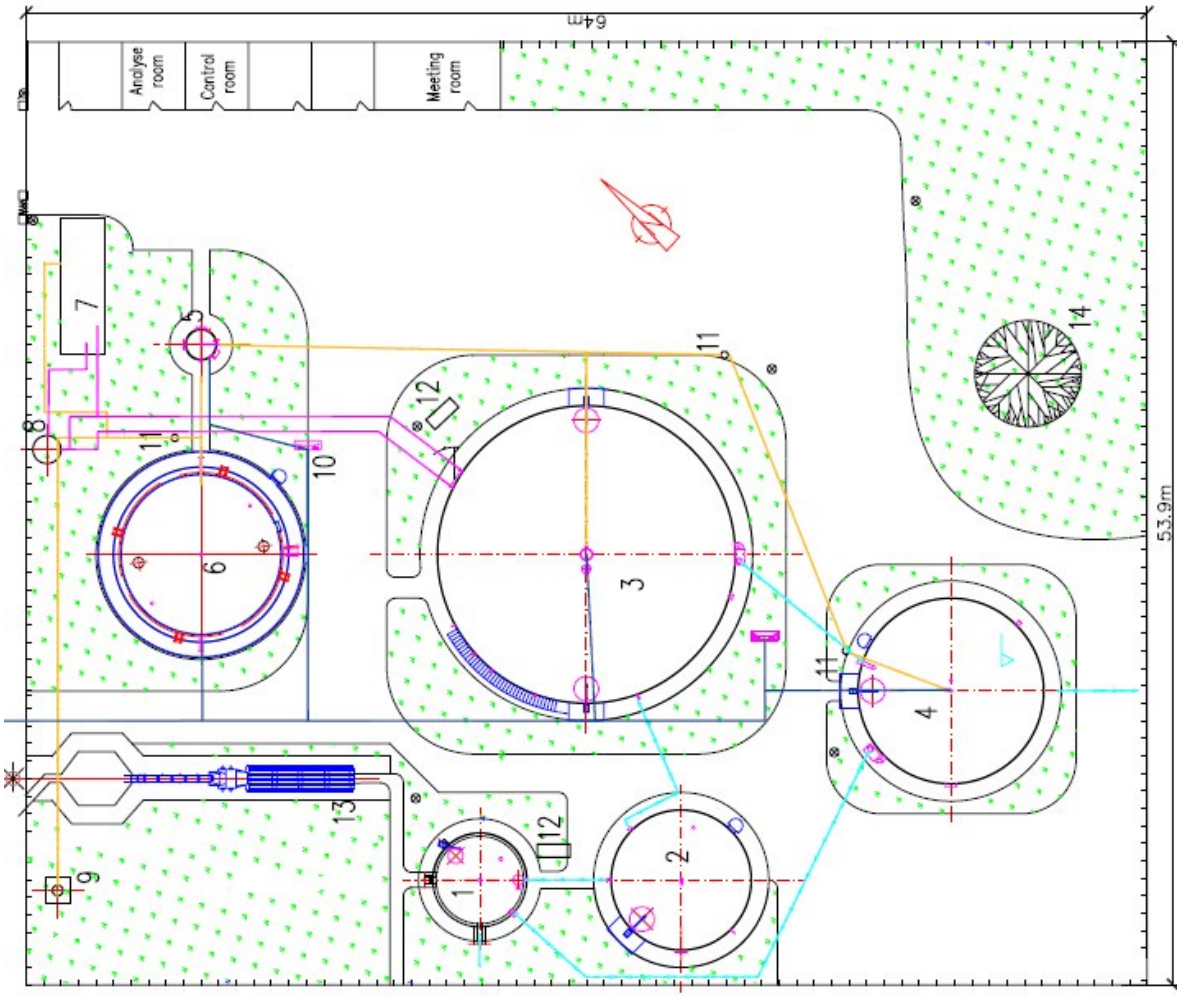
1.2 Flow Chart Biogas Plant



1.3 Layout Biogas Plant

POS.	EQUIPMENT NUMBER	DESIGNATION	TECHNICAL SPEZIFICATION	
			m	m³
1	B100	Collection-tank	Ø5x2.5	50
2	B200	Pre-storage a. Hydrolisetank	Ø8 x 6	300
3	B300	Methanizer tank	Ø16,9x 7,5	1700
4	B400	Outlet storage tank	Ø10,5 x 6	500
5	K500	Desulphic tower	Ø1,6 x 6,0	
6	B500	Gasstorage	Ø10,5 x 6,7	350
7	CHP	Modul in Container	1,77x 1,14 x 1,35	
8		Water cooling tower for CHP		
9		Safety flare		
10		Fire Block		
11		Condensate pit		
12		Outdoor panel switch		
13		Flume tow plant		
14		Tree a. Stony area		

Legend
- Substrate Pipe
- Gas Pipe
- Heating Pipe
- Water Pipe



2 BIOGAS PLANT MANAGEMENT (OPERATION, MAINTENANCE AND SAFETY)

2.1 Grids

2.1.1 Operation Management

- Foreign substances held up by grids shall be removed in time and treated properly by taking appropriate measures.
- Use machinery to dredge for the foreign substances and treat immediately if finding out something wrong.
- Inspect the grid every 8 hours and clean timely.

2.1.2 Maintenance

- Regularly overhaul and maintain the grids and replace damaged ones timely.

2.1.3 Safety operation

- Be careful to slipperiness while manually clearing foreign substances.

2.2 Pump System

2.2.1 Operation Management

- Regulate amount of water according to the variations of influent amount and the process design, ensuring effects of treatment.
- Patrol inspection system shall be implemented strictly in operation of water pumps and conform to following specifications:
  a) Observe whether the various instruments in normal and stable.
  b) Temperature rise of bearings are not allowed 35℃ higher than the ambient temperature and the maximum temperature shall be 75℃ at most;
  c) Water pump sets shall be free of abnormal noise or vibration;
  d) There shall be alarm and display devices for low water level of collection tank.
- Operating personnel shall keep pump rooms in clean and place the various instruments properly and orderly.
- Timely remove jams of pump impellers.
- Collection tanks shall be cleaned at least once a year.

2.2.2 Maintenance

- Regularly inspect pumps, filling materials of valves and airtightness of oil seal, adding or replacing filling materials, lubricating oil and lubricating grease according to needs.
- Regularly inspect and repair liquid level controller of collection tank and signal conversion device.
- Water trapped in pump body shall be drained off after the pump stops.

2.2.3 Safety operation

- Operators are not allowed contacting the running parts of water pumps as they started or in operation.
- For sudden power failure and equipment fault, firstly cut off the power supply, open the gate valve for emergency blowdwon and close all gate valves at influent inlet, and report immediately. The power supply cannot be resumed without authorization before the trouble being removed.
- Operators cannot leave till the water pumps operate stably.
- It is not allowed to start up water pumps frequently.
- Water pumps in operation shall be stopped in the following occurrences:

a) Bearings of the water pumps broken;
b) Sudden abnormal sounds;
c) Excessive high temperature of bearings;
d) Value of voltmeter and ammeter displayed too low or too high (exceed or lower than 5% of the rated voltage or current);
e) Large volumes of leakage occurred to pipelines and valves in machine room;
f) Motor faults.

2.3 Hydrolysis Tank (B200)

2.3.1 Operation Management

- Liquid level controller shall be aligned according to design requirements.
- Operators shall make patrol inspections every shift.
- Discharge sludge according to actual conditions as the operation being in normal.

2.3.2 Maintenance

- Pipes connecting storage regulators shall be inspected regularly.
- The regulator shall be cleaned once a year.

- Sludge-discharging valves shall be checked for normal open and close status the time to discharge sludge.
- Check liquid level controller daily for normal operation.

2.3.3 Safety operation

- Prevent sewage overflow.

2.4 Anaerobic Digester CSTR (B300)

2.4.1 Operation Management

- Start of anaerobic digester shall conform to the following specifications:

a) Remaining foreign substances at the bottom of anaerobic digester shall be removed completely.

b) Anaerobic digester shall be put through water test and air-tight test and repaired if there is seepage or gas leakage. And those repaired can be brought into service only if confirmed acceptable through retest.

c) Respectively align the various instruments related to monitoring of the anaerobic digesters for safety operation;

d) For start-up of anaerobic digester, anaerobic sludge of different anaerobic digesters, manure stored up for long, sludge in pit and pond, or granular sludge bought shall be employed for culturing. While the seeding materials are insufficient, successive culturing or primary culturing may be employed for multiplication culturing;

e) When seeding sludge is difficult to transport, it can be done by dewatering them first and then packing.

f) PH value of feed liquid in anaerobic digester shall be ensured to stay between 6.8 – 7.6, no matter at the time of start up or in operation.

- Sewage shall be fed into anaerobic digester at the amount, concentration and interval as required by specific processes.
- Anaerobic digester shall be kept at stable intermediate temperature or approximate intermediate temperature (about 35 or 25) for digesting. For those heated with heat exchanger, sewage temperature at the inlet and outlet of the heat exchanger shall be measured daily.
- The mixing in anaerobic digester shall be performed according to relevant process requirements. It shall be done with machinery.
- It's preferred to monitor the PH value and temperature of feed liquid in anaerobic digester, internal biogas pressure, biogas production and the

composition daily, and timely regulate the operating conditions of anaerobic digesters according to the monitoring data or take relevant measures.

- Sludge in anaerobic digester shall be discharged regularly according to design requirements. The sludge discharging capacity is controlled from the sampling opening of sludge blanket. Ensure the valves keep working in favourable conditions.
- Maintain free flow of the overflow pipes of anaerobic digester and also ensure the height of water seal.
- Following specifications shall be satisfied when emptying the anaerobic digester for clearing:

a) While emptying for clearing, stop feeding, shut down the joint valve connecting anaerobic digester and biogas storage and open the maintenance manhole at the top of anaerobic digester.

b) While entering anaerobic digester to clear, the working personnel have to operate according to relevant specifications;

c) When anaerobic digester has to be placed idle, water level inside the tank shall be kept not lower than 1/2 the height of tank body, and checked periodically and complemented timely.

2.4.2 Maintenance

- Anaerobic digester, the various pipes and valves shall be inspected and maintained once yearly.
- The various heating facilities of anaerobic digester shall often be descaled and cleared.
- While mixing with machinery, the bearings shall be inspected periodically and treated by applying additional lubricating oil, and connecting bolts of holding frames also have to be inspected and tightened frequently.
- Condensed water in biogas pipes shall be discharged regularly according to design specifications.
- Anaerobic digester shall be cleared and maintained once every 3~4 years preferably.

2.4.3 Safety operation

- It shall be ensured the biogas and liquid pips flow freely before operation of anaerobic digester.
- Regularly check anaerobic digester and biogas pipes for leakage, so as to ensure security.

- While emptying anaerobic digester for clearing and maintenance, firstly shut down the valve leading to biogas storage, then stop feeding and open the manhole at the top. Dumping and clearing can be performed then and just open the lower maintenance manhole till the liquid level falls under it.
- Safety provision is necessary when entering anaerobic digester for maintenance, and also cooperation and monitoring of other personnel out of the tank. Illuminating lamps shall be explosion proof light fittings of safety voltage.
- For sludge-discharging of anaerobic digester, it shall be ensured the anaerobic digester and biogas storage are connected reliably for communication.
- If the explosion proof window of anaerobic digester cracks for excessive positive pressure or negative pressure, replace with other explosion proof materials of equivalent thickness and quality, and in the meanwhile eliminate jams of all gas transmission pipes, related valves and overflow pipes. Resume the operation till ensuring the gas pipes are unobstructed and the explosion windows sealed.
- While performing patrol inspection on anaerobic digester or climbing up and down ladders, operators shall be careful to slipperiness and fall from high altitude causing physical injuries.

2.5 Outlet (After) storage (B400)

2.5.1 Operation Management

- Settling tank shall operate continuously.
- Regularly inspect the effluent from the tank.

2.5.2 Maintenance

- Regularly inspect the drainage valves and perform relevant maintenance.
- Outflow gate shall be regularly cleaned to prevent blocking.
- The tank shall be emptied once per year, to washing the tank wall, clean the piping and valves.

2.5.3 Safety operation

- Prevent sewage overflow.

2.6 Gas storage (B500)

2.6.1 Operation Management

- Inlet and outlet biogas rate in and from the biogas storage and biogas pressure inside shall be monitored by shift and properly recorded.
- The proper pressure of biogas storage shall be 300Pa- 600Pa.
- The water sealing of biogas storage shall be kept in the design level and timely compensated with clean water.
- Prevent draining water when biogas storage is at the low level.

2.6.2 Maintenance

- Regularly check biogas storage, biogas piping and gate valves for leakage.
- Painting or coating on the external surface of biogas storage tanks shall be regularly reapplied.
- The lifting devices and inlet and outlet valves of biogas storage shall be regularly checked and lubricated with lubrication oil (grease).
- Sealing water of biogas storage shall be regularly replaced (ca. 6 months) and when pH value is over 6.
- After 3~5 years of operation, the biogas storage tank shall be generally overhauled and protection paint shall be reapplied on the drum cover.
- Regularly check the control of limiting switch of biogas measuring tank.

2.6.3 Safety operation

- Safety protection and operation of biogas storage shall conform to the requirements.
- Working personnel shall wear electrostatic prevention clothes before going up and into the biogas storage tank for inspection, operation and maintenance, but not put on shoes with iron nails or high-heel shoes.
- Safety and technical plan for emergent biogas storage repair shall be developed and such repair shall be implemented by professional working team.
- Prevent draining water from water seal of biogas storage without permission.
- Pay attention to the water seal and drainage valve to prevent negative or positive pressure accident.
- Flame arrestors shall be installed at the inlet and outlet nozzles of biogas storage and shall be regularly removed for cleaning.

- Lightening arrestors for biogas storage shall be tested and maintained before thundershower season.
- When negative pressure broke the explosion proof window, it shall be replaced with the explosion proofing material of the same thickness and material quality. Additionally, the explosion proof window may be sealed only when the relevant piping and valves are cleared.
- Before typhoon coming, the emergency release valve of biogas storage shall be opened and the biogas storage shall be lowered to the safety level. The blowdown pipe shall be 1.9m higher and equipped with flame arrestor.

2.7 Equipment for gas treatment system

2.7.1 Operation Management

- Regularly discharge condensed water from the condenser. Daily tour of inspecting the biogas pressure in the piping before and after the biogas treatment system.
- Maintain the normal operation of biogas system by using the bypass piping during servicing of biogas purifying equipment.
- Regularly check the gas tightness of the desulfurizer thionizer and the biogas pressure before and after the thionizer during the operation of desulfurization system.
- Regularly replace the circulating water in the desulphurizer thionizer(replacement cycle determined based on the content of hydrogen sulfide in the biogas).

2.7.2 Maintenance

- Regularly check the gas tightness of biogas treatment system and weekly have opening and closing operation of bypass valves and standby desulfurizer valves.
- Regularly discharge condensed water from the equipment for biogas treatment system.
- Determine the operation alternating cycle according to the equipment requirements and the hydrogen sulfide content in the biogas.

2.7.3 Safety operation

- Avoid biogas outflow when discharging condensed water from the equipment for biogas treatment system.

- Open bypass valves and check the valves to confirm the valves are completely closed before starting operation of biogas treatment system cleaning, and take measures to prevent fire, exploding and ensure the indoor ventilation.
- Regularly verify the function of combustible gas alarming.

2.8 Control room

2.8.1 Operation Management

- Operators shall inspect if the control signals of all the equipment and systems are normal with the operation records properly noted down, and inform the maintenance personnel or operation management personnel in case of any failure discovered.
- Have regular tour of inspecting the instruments for control, display and recording, and timely take responding measures in case of any abnormal situation.
- Clean off dirt and fouling from sensors, transmitters and converters of all the testing instruments according to the requirements.
- Do not change the set testing points without permission during replacing instruments, or remove any transmitter or converter at will.

2.8.2 Maintenance

- Maintenance of control panels shall conform to the following requirements:
  a) Keep the inside of the control panels clean;
  b) Regularly check and replace the contacts of contactors and relays, and regularly verify the programmed control systems;
  c) Regularly inspect the cable terminal clamps to ensure the close contacts and prevent rusting;
  d) Keep the cables in good order and clear sorting after the maintenance.
- Maintenance of instruments and meters shall conform to the following requirements:
  a) Keep all parts clean;
  b) Ensure the dial scales clear;
  c) Maintain the nameplate, marks and lead-sealing sound;
  d) Regularly check and replace damp-proof agent.
- Cleaning of instrument and meter parts shall conform to the following requirements:
  a) Cleaning with alcohol, cleaning detergent or supersonic wave;
  b) Do not use cleaning agent harmful to the parts or components;

- Regularly maintain the elements, probes and converters of each instrument and meter.
- Instrument and meter maintenance only by professional technicians. Important and expensive instruments are not dismantled at will. The maintenance is only by professional maintenance department or the manufacturer is consulted.

2.8.3 Safety operation

- Persons other than the operators shall not enter the control room without permission; equipment and instruments in the control room are only operated by professional personnel.
- Equipment servicing is only performed under the condition of power disconnection; in case of any procedure failure alarm or equipment tripping due to failure, the equipment shall be stopped for servicing and the switch shall not be closed until the default is eliminated.
- Keep smooth communication between the control room and each operation procedure. Make sure to tag out when servicing.

2.9 Testing Laboratory

2.9.1 Operation Management

- Testing items and cycle of normal operation shall conform to the following Table 1:

No.	Test item	Test cycle	Test method
1	pH Value	daily	pH test meter or pH-litmus test paper
2	Discharge amount	Monthly	Sewage flow meter
3	TS content	one time per week	Dryer
4	Biogas Analyse	one time per week	Equipment
5	H_2S	Monthly	Equipment

Table 1: Testing Items and Cycle

- All the instruments, devices, chemicals and samples shall be distributed based on the demand, and placed in the respectively fixed position in order. Special persons shall be designated for precise instruments and measuring devices shall contain “CMC” mark. All the chemicals and samples shall be labelled.
- Testing and analyzing personnel shall be familiar with the commissioning, and ordinary Maintenance of common instruments and equipment. Any failure of instrument or equipment shall be timely reported.
- Analyzing, summarization and filing of testing data shall be processed and management with computer.
- Keep sound ventilation in testing laboratory.
- Keep the original laboratory records for future reference.

2.9.2 Maintenance

- Routine Maintenance of instruments and equipment in testing laboratory is performed by operators.

2.9.3 Safety operation

- Particular attention shall be paid to electric heaters, combustible and explosive materials, harmful samples and etc. in the laboratory and relevant safety protection and safety operation requirements shall be followed for the operation.
- Testing operations that may release harmful gas or irrigative odour shall be performed under the condition of effective ventilation.
- Prevent to handle with dangerous chemicals with bare hands. Dangerous chemicals shall be controlled by designated persons and detailed consumption records shall be taken.
- Upon completing the work, monitoring and analyzing personnel shall timely switch off the instruments, water, power and gas.
- Place fire distinguishers in easily accessible positions in the laboratory.

2.10 The biological Desulphurization Tower (K500)

2.10.1 Introduction

The produced biogas from anaerobic digester consist of a small amount of H_2S, the level is dependent of the input material and the biogas system. Using the biological desulphuri-

sation tower the H_2S content of the biogas can be reduced down to a level of below 500 ppm by oxidised into elementary sulphur, which can be found as yellow-white incrustations .

The biological desulphurisation system consists a air blower and a recycling pump. In the system there some packing materials layers to keep the bacteria. In this way the desulphurisation bacteria are provided with oxygen, which is needed for the biocatalytic effect.

For the treatment of sisal liquid waste, the produced biogas amount in CSTR digester and the after storage tank is range from 1000 to1500 m^3 per day. For the whole biogas production a blower capacity of 3,5 m^3/h is required.

As a control for the quality of the process a H_2S measure device and a flow meter for the air flow control is necessary.

Litterature tell us that the biogas from crops have less H_2S contents. That the best way to confirm this issues. Anyway for this demonstration biogasplant a biological desulphuric tower is installed.

2.10.2 Operation Management

- Air input in the desulphurization tower shall be controlled with maximum 5 % air in the biogas gas flow.
- Before starting of the desulphurization tower, all the concern pipes, valves and pumps and equipment shall be inspected
- circulative pump system should work 6~8 periods per day, every period should be about 20 minutes.

2.10.3 Maintenance

- The feeding liquid(diluted cow manure) with rich of nutrients used in the desulphurization tower shall be partially replaced in a regular manner. Normally, the replacing quantity should be 1/4 of the total quantity when the pH value is low than 4.
- Solid sedimentation in the desulphurization tower shall be removed regularly.
- In case of any blocking in the circulative pump system or filling material in the

desulphurization tower, corresponding measures shall be taken timely to recover the normal operation.

- In case of any distinct fluctuation in the rate of removing hydrogen sulphides from the desulphurization tower, investigation shall be performed to find out the causes so that system operation parameters are adjusted or corresponding measures are taken to recover the normal operation.

2.10.4 Safety operation

- Particular attention during maintenance closed the gasvalve from Digester and from Gastank and release the gas in the tower trough the control pipe.

2.11 The gas pressure safety device (Water Seal)

2.11.1 Introduction

The safety water seal device is a protective equipment for biogas overpressure and negative pressure of biogas digester, designed positive protection pressure is 3200Pa, designed negative protection pressure is －300 Pa, and the protective range of pressure can be properly adjusted according to the pressure demand of anaerobic digester.

2.11.2 Operation Management

- The interface of biogas is connected with the gas transmission pipeline or the gas-storage chamber of anaerobic digester;

- Before the debugging process, adding clear water via the pressure discharging mouths for overpressure and negative pressure respectively, and the water level reaches to a position which is 430mm away from the bottom of water seal device;

- In the debugging process, firstly, measuring the practical pressure of biogas in the safety water seal place, the level of liquidometer in the area of positive pressure should reach to 430mm; and then adjusting the level of liquidometer in the area of negative pressure to the position of 430mm;

- The change of water level to which should be paid careful attention in the daily running process, maintaining that the rate of liquidometer change is no larger than 5%.

2.11.3 Maintenance

- Daily check up and filling with water.
- Visualcontrol off leckage and abnormal issue like water boobling.

2.11.4 Safety operation

- Particular attention during maintenance.

3 PROCESS VISUALISATION AND AUTOMATISATION

3.1 Computer Monitoring system

The computer monitoring system (briefly called the Visualisation) for the Biogas-plant at Hale Estate is specially designed for the Project according to relevant technological requirements. This configuration is only valid for the biogasplant at Hale Estate.

3.1.1 System functions

The monitoring system is composed of several functional modules as listed below:

(1) Real-time data collection and communication processing;

(2) Process monitoring and dynamic simulation display;

- Main startup screen
- Monitoring display of process flow
- Monitoring display of collection tank (B100)
- Monitoring display of hydrolize tank (B200)
- Monitoring display of CSTR digester (B300)
- Monitoring display of after-storage tank (B400)
- Monitoring display of desulfurizing tower (K500) a. CHP Unit Data

(1) Access to data record and data backup;

(2) Curves, statistic report and data compression;

(3) System fault diagnosis and alarms;

3.1.2 Operating conditions

(1) Minimum requirements for hardware configuration

- CPU: >PⅢ800MHZ;
- EMS memory: >128MB;
- Hardware (free space): >40G.

3 Operating conditions of software

- Operation system: WINDOWS series (WINDOWS 2000, WINDOWS XP and WINDOWS 2003)
- Tools: Visual Basic 6.0

4 Others

- Resolution of 1024×768 or above is recommended;
- The character style is of lower-case type (100% scale). Others different from said setting may cause display-window morphing.

3.1.3. Basic operation instructions

4.1.3.1 Operation with mouse

The left and right key of a mouse are different in functions, with the left functioning as the main key for realizing normal selection and the right for displaying shortcut menu by pressing. The shortcut menu consists of operations related to current mouse position;

- Pointing with mouse: move the mouse to certain target;
- Click once by pressing the left key: press the left key of a mouse and then release;
- Double click by pressing the left key:repeat pressing and releasing once;
- Click once by pressing the right key: press the right key of a mouse and then release;
- Dragging: click some object; and then press the left key of mouse and hold; move mouse to another position and release the pressed key.

3.1.4. Start and Exit

4.1.4.1 Start

1) After switching the computer who is put behind the Monitor. Windows 2000 will processing until the desktop is show as in *fig.1*

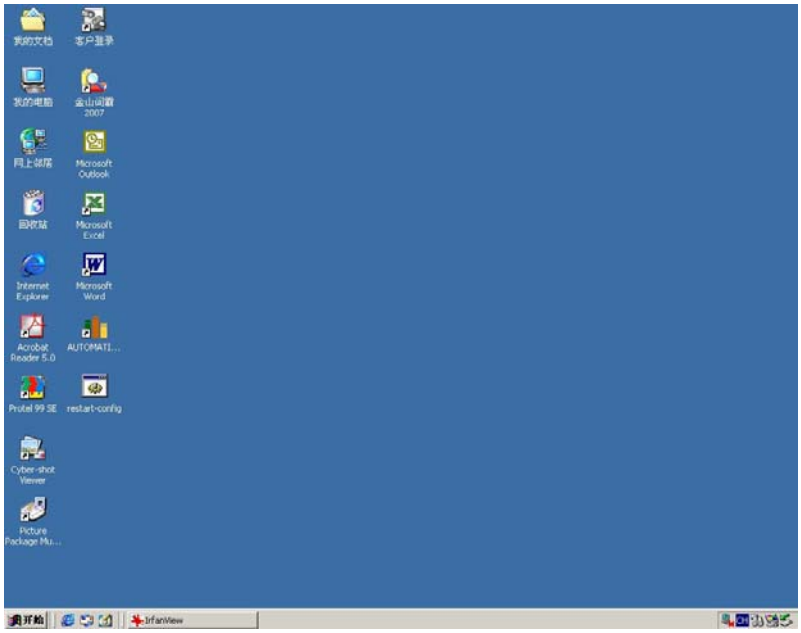


Fig.1

2) Activitate the monitoring program by clicking the label AUTOMATISATION as show in the *Fig.2*

Fig.2

4.1.4.2 System start

The PLC is start by opening the program Automatisation. Please confirm for going on of the on-site control station firstly and then power the computer of the same station to start. Start interface displays (see *Fig. 3*), entering PLC checking window.

Fig.3

Fig. 4

Fig. 4 displays as the checking is finished and click “ok” to enter the main interface of the monitoring system.

4.1.4.3 System exit

To exit from the PLC, click function icon 

on the monitoring display of the system.

3.1.5. Instructions for system operation

3.1.5.1 Main interface

A main interface as in *Fig.5* displays with the startup and running of the monitoring system.

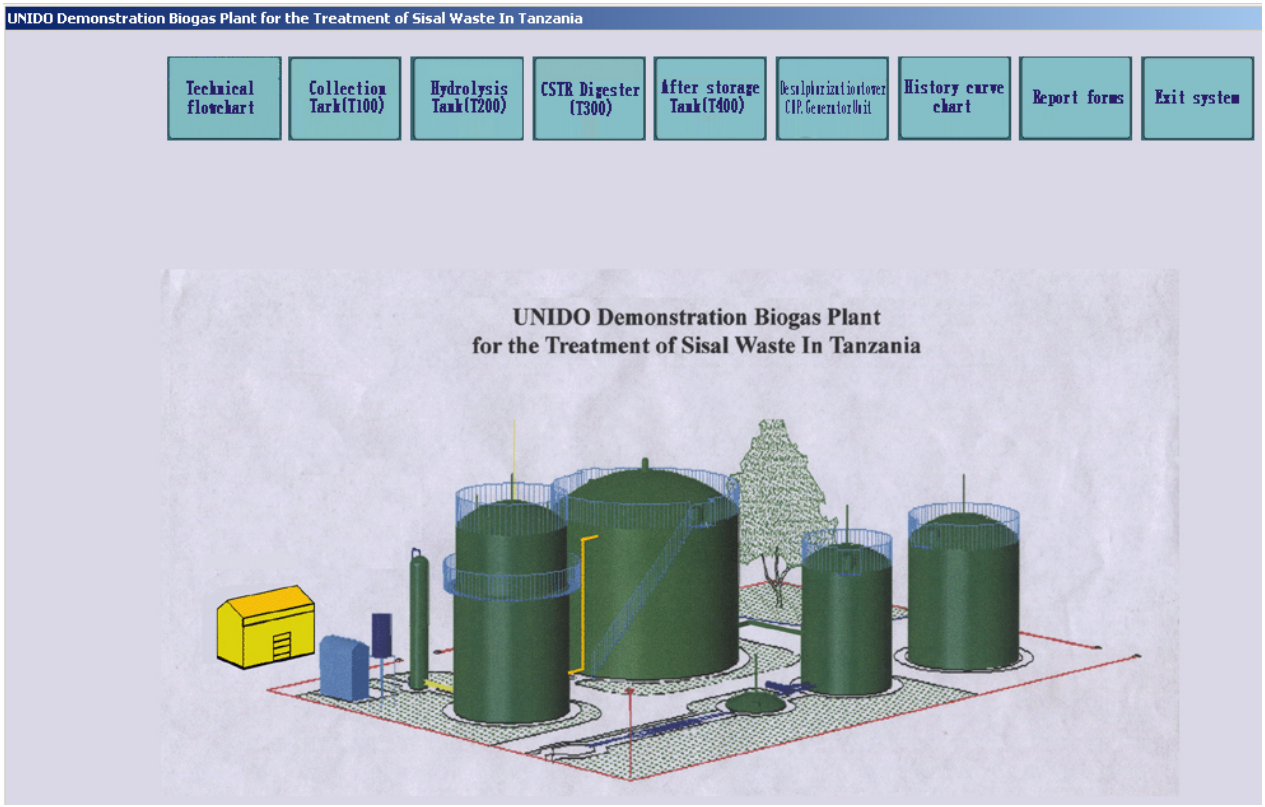


Fig.5

Select and click the function icons on the main interface (see *Fig. 6*) to enter sub-displays of the control system.

Fig. 6

3.5.1.2 Monitoring display of process flow

Click function icon “process flow” to enter the monitoring display of process flow (see *Fig. 7*).

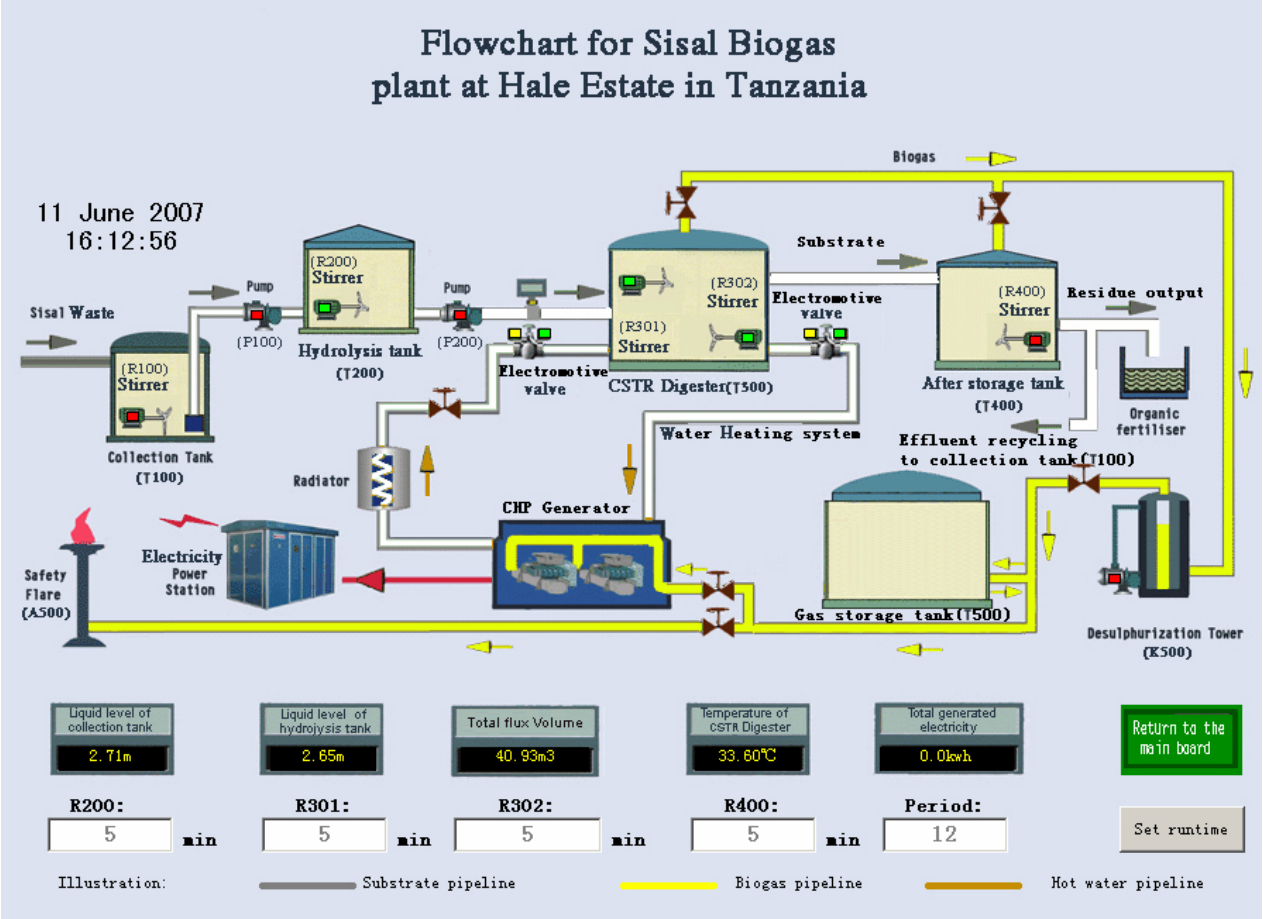


Fig. 7

Corresponding indications of colors of **the pumps, motors** and **valves** in the display:

Yellow --- busy (in operation)

Red --- stop (off)

Green --- running (startup)

Corresponding indications of the **pipe colors**:

White --- no medium flow;

Yellow --- biogas pipeline;

Green --- circulating pipe;

Grey ---feed liquor pipeline;

Those under the said display are display windows of on-line instrument parameters. From left to right, there are the liquid level of the collection tank *(B100)*, liquid level of the hydrolize tank *(B200)*, flow volume of the feed liquor pump, temperature of the anaerobic digester.

Click 

to go back to the main interface.

3.1.5.2 Monitoring display of collection tank (B100)

Click function icon “collection tank” to enter the dynamic monitoring display of the collection tank (see *Fig.8*).

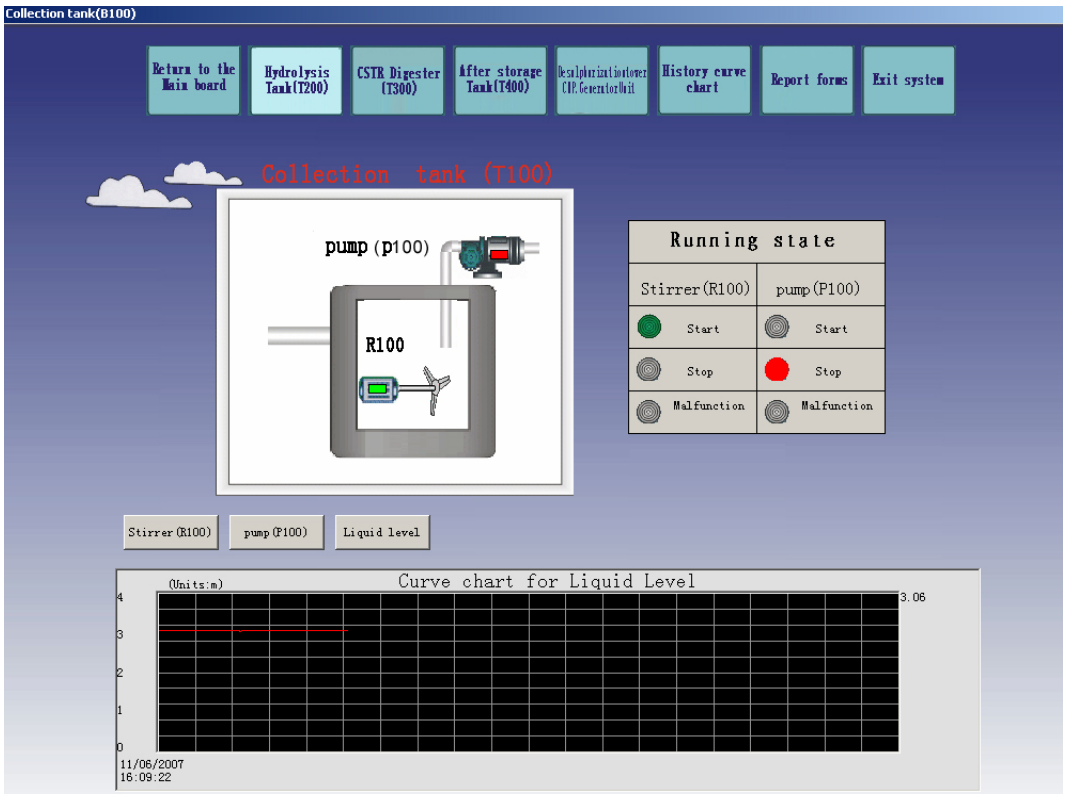


Fig. 8

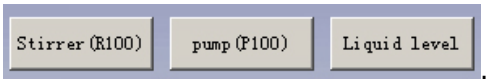
Corresponding indications of the switch colors of pumps and mixers in the display and the flow chart:

Yellow --- busy (in operation);

Red --- stop (off);

Green --- running (startup);

The left displays operation condition of the equipment, for which the color indications are the same as those defined above.

That under the display is the real-time curve for operation conditions and process parameters of equipment and on-line detecting instruments applied currently. Corresponding real-time curve will be shown in the curve graph while clicking function icons - 

. Click function icon 

to exit.

3.1.5.3 Monitoring display of hydrolise tank (B200)

Click function icon “hydrolize tank” to enter the dynamic monitoring display of the hydrolize tank (see *Fig.9*).

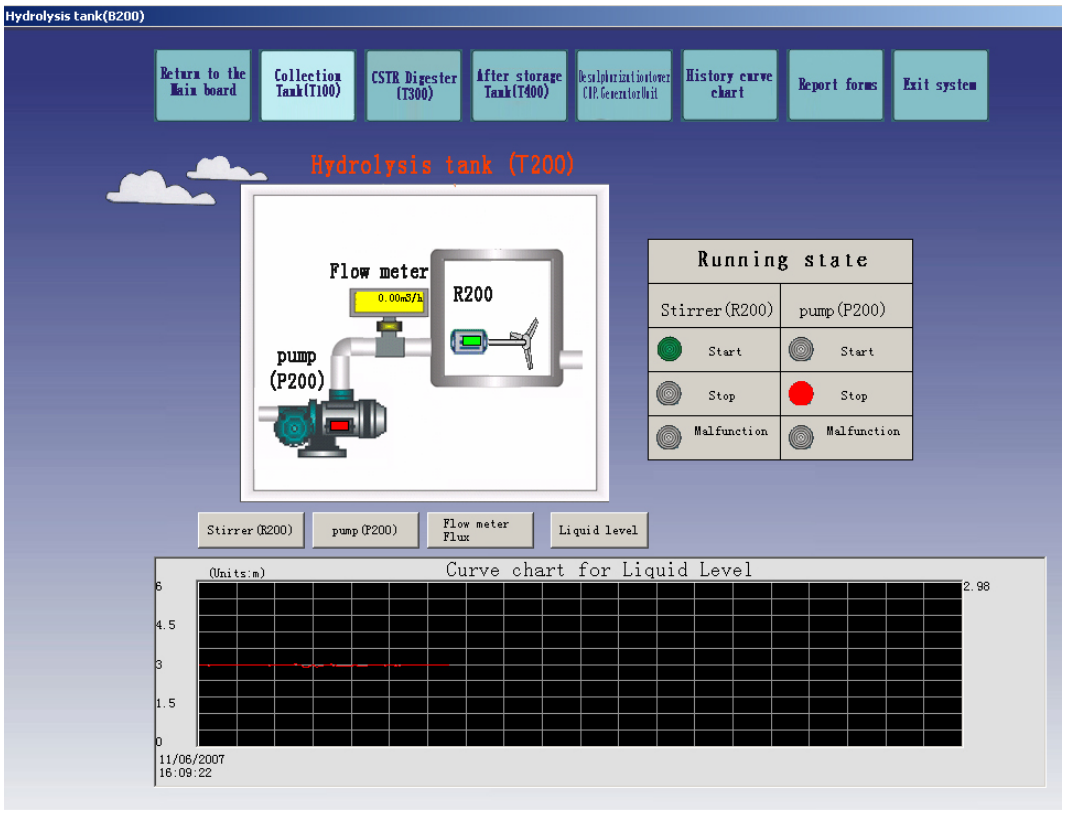


Fig. 9

Function descriptions on this monitoring display are the same that of the collection tank (*B100*). Click function icon 

to exit automatically.

3.1.5.4 Monitoring display of CSTR digester (B300)

Click function icon “CSTR digester” to enter the dynamic monitoring display of the anaerobic digester (see *Fig.10*).

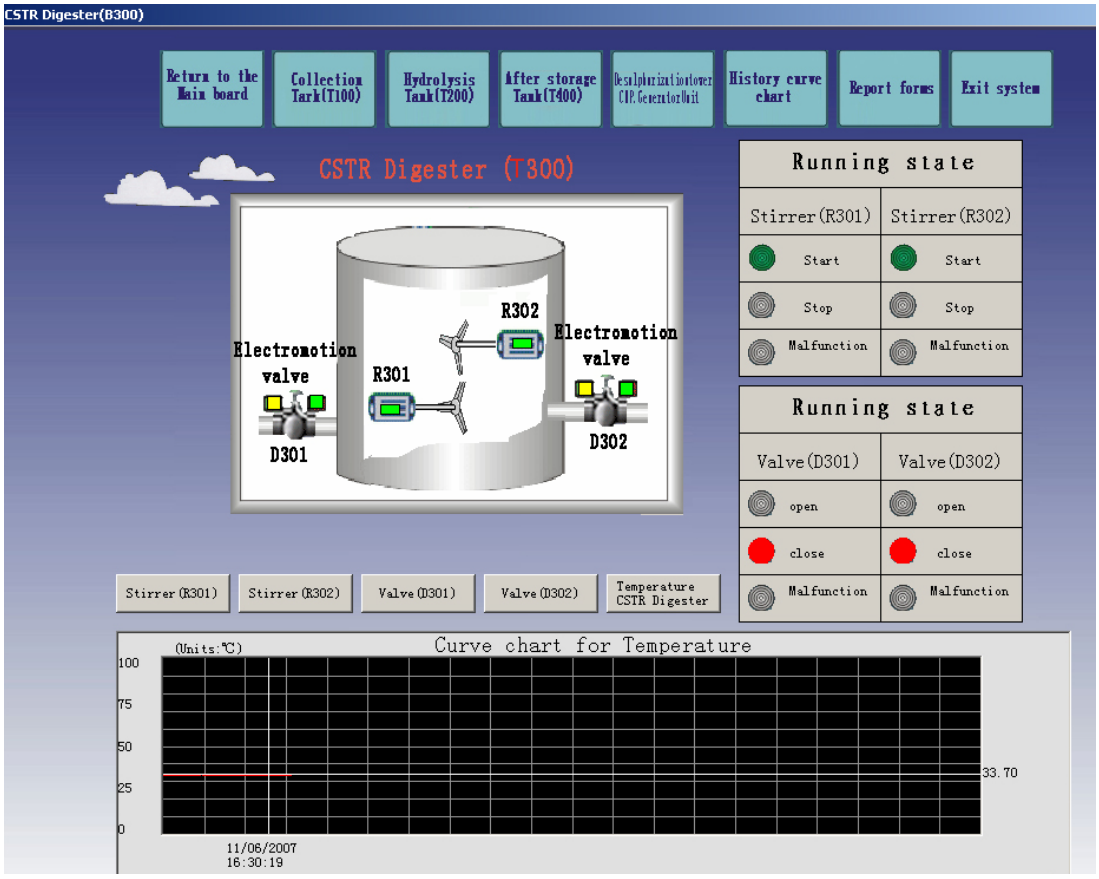


Fig. 10

Function descriptions on this monitoring display are the same that of the collection tank.

Click function icon 

to exit automatically.

3.1.5.5 Monitoring display of after-storage tank (B400)

Click function icon “after-storage tank” to enter the dynamic monitoring display of the after-storage tank (see *Fig.11*).

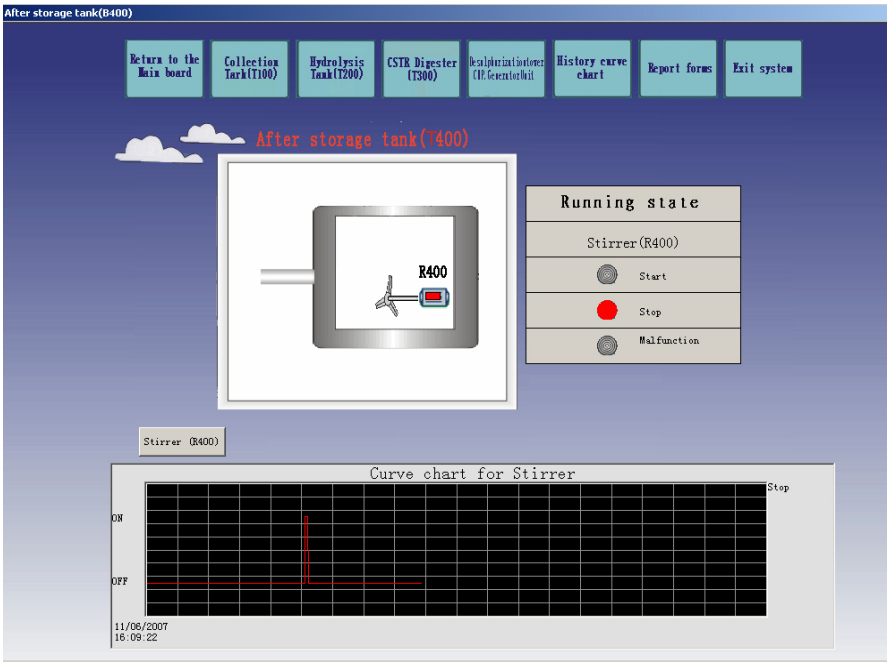


Fig.11

Function descriptions on this monitoring display are the same that of the collection tank.

Click function icon 

to exit automatically.

3.1.5.6 Monitoring display of desulfurizing tower (K500) /CHP unit

Click function icon “desulfurizing tower/CHP unit” to enter the dynamic monitoring display of the desulfurizing tower(K500) /CHP unit (see *Fig.12*).

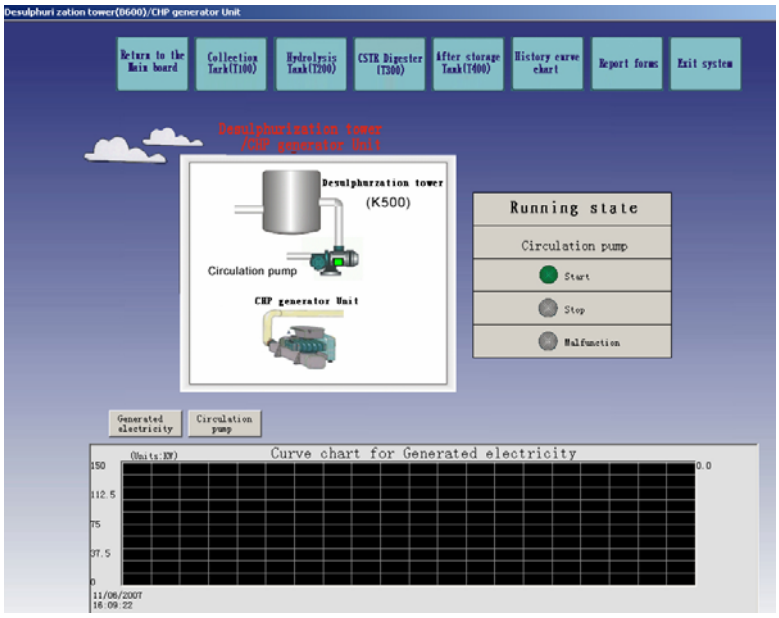


Fig.12

Function descriptions on this monitoring display are the same that of the collection tank.

Click function icon 

to exit automatically.

3.1.5.7 History curve

Click function icon "history curve" to enter the selection interface (see Fig. 13);

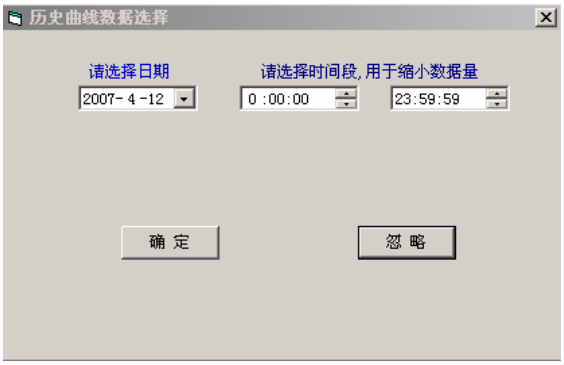


Fig.13

Select the time range for checking (see Fig. 14).

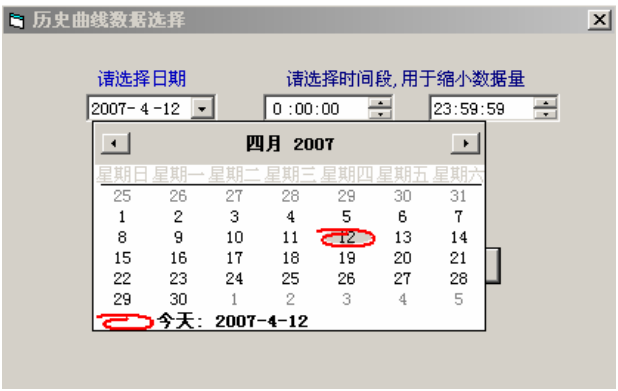


Fig.15

Click “ok” to enter the window for checking history curve (see *Fig. 16*).

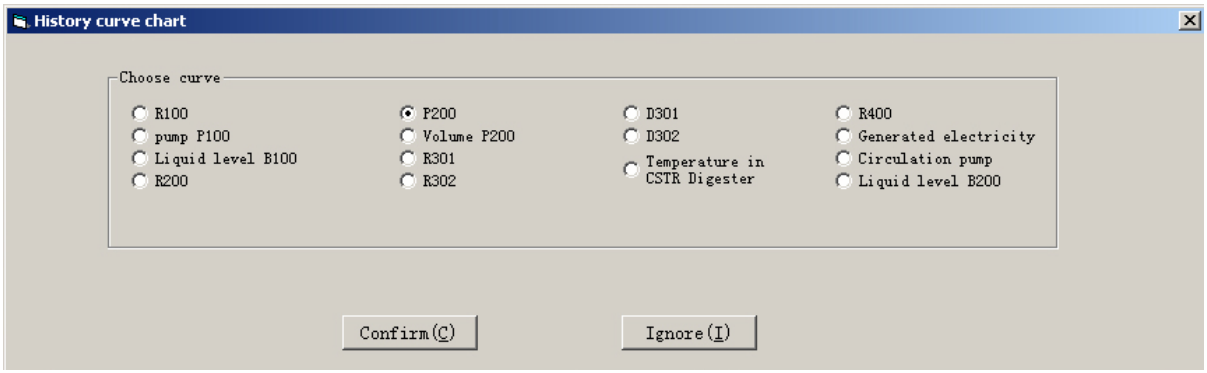


Fig.16

Select an object to be checked and click “ok”. History curve for corresponding parameter will display in the curve shown in *Fig. 17*.

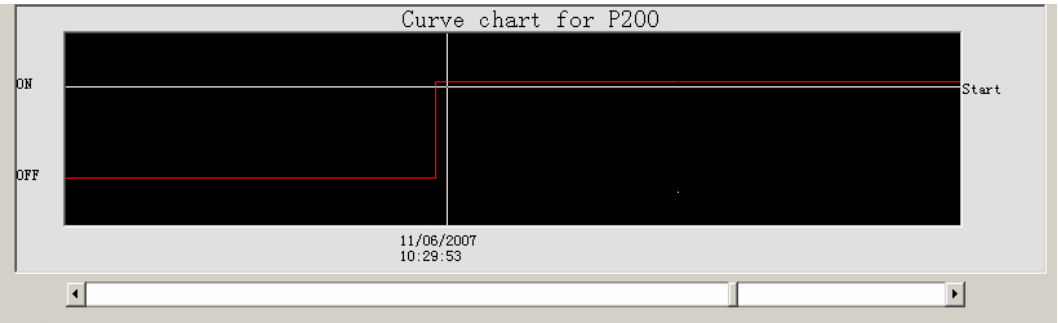


Fig. 17

Parameter curve within certain time range can be checked through dragging the “time frame bar”.

3.1.6 Fault diagnosing and system maintenance

3.1.6.1 Fault diagnosis and alarms;

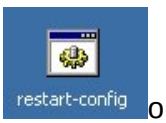
Once fault signals related to electric equipment as pumps, motors, mixers and electronic valves are detected, the monitoring system will find out fault equipment immediately through diagnosing. Then “red" and “yellow” icons flashing alternatively will be shown on the monitoring display and an alarm signal will also be given. There, the operator is not required to close the system but to handle fault electric equipment according to the system prompts.

3.1.6.2 System maintenance

(1) Check whether the PLC control station and other hardwares are ready and status display are correct before starting the system; then start the computer operation station.

(2) Don’t close PLC or change the status while the system is running. If PLC is closed while the system is in running status, close the monitoring system of operation station immediately and then restart the whole control system in precedence.

(3) While the monitoring system is in normal operation condition, there will be continuous curve in the curve graph; if the monitoring system is closed during the operating process or some fault occurs in the online communication and online instrument detection, which interrupt the data collecting process, then there will be jump curve on the time line of the curve graph.

(4) For rebooting the PLC System the Dos link 

on the windows desktop have to be used.

3. 2 The Description of Automatic Controlling System

3.2.1 Collection Tank (B100)

This tank is feeded manually, the stirrer R100 starts stirring after feeding, and the time of stirring is 15 minutes. After the manual stirring process is finished, the dived pump P100 is switched on manually, the amount of input material (sisal liquid waste) is 32.5m^3 every time, and the total amount of input material is 65 m^3 (from B100 to B200), namely, inputting twice a day (this whole process is controlled manually).

3.2.2 Hydrolysis Tank (B200)

The stirrer R200 is not switched on until the time is prolonged for 1 minute after the pump P100 is switched off (the prolonged time is not adjustable), and the operating time of R200 is 10 minutes every time (the operating time of stirring is adjustable). The stirring period of R200 is 12 times per day (every 2 hours).

The amount of input material from B200 to B300**:** 12 times per day, about 5.4 m^3 every time, and the time of inputting process is about 30 minutes every time (the operating time is fixed according to the actual test on the spot). The pump for inputting material is P200.

3.2.3 CSTR Digester Tank (B300)

R200 is switched off after its operating time goes on 10 minutes (the operating time of stirring is adjustable), after the immediately following time is prolonged for 1 minute (this prolonged time is not adjustable), P200 is switched on, and P200 is not switched off until the time of inputting material every time is up to 30 minutes (about 5.4 m^3). After the immediately following time is prolonged for 1 minute (this prolonged time is not adjustable), the stirrer R301 & R302 are switched on, and after 15 minutes of stirring (the operating time of stirring is adjustable), the stirrer R301 & R302 are switched off.

In the CSTR Digester of B300, the temperature of hot water must be automatically controlled completely, namely, t＞35℃, the hot water gate-valve is closed, t＜30℃, the hot water gate-valve is opened.

3.2.3 After-storage Tank (B400)

The stirrer R301 and R302 is switched off after 15 minutes of stirring process, the immediately following time is prolonged for 1 minutes (the prolonged time is not adjustable), then the stirrer R400 starts to stir, and R400 is stopped after 5 minutes of stirring process (the operating time of stirring is adjustable), the stirrer R400 is run 6 times every day, and 5 minutes at a time.

3.2.4 The Description of Automatic Controlling for Pump and Stirrer

P100 Stop(manual controlling), prolonged for 1 minutes ⟶ R200 Startup, running for 10 minutes ⟶ R200 Stop, prolonged for 1 minutes ⟶ P200 Startup, attain the pre-estimated amount of inputting material(about 30 minutes).
⟶ P200 Stop, prolonged for 1 minutes ⟶ R301 & R302 Startup, running for 15 minutes ⟶ R301 & R302 Stop, prolonged for 1 minutes.
⟶ R400 Startup, running for 5 minutes ⟶ R400 Stop.

The whole above-mentioned technological process demonstration is a complete period, one circulation of this period needs about 60 minutes, 12 complete periods per day (24 hours) totally (the amount of periods is adjustable) .

3.2.5 Remark

The 2 times of manually inputting material every day in B100 and the 2 times of operating of R100 & P100, which must be definitely accorded with the following 12 times per day of automatic timing circulation process, (that is to say, the inputting material time of P100 must be well controlled manually), otherwise the timing periods will be disturbed day to day.

The temperature in the tank would be controlled in the scope of 30℃-35℃ due to the electric valve controlling scope of tolerate 5°C so that frequently valve could be alternately opened and closed.

4 CHP- Unit

4.1 CHP- Unit Operation and Maintenance Instruction

4.1.1 Introduction

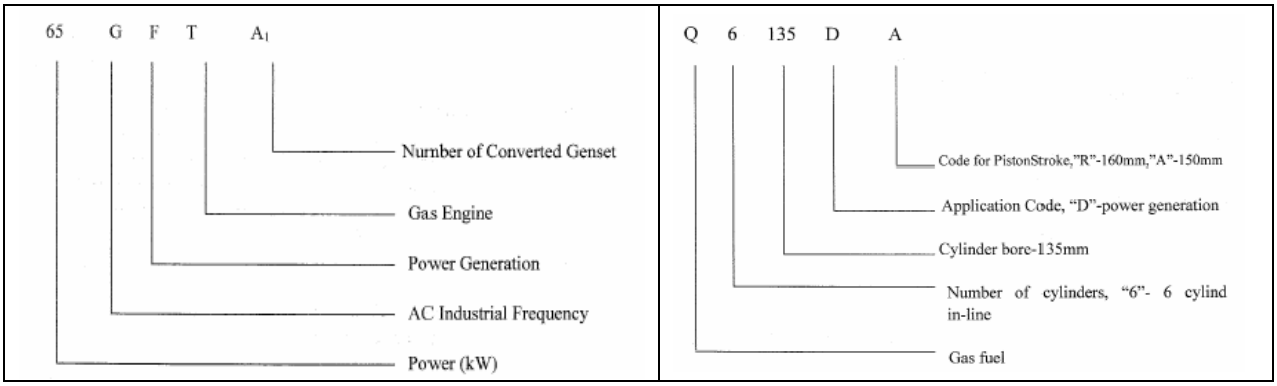
Series 135 gas engine generating sets (gen-set) are packaged with series gas engines, with power rating from 30kW to 140kW. The generating sets are power supply equipment which are of continuous, steady, safety and environmental protection.

This instruction gives descriptions only on the operation and maintenance.

Caution

1. Read carefully this instruction, Operation and Maintenance Manual for series 135 Gas Engine, and master the structural features and operating method of gas engine.
2. In Order to extend the operation life of the generating set, it is recommended to use good quality oil (i.e. 40CD or 40ECD, etc) and avoid idle running for long time. Natural gas should be filtered to requirement before being used.
3. When new engine operates at the initial 60hours, the opening of gas throttle valve should be controlled at the position within ¾ working condition to make engine running at partial load.
4. After the initial 60 hours running, re-tightened up cylinder head nuts, exhaust pipe nuts and all other accessible nuts and bolts with specified tightening torque.

Composing Instruction for Models of Series 135 Gas Engine and generating set:



Composition of generating set

Gas generating set is composed of gas engine, AC alternator, control system and cooling system. The cooling of gas generating set is closed, forced circulation cooling system by means of water

pump, fan and water tank, with good cooling effect et is mounted on a rigid common base frame which can be transported completely a. fixed on the foundation.

4.1.1.1 GAS SUPPLY SYSTEM

The system includes pressure-stabilized vessel (used to separate oil and water), pressure regulating valve, and solenoid valve for air intake, etc.

Customers can chose for order according to their own requirement.

4.1.1.2 CONTROL SYSTEM

The generating set is fitted with multi-functional a. auto monitoring control panel to carry out main data monitoring, over-limit alarm a. auto shutdown.

4.1.2 Technical Performance a. Main Technical Data

4.1.2.1 Operation condition

Series 135 gas generating set can continuously output rated power in the following condition:

1) Atmospheric pressure 100 kPa;
2) Ambient temperature 5-40°C;
3) Altitude < 1000m
4) Relative humidity < 90%
5) Exhaust back pressure < 5kPa

For the gas quality requirement, refer to “Operation a. Maintenance Manual for Series 135 Gas Engine”

The maximum output power of the generating set ca not be 4% larger than the rated power on the name plate.

As the generating set is continuously running, the output power should not exceed 80% of the rated power.

4.1.2.2 Technical performance

The voltage regulating range with no load is 95-105% of the rated voltage. The models, specifications a. technical data are shown in the following table:

发电机组型号 Gen-set Model	40GFTA-1	65GFTA-1	80GFTA-1
发动机型号 Engine Model	Q4135DA	Q6135DA	Q6135DR
额定功率 Rated power (Kw)	40	65	80
额定转速 Rated Speed (r/min)	1500		
额定电压 Rated Voltage (V)	400		
额定电流 Rated Current (A)	72	117	144
额定频率 Rated Frequency (Hz)	50		
功率因数 Power Factor	0.8（滞后 lagging）		
供电制式 Wiring Way	三相四线制 Three-phase, four-wire		
励磁方式 Excitation Mode	无刷 Brushless		
启动方式 Starting Mode	电启动 Electric starting		
冷却方式 Cooling Mode	闭式水冷 Closed, water cooled		
燃气耗 SpecificGasConsumption (m^3/Kw·h)	≤0.32		
外形尺寸 Overall Dimension (mm)	2420×905×1500	3000×905×1500	3000×905×1500
净重 Net Weight (Kg)	1980	2310	2430

4.1.3 Alternator

4.1.3.1 Structural features

Brushless excitation and class F insulation are used for series 1FC6 alternator, which are mainly composed of main alternator, exciter and exication system. The armature winding of the alternator is specially insulated to have the features of operating normally under various conditions.

The exciter is a rotary armature type salient pole synchronous alternator, with main magnet pole in stator and main pole coil. AC armature windings is set on the rotor, with output transformed trough rotary rectifier into DC power to led to the rotor winding of the alternator to excite for the alternator.

The excitation system of the 1FC6 alternator is composed of excitation device and auto voltage regulator (AVR).

4.1.3.2 Operation of alternator

1) Preparations for operating alternator
2) Appearance check. And make that nothing fall into the alternator and all covers are in their position. Check ground for secure.

1.1. Starting a. running

1) For the initial starting, turn the voltage regulating potentiometer counter-clockwise to end.
2) Turn off the auto air circuit breaker.
3) Start the engine and make speed up to rated value.
4) Regulate voltage regulating potentiometer to rated value

1.2. Shutdown

1) Reduce alternator load to minimum.
2) Turn off the auto air circuit breaker.
3) Shutdown the engine.

4.1.3.3 Caution for operating alternator

1) The relevant performance data of alternator have been adjusted before delivery. If on-site adjustment has to be made, it should be done carefully by qualified personnel.
2) A alternator running, closely pay attention to the variation off all instrument in control panel. The variation of voltage indication should be within prescribed limit. Tree-phase current and voltage should be balance.
3) Pay attention to the working temperature and vent cooling of alternator.
4) Keep alternator clean in operation, and prevent dust, water drop or metal falling in it. Clean dirt in alternator regularly with dry compression air.
5) It is strictly forbidden for the overload operation of alternator.

4.1.4 Installation of Generating set

Attention should be taken for the following in the handling of generating set:

1) Before lifting, first dismantle all the oil, water, air pipes and cables connecting with the generating set. Close tightly all the pipe openings with plastic or suitable materials.
2) During lifting, use the steel cable and lifting tolls which are strong enough to bear the weight of generating set. The steel cable should be hung in lifting hooks at 2 ends of base frame. Its lengh should be suitable. Make the lifting hook 1m higher than the top surface of the exhaust pipe so that stell cable may not get in touch with the parts of generating set directly.
3) As handling, pay special attention to the control panel to prevent external knobs and instrument from damage.

4.1.4.1 Safety a. environmental requirement

The installation environment for the gas generating set should meet the following requirement:

1) The generating set should be installed in the engine room with good ventilation a. clean environment, a. close to the main load equipment a. distribution room.
2) Good forced ventilation should be guaranteed at the fan side of the engine room.
3) Goods that can cause acid a. soda corrosiveness gas are not allowed to be laid in the engine room.
4) Set leading exhaust pipe to vent the exhaust gas out of the engine room.

4.1.4.2 Foundation

The installation foundation for generating set i

Required to be level and solid. The depth is 0.6-0.8m. The width of foundation should be 0.2-0.4m wider than of the common base frame. The generating set is mounted with foot bolts, cable ditch a. dust drain duct should be set up around the foundation.

The installation foundation for control panel should be set up and vibration resistant measures be made.

Installation for the accessories should meet the following requirement:

1) The mounting of water, oil, gas pipe etc should meet the specified requirement
2) He battery should be mounted close to the motor a. connecting wire be as short as possible.

3) The wire between generating set a. control panel should be short as possible
4) The connecting cable between alternator a. control panel a. all wires of instrument should be set correctly a. avoid bending. It is best to lay them under slot plate or in ditch.

4.1.5 Operation a. Adjustment of Gas Engine

Before operating the engine select proper gas, lube oil a. cooling water according to specific operational environment and condition, which will have great influence on the performance and service life of the engine.

4.1.5.1 Gas

Series 135 gas engines are mainly fuelled on natural gas, and also oil field company gas, liquefied petroleum gas and other combustible gas. The used gas should be dried and de-watered to be of no free water, crude oil and light oil, with the low calorific value of no less than 35MJ/m, total sulphur content of no less than 480mg/m³, and content of hydrogen sulphide no less than 20mg/m³. In Addition, gas pressure shoud be at the range of 0.05-0.3MPa.

4.1.5.2 Lube Oil

Lube Oil should of good fluidity under minimum ambient temperature and of appropriate kinematics viscosity under maximum oil temperature. Series 135 gas engine should use the special oil for gas engine such as 15W40CD or 15W40CC. The lube oil must be clean and no water is allowed to enter the oil. The mixture of lube oil of different grade is forbidden. Before a different kind of lube is filled into the engine replace the used oil, the lubricating system must be thoroughly cleaned.

4.1.5.3 Cooling Water

As a coolant of cooling system to cool the engine directly, clean fresh water is recommended. Well water or other underground water (hard water) containing too much minerals should not be used because scale will be formed in the water jacket, affecting the cooling efficiency and thus causing engine fault. In case only water is avaible, it must be softened before it can be used as coolant. The softening treatment can be carried out in the following methods:

a) Boiling: Heat water to boiling point and then let it settle; adding caustic soda (in proportion of 0.67g/l) and then stir and settle it again. The upper clean water without sediment can be used.

When the engine is operated under the ambient temperature of lower than 0°C, care must be taken to prevent cooling water from freezing and ensure thet the parts concerned will not be damaged by frozen

water. Anti-freeze coolant of proper condensation point is used or hot water filled before starting engine, but after the engine stops, the coolant of all parts should be discharged.

b) Valve clearance of series 135 gas engine in cold state

Item	Intake valve clearance	Exhaust valve clearance
Value (mm)	0.3~0.35	0.3~0.4

c) Cylinder order

The cylinder order of series 135 gas engine is counted from the end (free end). The firing order of series 135 gas engine are as the following table:

Description	Firing order
4- cylinder engine	1-3-4-2
6-cylinder engine	1-5-3-6-2-4

4.1.5.4 Valve adjustment

Before adjusting the valve clearance, remove the cylinder head cover and turn the crankshaft until the timing pointer on the inspection window of flywhell housing points to the “0” mark on the rim of the flywheel. During operation, it is necessary to prevent distortion of the timing pointer. The pointer should be licated between 2 limiting marks on the flywheel housing. At this moment, the pistons, the 1st and 4th cylinder engine, and the 1st and 6th cylinder engine are at their top dead center position. Then, determine which one is at the beginning of its expansion stroke. Turn the crankshaft slightly to see whether the intake and exhaust valves of a cylinder maintain still. If the intake and exhaust valves of the corresponding cylinder remain still when the crankshaft is slightly turned, it means that cylinder is at the beginning of its expansion stroke.

Adjustment of valve clearance:

	Description	Cylinder Number whose valve clearance can be adjusted when the piston of the 1st cylinder is at the beginning of its expansion stroke	Cylinder Number whose valve clearance can be adjusted when the piston of the 4th cylinder of the 4- cylinder engine ot the 6th of the

			6-cylinder engine is at the beginning of its expansion stroke
4 cylinder	Intake valve	1-2	3-4
engine	Exhaust valve	1-3	2-4
6-cylinder engine	Intake valve	1-2-4	3-5-6
	Exhaust valve	1-3-5	2-4-6

When adjusting the valve clearance, loose the lock nut and adjustment screw on the rocker arm by means of wrench and screw driver and slip a feeler gauge corresponding to the specified valve clearance between the rocker arm and the tip of the valve tem, then turn the adjustment screw till the rocker arm just press the feeler gauge against the valve stem tip and the feeler gauge can just be withdrawn by a slight pull. After adjusting, lock the adjusting screw by tightening the lock nut and check the valve clearance again by moving the feeler gauge.

4.1.5.5 Adjustment of Lube Oil Pressure

For Series 135 gas engines, the oil pressure should be: at rated speed, 0.245~0.343MPa; and at idle speed , not lower than 0.05MPa; If the oil pressure in engine operation is not within the above limits, it must be adjusted promptly. When adjusting, unscrew the oil sealing nut on the pressure regulating valve, loose the lock nut, and then turn the adjusting bolt with a screw driver. Screwing the adjusting bolt in or out will raise or lower the oil pressure respectively. After adjusting, the lock nut and oil sealing nut should be tightened in sequence.

4.1.5.6 Adjustment of V-belt Tension

During engine operation, the rubber V-belt must be kept at a proper tension. In the normal case, the V-belt can be pressed down 10-20mm when 3˜5 kgf is applied to the midway of the V-belt. Hence the tension of the V-belt should be checked a. adjusted periodically. The tension of the V-belt on the engine can be adjusted by changing the position of the charging alternator bracket. After the V-belt has been adjusted to a proper tension, fix the bracket again. Renew it when peeling or extension too excessive.

4.1.6 Operation and Maintenance of Generating Starting gas gen-sets

Preparations before starting gen-sets. The following works should be fulfilled before starting gas gen-sets:

1) Read this instruction and relevant document carefully, make a better understanding of the structure and operation of the gen-sets.

2) Check assembling conditions of gen-sets. The wires should be well connected and the operating part should be flexible and without any seizure.

3) Check conditions of gas, oil, cooling and starting system as well as controlling to requirement of gen-sets before starting.

4) The switches state before ge-sets starting are: the auto air switch tripping Off, the voltage switch at any position, the current switch at any position, the DC power switching on, and solenoid valve switching on.

5) For the initial operation of control panel, before power on, you should check master switches and instruments whether damaged or not, whether the buttons can reset freely, then measure insulating resistance to ground of primary a. secondary circuit with 500V megger, the measured value should be more then 2M ohm.

6) Adjust the speed potentiometer on control panel to middle position (about 5 turns), voltage potentiometer to about 1/5 turn. Turn starting key to shutdown position. Switch on DC voltage should be about 24V at the time and with display on monitor,

4.1.6.1 Starting and loading of Gen-sets

1) Well prepared in accordance with above- mentioned items and then start gas engine. Run at idle speed for warming up engine. Speeding up and loading after the temperature oil and water rising to 40°C.

2) Keep engine running at rated speed, and adjust speed through potentiometer to slightly higher than rated speed.

3) Regulate the voltage potentiometer to hold the no-load voltage of gen-set at 400V.

4) Press button of master switch, and switching on display lamp for master switch should be light and switching off display lamp light off. Then the gen-sets will supply power.

5) Gradually loading, meanwhile adjusting speed and voltage to keep the gen-sets runnig at rated frequency and rated voltage,

6) Turn voltage switch and check the balance of tree-phase voltage.

4.1.6.2 Precautions during starting and loading

1) The starting time of gen-sets should not be more than 5s. If failed in initial starting. Start again with 15s intervals. If you can not succeded in starting with tree times, look out troubles and shoot it.

2) It is not permitted to start gen-sets with load.

4.1.6.3 Operation of Gen-sets

The following should be paid much attention during gen-sets operation:

1) Observe conditions of electric appliance (such as Ampere-, volt-, frequency- and powermeter. And angine instruments (such as oil pressure-, oil temperature, water temperature and tachometer) during the operation. Take care of the signals of every meter and adjust thems to enable the gen-sets running normally.
2) Keep three phase in balance during loading and unloading.
3) Be careful about the consumption situation of cooling water and oil for the engine. Feeding water and oil if necessary.
4) Look out abnormal conditions such as over-heat, vibration or abnormal sound, find out trouble and shoot it in time.
5) Be careful of the running conditions of alternator. If any over-heat phenomena or abnormal sparks is found, shutdown engine to find trouble and shoot it.
6) Keep the surrounding area of alternator clean. Prevent water, oil or dust from entering into alternator. Do not rinse gen-sets with water.
7) Strictly forbid operating gen-sets under conditions of out-of-order instruments and with other troubles.
8) Note down running conditions of gen-sets, trouble analysis and solutions. A complete overhaul recording and trouble analysis report should be kept.

4.1.6.4 Shutdown of Gen- sets

The shutdown procedures and cautions are as following:

1) Unloading gradually before stopping engine, then trip off the master switch.

2) Adjust “idle/rating” switch to decrease engine´s speed to idle condition.

When oil temperature decreases to less than 50°C, cut off power for solenoid valve and shutdown engine. Disconnect DC power and cut out air after engine stops. In case of any accident or in emergency

condition, turn starting key to shutdown position imminently (cut off air) and turn off intake valve knob.

4.1.6.5 Precautions and Daily Maintenance

1) Operator should be carefully read this instructions and relevant drawings of control panel before it is put into operation.

2) Be care of the voltage of battery during gen-sets operation. Make sure that 2A current can be charged to battery by floating power supply at any time.

3) It is not necessary to adjust the control panel since it has been set well.

4) The control panel should be kept clean and the tightening parts should be inspected regularly.

5) Clean the dusts in control panel every half year and check components whether damaged or not.

4.1.7 Operation a. Adjustment of Electronic Ignition System

Generalisation

Altronic CD1 ignition system used by series 135 gas engines is composed of CD1 controller, magnetic pickup, primary wire, separate ignition coil, etc. The whole system needs 24V power supply.

4.1.7.1 Adjustment of ignition time

1) Set the magnetic pickup in a proper position at signal plate a. make it sensing signal holes in rotating signal plate. The adjust engine to BTDC 27° +-3% in compression stroke of No.1 cylinder to right against pickup. Adjust tightening nut on the pickup to keep 0.5-0.75mm clearance between pickup a. signal plate, and the centre of pickup should on the link centreline of all signal holes. Finally, plug in pickup to connect it to CD1 controller.

2) A “ignition time adjusting knob” with white plastic cap is set on one side of the controller case. Following are the adjusting range for ignition time:

Engine type	Adjustment range for each shift	Total adjusting valve
4 cylinders	2.8°	20° (2.8x7)
6 cylinders	1.9°	13° (1.9x7)

Shift 7 is a shift for the max firing advanced angle. Ignition time is retarted in the order of 6,5,4,3,2,1,0

4.1.7.2 Precautions

1) Do not adjust from shift 7 to 0 or from shift 0 to 7 during engine operation. The large change may result in engine stopping and even damaging engine and CD1 controller.
2) 2) The proper firing time has been set before engine delivery. Consult technicians if do need adjustment. Protect adjustment knob by using white plastic cap.
3) Be aware of the positive and negative poles of power. Strictly forbid connecting positive and negative poles by contrary.

4.1.7.3 Troubles and remedies

There are 2 display lamps beside 2 side of “ignition time adjustment knob”, in witch the left one indicating running condition of magnetic pickup, and the right the output signal of controller.

If engine can not be started or runs abnormally, you should cut off fuel, crank engine and check according to the following table:

Phenomena	***Remedy***
(1) *2 display lamps are off*	
(A) Check 12-24V DC power whether it goes to 12~28V DC	
If (A) is yes	Reinstall controller (replacement)
(2) *Display lamp for pickup is off while display lamp for outside is on*	
(A) 1.0mm Check up clearance whether it is more than 0.5mm or less than 0.1mm	Adjust clearance
(B) Check wiring between pickup and controller	Connecting properly
(C) Remove double-core plug of pickup, measure resistance between 2 wires of pickup, the normal value is 2700-3300 ohm	Reinstall pickup (replacement)
(D) If it is no problem for above-mentioned checks	Replace controller

(3) D*isplay lamp for pick up is on, while output display lamp is off or flashing at low frequency*	
(A) Check connection between ignition coil a. controller	Connecting properly
(B) if it is well connected	Replace controller
(4) *2 display lamps are flashing at the same frequency*	
(A) Both controller a. pick up run normally	(A) Check or replace ignition coil (high voltage coil)
(B) if it is well connected	(B) Check full supply for the engine, etc.

4.1.8 Operation a. Adjustment of the Electric Governor System a. Actuator System

4.1.8.1 Electric governor

The following diagram gives us the basic circuit connections for the governoe, and the terminal 1 and 2 should be connected to the actuator, 3 and 4 to pick up, 5(-) and 6(+) to the power supply, 7 and 9 to the speed potentiometer (5K) and M and G to the idle speed/rated speed switch. While the engine is in stop, adjust the clearance between the speed pick up and the gear ring. Generally, draw the pick up ¾ turns backward after its forward end touches the top of the gear in the gear ring, and an appropriate clearance is obtained.

4.1.8.2 Operation

Before start, adjust the oil volume knob clockwise to the maximum, regulate the ramp time knob anti-clockwise to the minimum, check the “GAIN” and “differential” and the speed potentiometer arranged outside to ensure the middle positions, and then start the engine. Before sale, the engine is given an idle speed in advance. During the start, the actuator holds the maximum fuel supply position until the start is successful, and then the governor make the engine operate under the idle speed. If the speed is not stable. You can set the present speed higher by adjusting the “low speed” button clockwise. Remote speed control can be acquired by a speed potentiometer.

4.1.8.3 Control function

When the engine is under rated speed and no load, you can perform the following control:

a) Regulate the “GAIN” button clockwise until the speed becomes unstable, and then gradually adjust it anti-clockwise until the speed gets stable again. Turn back one more shift anti-clockwise to guarantee the speed control stability.
b) Regulate the “differential” button clockwise until the engine becomes unstable, and then gradually adjust it anti-clockwise until the stable speed is obtained again. Turn back one more shift anti-clockwise to guarantee the speed control stability.
c) After the load is added on the engine, the “GAIN” and “Differential” knob possibly need fine adjustment. Generally, the control unit should be adjusted all right when the engine is under zero load.

4.1.8.4 Electromagnetism actuator

The electromagnetism actuator is linear electric servo system which gives torque output by means of rotation. It can drive the mechanic pulling rod type fuel splly sytem. Excitated by the corresponding speed control signals, the actuator can make the pulling rod rotate by 28°.

4.1.8.5 Operation

Connect the actuator and the control unit with the inserts provided. Put the indicating rod of the actuator to the fuel feeding maximum position, and then make the rod free, it should go back ti the minimum position smoothly. Examine the connections again to ensure that every part of the pulling rod and the indicating rod are fastened and there is no stuck. And then you can start the engine.

4.1.9 Trouble shooting of Generating Sets

As the generating set running, operation should closely detect and monitot its running condition. If find some abnormal phenomenon search the cause and shoot the trouble in time

The common troubles and shooting methods for the generating set are following:

Trouble	***Cause***	***Troubleshooting***
Starting motor not run	Starting power wiring error	Wiring according to prescribed requirement
	Ground wire of starting switch loosening	Retighten ground connection wine

	Starting relay not on	Check, renovate or change relay
	Starting motor burn out	Charge the starting motor
	Contact of starting relay can not separate	Overhaul or change starting relay
	starting button can not reset	Change starting button
	Battery power capacity not enough	Charging battery
Alternator no or low voltage	Wiring error	Search the cause according to the wiring diagram a. correct it
	Rotation rectifier in generation burnt out	Change rectifying module
	Joint loosening or not good contact	Reweld up wiring joint
	Engine speed not up to rated value	Speed up to rated value
	Low setting value of voltage regulation potentiometer	Regulate voltage regulation potentiometer
	Voltage regulation potentiometer wiring short circuit	Eliminate short point
Alternator high voltage	Voltage regulation potentiometer wiring broken	Eliminate broken point
	Large setting value of voltage regulation potentiometer	Regulate the voltage regulation potentiometer
Alternator unstable frequency	Engine governor running unstably	Seek cause a. shoot trouble
Master switch can not turn on	Outer circuit short	Eliminate short point
	Master switch mechanical failure	Repair trouble section
	Over load or phase order error	Check load a. phase order
Master switch tripping	Alternator load circuit short	Eliminate short point
	Alternator low voltage	Check trouble a. eliminate
	Alternator overload	Check load
Monitoring failure	Instrument circuit wiring error	Check wiring
	Sensor damaged	Change sensor
	Sensor wiring broken	Check sensor wiring
	Relay for alarm damaged	Change relay

4.2 Operating procedure

4.2.1 Preparations prior to starting up

- Make strict check of preparation work of gas, lubricating, cooling, starting, control systems.
- The step shall be in following states before starting up of the generating set:

Item No.	Item	State	Location
1	DC power switch	On	Engine
2	Solenoid switch	On	Generator
3	Master switch	Start	Panel
4	Voltage switch	Any phase	Panel
5	Current switch	Any phase	Panel
6	Idle/rating speed switch	Idle	Panel
7	Speed governor power supply	On	Panel
8	Gaspipe valve	On	Engine
9	Pre supply oil	On	Panel

4.2.2 Starting and loading

4.2.2.1 Operating procedures for starting and loading

- Make preparation as required, and then start up the generating set. Warm up the set at idle speed (**700r/min**). **Speed up** when oil and water temperatures of engine rise to **over 45°C**.
- Run the generating set at rated speed (**1500r/min**). No-load voltage is up to 400V by regulating the voltage adjustment potentiometer on the control panel. Rotate the voltage changeover switch to check 3-phase voltage for balancing in the control room.
- When closing the master switch, the switching-on indicator lamp shall be lit, at the same time the switching-off indicator lamp goes out, and the generating set supplies power to the loads.
- Increase load gradually and regulate speed and voltage simultaneously to get the generating set running at rated frequency and voltage.

4.2.2.2 Precautions in the course of starting up and loading

The time that the aircrew starts each time can't exceed 5s on the attentive matter

- Starting time of the generating set each time must not exceed **5s**. If one failure in start, start the

set **after 15s** once again. If **3 failures** in start operation, carry out restarting only after finding out cause and troubleshooting.

- To start up the generating set with load is forbidden!

4.2.3 Pay attention to the followings in operating

- During running of the generating set, observe the scoreboard of the electrical parameter meters (ampere, voltage, frequency and power) and the engine parameter (oil pressure, oil thermometer, speed indicator, exhaust temperature and water temperature) to check for their values within normal range.
- In increasing or decreasing loads, keep three-phase balance.
- ***Pay attention to cooling water and oil consumption of the engine. If necessary, replenish them in time.***
- Observe the parts for abnormal phenomena such as overheating, vibration and abnormal noise at any time. And find out cause in time and remove trouble.
- Pay attention to working condition of the generator. If finding out overheating or off-normal spark, stop it in time to carry out check and maintenance.
- Keep the surrounding of the generator clean. Avoid entering of water, oil or dust into the generating set and generator. Wash the generating set with a wet towel.
- To run the generating set in case of scoreboard failure or other troubles is prohibited.
- Keep a record of running and failure analysis and handling in the course of the generating set operation. In maintenance of the generating set, keep complete record and make report of causes.

4.2.4 Stop

- Before stopping the generating set, release load gradually and break the master switch.
  To stop the set with load is not allowed, otherwise the generator is apt to be damaged!
- Switch to idle speed (700r/min) for **5min** to reduce the generating set.
- When oil temperature of engine drops **below 40°C**, cut off the solenoid power supply or gas supply valve, switch off the governor power to stop the engine. After stopping, turn off the DC power supply and cut off the gas source.
- **In case of failure in the generating set or in emergency, *cut off* the power switch of *the solenoid* with great speed, *turn off* the *governor power*, rotate the *start key* to the *Stop position* and *close* the *gas valve* at the same time.**

4.2.5 Precautions on operation and routine maintenance

- **Operators shall read the Operating Instruction Manual of the products and relative drawings of generating set's control panel in detail before putting the generating set into service.**
- In operation of the generating set, 24V battery must be used as power supply. To use voltage stabilizing power for supplying to the set is forbidden. Pay attention to the battery voltage in use. The floating power supply shall charge 4-6A current to the battery at any moment. Take notice of correct wiring. Never make wrong connection of power supply's polarity!
- **The components inside the control panel of the generating set have been adjusted. So no further adjustment is necessary. The control panel shall be kept clean. Make regular check of the fasteners. Clear away dust and check the components for damage** every half a year **at least.**
- **Cooling water must be drained out of the water tank at least** once a week **in order to avoid damage of pump by the sand.**

4.2.6 Main specification

4.2.6.1 Technical specification

Item	Unit	Parameter
Model		180GF-Z
Rated power	kW	180
Rated voltage	V	400
Rated frequency	Hz	50
Rated current	A	324
Supply connection		3 phase,4 lines
Rated power actor		0.8（ hysteresis）
Excitating way		brushless
Voltage regulation mode		AVR AVR automatism
Engine dimension	mm	3300×1400×1700
Net weight	Kg	3120
Container dimension	mm	4300×2160×3000
Brutto Weight	Kg	4500
Note: Engine oil type required by operation of generator unit is "Mobil" Pegasus 705.		

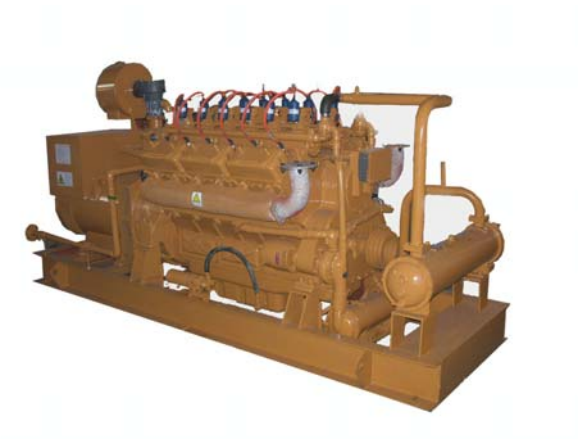
4.2.6.2 Technical parameter

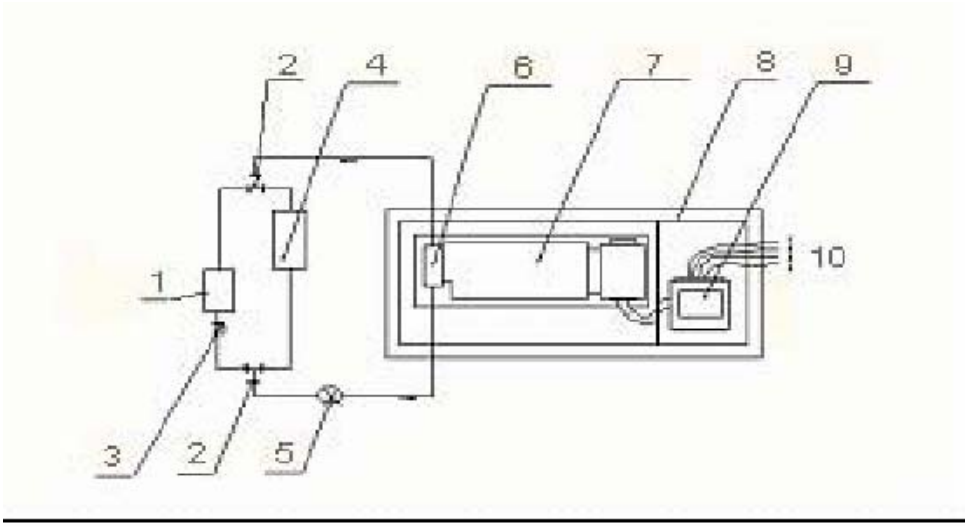
Item	Unit	Parameter
Model		12V138AD-Z
Bore	mm	138
Rated power	kW	190
Rated speed	rpm	1500
Starting method		24VDC Electric starting system
Lgnition		Spark plug igniting system
Speed control		Speed control system
Cooling		)pened-circuit cooling system
Lubricating		ressure and splash lubricating system
Gas pressure	MPa	0.10～0.30
Gas consumption	M^3/kW.h	≤0.66
Overall dimension	mm	1775×1145×1353
Net weight	Kg	1750

4.2.6.3 Equipment subentry quotation table

No.	**Equipment name**
1.	Engine
2.	Generator
3.	Control panel
4.	Pressure reducing, separating and buffering device
5.	Heat exchanger
6.	Exhaust muffler

4.2.7 CHP Pictures a. schematic diagram cooling system





1 thermal water utilization	6 Heat exchanger
2 wye	7 Power generator unit
3 valve	8 Machine room
4 Cooling tower	9 Control panel
5 Water pump	10 To power distribution room

Jinan Diesel Engine Co., Ltd. Gas Engine Branch

Jinan City, Shandong Province

Quality standard: National standard GB/T 9583.1-99.

5 MAINTENANCE PLAN

Service plan for plant operators

service	continuous	daily	weekly	monthly
monitoring of the operating parameters	X			
visual inspection of the pipes	X			
observe the explosion protection	X			
observe the fire protection	X			
safty briefing for the operating staff	X			
caution and danger signs	X			
filling the pressure compensating valve	X			
notice emergency plan !!!	X			
electrical power output (CHP)		X		
oil pressure (CHP)		X		
oi temprature (CHP)		X		
cooling water tempreture (CHP)		X		
visual inspection of leakage (CHP)		X		
forward and return line temperature (CHP)		X		
visual inspection of rough runnig (CHP)		X		
visual inspection of the pretratment		X		
lubrication of the rope winches		X		
visual inspection of the digester		X		
visual inspection of the desulpheration system		X		
visual inspection of the overflow pipe		X		
control the liquid level of the safety valve		X		
visual inspection of the after storage		X		
control liquid level (condensat outlet device)		X		
control swimmer mobility (condensat outlet device)		X		
control filter (condensat outlet device)		X		
visual inspection of the gas tank		X		
lubrication of rail system		X		
control of the pumpsystem		X		
control batterie voltage (CHP)			X	
control liquid level oil tanks (CHP)			X	
control the operating hours (CHP)			X	
control engine smoothness (CHP)			X	
control of the stirrers			X	

liquidation of the stirrers			X	
liquidation of the rope winches			X	
move the stirrers using the lifting gear			X	
removal of swimming films in water system			X	
control pump case for leaks				X
control power supply of the pumps for leaks				X
use of corrosion protection and painting				X
clean CHP unit				X

6 SUPPLIER LIST

Devices name	Company name	address	telephone
Electromotion Brake & Valves	Beijing general company of valve	Beijing	008628-83518295 008613980533296
Screw Pump	Lanzhou limited company of Naizhi pumps	Lanzhou	008628-87621418
Flowmeter in screw pump	Shanghai Guanghua instru-ments company	shanghai	008621-67697202
Diving Pump	Lanshen Pumps Company	Chengdu	008613330983098
Safety Flare	Shansheng com-pany for industry trade	Shiyan city, Hubei province	0086719-8631016
Gas Flow Meter	Chongqing flow meters factory	Chongqing	008623-67601673
Power Supply Box	Lanshen Pumps Company	Chengdu	008613330983098
Electromagnet-ism Flux Unit	Huangshi Weiyuan automatic limited company	Huandshi city, Hubei province	0086714-6232763
Temperature Dif-ferent Transfer	Huangshi Weiyuan automatic limited company	Huandshi city, Hubei province	0086714-6232763
Liquid difference transfer	America Flow line	Shanghai	008621-64850022
CHP Unit	Jinan Diesel En-gine	Jinan	0086531-2965971