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UNIVERSITI MALAYSIA SABAH

NATURAL RESOURCES OFFICE OF SABAH

WORK OF ENGINEERING, COST ESTIMATES AND SUPERVISION FOR THE PROJECT ON PROMOTION OF GREEN ECONOMY WITH PALM OIL INDUSTRY FOR BIODIVERSITY CONSERVATION IN MALAYSIA

FINAL REPORT

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JAPAN INTERNATIONAL COOPERATION AGENCY

NJS CONSULTANTS CO., LTD.

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Source: Website of Bornean Biodiversity & Ecosystems Conservation Programme Phase II (BBEC II) in Sabah, Malaysia (http://www.bbec.sabah.gov.my/phase2/sites.php)

Source: Google Earth

The Pilot Plant Location (KPOM)

Before construction of the Pilot Plant

After construction of the Pilot Plant

Photo (1)

	
Anaerobic and Aerobic Bioreactors	Energy and water recovery system from waste steam
	
Final effluent polishing system by Engineered Wetland	Rainwater recovery system
	
Composting (Fertilizer) system	Carbonization system

Photo (2)

Table of Contents

Page

Location Map of Project i

Photos of Proposed Palm Oil Mill (1) ii

Photos of Proposed Palm Oil Mill (2) iii

Table of Contents iv

List of Figures and Tables viii

Abbreviations and Acronyms xi

Summary xii

Chapter 1 Outline of the Survey 1
1-1 Background 1
1-2 Outline of the Projects 1
1-3 Outline of the Work 2
Chapter 2 Working Directions 4
2-1 Presentation of Inception Report 4
2-2 Confirmation of Undertakings by the Malaysian Side 4
2-3 Discussion and Policy Decision of the Preliminary Test with SATREPS Team 5
2-4 Evaluation of the Preliminary Test Result issued by SATREPS Team 5
2-5 Site Survey 5
2-6 Examination of Pilot Plant Construction Policy 6
2-7 Basic Planning of the Pilot Plant 6
2-8 Cost Survey 6
2-9 Tendering support 7
2-10 Fabrication and construction supervision 7
2-11 Commissioning, Instruction for operation and maintenance 7
Chapter 3 Results of Site Survey 9
3-1 Existing Facility Survey 9
3-1-1 Access to the Mill 9
3-1-2 Outline and Surrounding Environment of the Mill 9
3-1-3 Operation Results of the Mill 13
3-1-4 Effluent Volume Discharged from the Mill 15
3-1-5 Generation of Waste Steam 18
3-1-6 Material Balance of KPOM 24

3-1-7 Heat Balance of KPOM....26
3-1-8 Construction Site....27
3-2 Related Laws and Regulation for the Pilot Plant Construction....29
3-2-1 Environmental Quality Act....29
3-2-2 Regulations for the Palm Mill Factory....30
3-2-3 Regulations for Environmental Impact Assessment....31
3-2-4 Regulations for Facility Construction....35
3-2-5 Regulations for Equipment Installation....36
Chapter 4 Environmental and Social Considerations....37
4-1 Permits and Explanations....37
4-2 Pollution Control....37
4-3 Natural Environment....39
4-4 Social Environment....39
4-5 Others....41
4-6 Note....43
Chapter 5 Facility Design....45
5-1 Anaerobic and Aerobic Bioreactors....45
5-1-1 Configuration Process....45
5-1-2 Oil Recovery from Wastewater generated from Sterilization Process....46
5-1-3 Anaerobic treatment method....47
5-1-4 Aerobic treatment method....48
5-1-5 Pump type....48
5-1-6 Design Calculation....49
5-2 Energy and Water Recovery System from Waste Steam (Heat Exchanger)....51
5-2-1 System Summary....51
5-2-2 System Design....52
5-3 Final Effluent Polishing System by Engineered Wetland....52
5-3-1 Summary of Engineered Wetland....52
5-3-2 Adopted technology....54
5-3-3 Design calculation....54
5-4 Rainwater Recovery System....55
5-4-1 Setting for the Amount of Rainfall....55
5-4-2 Design Calculation....56
5-5 Composting (fertilizer) System....56
5-5-1 Summary of composting technology....56
5-5-2 Design Calculation....57
5-6 Flatbed Carbonization System....58
5-6-1 Summary of Carbonization System....58
5-6-2 Construction of Carbonization system....59

Chapter 6 Procurement Lot 60
6-1 Basic Policy for Procurement Lot 60
6-2 Plant Fabrication and Construction Work Lot (LOT 1) 60
6-2-1 Scope of Plant fabrication and Construction work Lot 60
6-2-2 Special Equipment 60
6-3 Equipment Procurement Lot (LOT 2) 61
Chapter 7 Contractor and Supplier Selection 62
7-1 Plant Fabrication and Construction Work Lot (LOT1) 62
7-1-1 Process of the Contractor Selection 62
7-1-2 Support for the Contractor Selection 63
7-1-3 Supporting for pre-bidding Meeting 64
7-1-4 Assistance for Bidding, Evaluation and Contract 64
7-2 Equipment Procurement Lot (LOT2) 65
7-2-1 Process of the Supplier Selection 65
7-2-2 Support for the Supplier Selection 66
7-2-3 Assistance for Bidding, Evaluation and Contract 66
Chapter 8 Fabrication and Construction Supervision 67
8-1 Plant Fabrication and Construction Work Lot (LOT 1) 67
8-1-1 Developing Construction Supervision Plan 67
8-1-2 Procurement Supervision 67
8-1-3 Fabrication Supervision 67
8-1-4 Construction Supervision 69
8-2 Equipment Procurement Lot (LOT2) 72
8-2-1 Delivery and Inspection of Equipment 72
8-2-2 Operation Instruction and Safety Briefing 72
Chapter 9 Commissioning and Operation Instructions 73
9-1 Outline 73
9-1-1 Schedule 73
9-1-2 Commissioning Plan 73
9-2 Commissioning and Operation Instructions 74
9-2-1 Safety Briefing 74
9-2-2 Operation Instruction by Discourses 74
9-2-3 Commissioning and Operation Instructions for Each Process 75
Chapter 10 Recommendations for Operation and Maintenance 80

List of Figures

Figure 3-1 Layout Drawing of KPOM....10
Figure 3-2 Process of KPOM....11
Figure 3-3 Monthly processed FFB (2010 to 2013....14
Figure 3-4 Monthly CPO Production (2010 to 2013)....15
Figure 3-5 Process Flow Diagram of Water Treatment Facility....16
Figure 3-6 Process Flow Diagram of Boiler Water Treatment Facility....16
Figure 3-7 Schematic Diagram of POME Collection System....17
Figure 3-8 Schematic Diagram of Steam Line Flow....18
Figure 3-9 Schematic Process Flow of the Sterilization Station....19
Figure 3-10 Operation Record of the Sterilization Station (January 1st to July 31st of 2014)....20
Figure 3-11 Operation Pattern of the Sterilization Station....20
Figure 3-12 Result of Time and Motion Study of the Sterilizer....22
Figure 3-13 Relation between Batch Number and One Batch Operation Time....23
Figure 3-14 Steam Dosing Pattern into the Sterilizer....23
Figure 3-15 Operation Pattern and Steam Consumption in the Sterilizers....24
Figure 3-16 Material Balance of KPOM....25
Figure 3-17 Heat Balance of KPOM (per hour)....27
Figure 3-18 Pilot Plant Construction Site....28
Figure 3-19 Application Procedure for Environmental Requirements in Malaysia....32
Figure 4-1 Proposed Organization Structure for Monitoring....43
Figure 5-1 Schematic Configuration Process of Anaerobic and Aerobic Bioreactors....46
Figure 5-2 Oil Recovery Test Result for Wastewater Generated from Sterilization Process by Ordinary Pressure Floatation....47
Figure 5-3 Material Balance of Aerobic and Anaerobic Bioreactor....50
Figure 5-4 Energy and Water Recovery System from Waste Steam....51
Figure 5-5 Schematic Diagram of Horizontal Flow (HF) typed wetland....53
Figure 5-6 Schematic Diagram of Vertical Flow (VF) typed wetland....54
Figure 5-7 K_{BOD} from VF type Treatment Method....55
Figure 5-8 Layers on VH type Treatment Method....55
Figure 5-9 Transition of Annual Rainfall in Keningau (year 1976 to 1992)....56
Figure 5-10 Monthly Average of Rainfall in Keningau (Average on Year 1976 to 1992)....56
Figure 5-11 Carbonization Process of Yamasen Flatbed Carbonization System....58
Figure 5-12 Outline of Yamasen Flatbed Carbonization System....59
Figure 7-1 Contractor Selection Procedures (LOT 1)....62
Figure 7-2 Supplier Selection Procedures (LOT 2)....65

List of Tables

Table 3-1 Outline of KPOM....9
Table 3-2 Final Discharge Quality Analysis Result....12
Table 3-3 Result of River Water Quality Analysis around KPOM....13
Table 3-4 Water Consumption of Process water and Boiler water....16
Table 3-5 Wastewater Generation Amount....17
Table 3-6 Specifications of the Sterilization Station....18
Table 3-7 Outline of Material Balance....26
Table 3-8 Characteristics of the Boiler and Wet Base Lower Heat Value....26
Table 3-9 Regulations and Orders based on Environmental Quality Act 1974....29
Table 3-10 Prescribed Activities (EIA required industries and the conditions)....32
Table 3-11 Self-Evaluation Result of Necessity of EIA for the pilot plant construction....34
Table 3-12 Type of CIDB Registration....35
Table 4-1 Checked Items and Results of Evaluation Related to "Permits and Explanations"....37
Table 4-2 Checked Items and Results of Evaluation related to "Pollution Control"....38
Table 4-3 Applied Exhaust Gas Standards for the Flatbed Carbonization System....38
Table 4-4 Checked Items and Results of Evaluation Related to "Natural Environment"....39
Table 4-5 Checked Items and Results of Evaluation Related to "Social Environment"....39
Table 4-6 Checked Items and Results of Evaluation Related to "Others"....41
Table 4-7 Proposed Monitoring Plan (Anaerobic and Aerobic Bioreactor)....42
Table 4-8 Proposed Monitoring Plan: Energy and Water Recovery System from Waste Steam (Heat Exchanger)....42
Table 4-9 Proposed Monitoring Plan: Final Effluent Polishing System by Engineered Wetland....42
Table 4-10 Proposed Monitoring Plan: Rainwater Recovery System....42
Table 4-11 Proposed Monitoring Plan: Composting (Fertilizer) System....42
Table 4-12 Proposed Monitoring Plan: Carbonization System....43
Table 4-13 Checked Items and Results of Evaluation Related to "Note"....44
Table 5-1 Qualitative Characteristics and Collection Point of Wastewater Discharged from each Process in KPOM....45
Table 5-2 Major design criteria for Anaerobic and Aerobic Bioreactor....49
Table 5-3 Characteristics of Raw Water....52
Table 5-4 Necessary Steam and Cooling Water Condition....52
Table 5-5 Major Design Criteria and Specifications....52
Table 5-6 Two types of Adopted compost (fertilizer) production system....57
Table 5-7 Major Design Criteria for Composting (Fertilizer) System....57
Table 6-1 Specification for procured equipment in Lot 2....61
Table 7-1 Qualification Criteria for LOT1....63
Table 7-2 Bid Documents required by "Instruction to Bidders"....65

Table 7-3 Qualification Criteria of LOT2 66
Table 7-4 Required Documents in Bidding Meeting 66
Table 8-1 Contents of Construction Supervision Plan 67
Table 8-2 Comparison of Major Nondestructive Tests 68
Table 8-3 Meetings and Discussions Held 69
Table 8-4 Modification of Flatbed Carbonization System 71
Table 9-1 Implementation Schedule of Commissioning and Operation Instructions 73

Abbreviations and Acronyms

AS	Activated Sludge
BEM	Board of Engineers Civil and Structure
CCM	Companies Commission of Malaysia
CIDB	Construction Industry Development Board
CPO	Crude Palm Oil
C/P	Counterpart
DOE	Department of Environment
DOSH	Department of Occupational Safety and Health
EFB	Empty Fruit Bunch
EIA	Environmental Impact Assessment
FFB	Fresh Fruit Bunch
HDPE	High Density Poly Ethylene
IC/R	Inception Report
JET	JICA Expert Team
JICA	Japan International Cooperation Agency
JICS	Japan International Cooperation System
KPOM	Keningau Palm Oil Mill Sdn. Bhd.
Kyutech	Kyushu Institute of Technology
MF	Mesocarp Fiber
NRO	Natural Resources Office, the State of Sabah
O&G	Oil and Grease
OD	Oxidation Ditch
PK	Palm Kernel
POM	Palm Oil Mill
POME	Palm Oil Mill Effluent
R/D	Record of Discussion
SATREPS	Science and Technology Research Partnership for Sustainable Development
SBR	Sequential Batch Reactor
SLDB	Sabah Land Development Board
SOP	Standard Operation Procedures
SVI	Sludge Volume Index
UASB	Upflow Anaerobic Sludge Blanket
UMS	Universiti Malaysia Sabah
UN-HABITAT	United Nations Human Settlements Programme
UPM	Universiti Putra Malaysia
VFA	Volatile Fat Acid

Summary

Kinabatangan and Segama river basin is the largest watershed in the State of Sabah, Malaysia. It embraces a wetland registered under a Ramsar Convention, a number of protected areas and forest reserves, which function as important habitats for rare and endangered species. Palm oil industry is a key industry in the State. In fact, there are more than 300 oil palm plantations (1.4 million hectares) and 40 palm oil mills within the Kinabatangan and Segama river basin. Negative impact concerning the biodiversity may occur by polluted river water due to farm chemicals from the oil plantations and treated wastewater discharged from the old-fashioned treatment system in the mills.

SATREPS team consists of Kyutech and UPM mainly has been carrying out "Project on Promotion of Green Economy with Palm Oil Industry for Biodiversity Conservation in Malaysia" in order to generate sustainable green industry through zero-discharge, and utilization of excess biomass and surplus energy at a palm oil mill.

Based on comments and suggestions from chief advisor of the Project, JET carried out following works.

- Survey and design
  Necessary survey for planning and designing of equipment and facility to be built for the Project were implemented by JET. Detailed design and cost estimate, tender documents and related documents were also prepared by JET.

- Supporting for Tendering
  JET supported tendering implemented by JICA Malaysia office.

- Supervision for fabrication and construction
  JET implemented supervision for fabrication and construction of the equipment and facility after contract between JICA Malaysia office and a local contractor. Work of supervision were performed examination of qualities, quantities and implementing necessary inspection based on tender document and contract between JICA Malaysia office and the contractor.

- Test Operation and instruction for operation and maintenance
  JET implemented test operation of the facility after completion of construction. JET provided necessary instructions of operation and maintenance to the counterparts and persons working for the Palm Oil Mill.

JET also made recommendations of an organization structure for sustainable operation and maintenance to the counterparts.

Chapter 1 Outline of the Survey

1-1 Background

Kinabatangan and Segama river basin is the largest watershed in the State of Sabah, Malaysia. It embraces a wetland registered under a Ramsar Convention, a number of protected areas and forest reserves, which function as important habitats for rare and endangered species. Palm oil industry is a key industry in the State. In fact, there are more than 300 oil palm plantations (1.4 million hectares) and 40 palm oil mills within the Kinabatangan and Segama river basin. Negative impact concerning the biodiversity may occur by polluted river water due to farm chemicals from the oil plantations and treated wastewater discharged from the old-fashioned treatment system in the mills.

Kyushu Institute of Technology (Kyutech) and Universiti Putra Malaysia (UPM) have jointly developed a production technology of bio-composite plastics from biomass, and then focused oil palm as a source of biomass supply. Large volume of biomass (EFB, mesocarp fibre, etc.) with stable quality has been produced throughout the year from the palm oil mills, and a new business / industry will be able to create by the effective utilization of biomass. Almost all of biomass is currently consumed as energy sources due to inefficient facilities in the mills. Biogas generated from palm oil mill effluent (POME) and surplus heat are also not in use.

By improving production efficiency through modification of milling process and installation of high performance equipment, environmental impact will reduce. Excess biomass (EFB, Mesocarp Fibre) and surplus energy (methane fermented of POME efficiently, utilized as energy) can be utilized, new business model will also be generated by development of new production such as bio-plastics, activated carbon and fertilizer from POME.

Kyutech and UPM, as representative organizations, have signed on Record of Discussions (R/D) concerning "Project on Promotion of Green Economy with Palm Oil Industry for Biodiversity Conservation in Malaysia" (hereinafter referred to as "the Project") dated on 25th September 2013, under the scheme of Science and Technology Research Partnership for Sustainable Development (SATREPS). The Project implementing for 4 years started since 21st November 2013, and will finished on 20th November 2017. The purpose of the Project is to verify and to demonstrate generating sustainable green industry through zero-discharge, utilization of excess biomass and surplus energy at a palm oil mill (site of the Project).

As a part of the Project, Japan International Cooperation Agency (JICA) hired NJS Consultants Co., Ltd, as JICA Expert Team (Hereinafter referred to as "JET") in order to ensure the services of provision of basic and detail design information, cost estimates, preparation of specification of the plant, tender document, support of the tendering implemented by JICA, and supervision of fabrication and construction (hereinafter referred to as "the Work").

1-2 Outline of the Projects

The outline of the project is as below:

(1) Project Implementing Agencies

Universiti Putra Malaysia (UPM, representative)
Universiti Malaysia Sabah (UMS)
Natural Resources Office (NRO), the State of Sabah

(2) Duration

21st November 2013 until 20th November 2017

(3) Overall Goal

Green economy is promoted for biodiversity recovery through reduction of pollutants due to waste water from the palm oil industry in relevant areas in Sabah, Malaysia including Kinabatangan.

(4) Project Purpose

Innovative knowledge and viable technologies for business models are developed in Keningau and shared positively among the potential users for the transformation of palm oil industry into sustainable green industry.

(5) Output

Output 1: The effectiveness of *zero-discharge is ensured through energy efficiency improvement resulting surplus biomass and excess energy at showcase facilities of zero-discharge established at an oil mill.

Output 2: Viability of business model is verified through the proposed zero-discharge and creation of new industry from surplus biomass and excess energy.

Output 3: The innovative research is pursued on the effective utilisation of palm biomass and energy for the reduction of environmental burden caused by palm oil processing.

Output 4: Validity of business model and the research results are shared extensively and recognised within the Sabah Government and domestic/international investors and firms.

1-3 Outline of the Work

(1) Objects of the work

In order to achieve the Output 1 mentioned above, JET implemented the survey to investigate the suitable facilities and equipment of the palm mill plant as a pilot plant and make repoint. In addition to the work, JET supported the tender of specified contractors implemented by JICA Malaysia office and JET implemented the supervision for fabrication and construction. All works were based on comments and suggestions from the chief advisor of the Project.

(2) Contents of the works

The works were composed by the four contents as follows:

1) Survey and design

Necessary survey for planning and designing of equipment and facility to be built for the Project were implemented by JET. Detailed design and cost estimate, tender documents and related documents were also prepared by JET.

2) Supporting for Tendering

JET supported tendering implemented by JICA Malaysia office.

3) Supervision for fabrication and construction

JET implemented supervision for fabrication and construction of the equipment and facility after contract between JICA Malaysia office and a local contractor. Work of supervision were performed examination of qualities, quantities and implementing necessary inspection based on tender document and contract between JICA Malaysia office and the contractor.

4) Test Operation and instruction for operation and maintenance

JET implemented test operation of the facility after completion of construction. JET provided necessary instructions of operation and maintenance to the counterparts and persons working for the Palm Oil Mill. JET also made recommendations of an organization structure for sustainable operation and maintenance to the counterparts.

(3) Mill

The Project planned initially to build the plant in east side of Sabah, the plant construction site were changed to a palm oil mill located west side of Sabah due to hazardous security status of east side of Sabah (including Kinabatangan and Segama River Basin) since March, 2013. Keningau Palm Oil Mill (hereinafter referred to as "KPOM") located in Keningau, west side of Sabah was selected as the alternative construction site for the pilot plant construction.

Chapter 2 Working Directions

2-1 Presentation of Inception Report

JET explained the inception report to NRO, UMS, KPOM and UPM during 5th August 2014 to 7th August 2014 and obtained consent from them about the contents of the work and sharing roles.

And on 15th August 2014, JET carried out the explanation of inception report to stakeholders of SATREPS.

IC/R explanation at UMS

IC/R explanation at KPOM

IC/R explanation at UPM

IC/R explanation for stakeholders of SATREPS (at UPM)

2-2 Confirmation of Undertakings by the Malaysian Side

The undertakings of UPS, UMS and Sabah State, as stipulated in the "Record of Discussions (R/D)" on Project on Promotion of Green Economy with Palm Oil Industry for Biodiversity Conservation in MALAYSIA Agreed upon between Universiti Putra Malaysia, Universiti Malaysia Sabah and The State Government of Sabah and Japan International Cooperation Agency (JICA) dated on 25th September, 2013, were as follows:

1. Provision of Malaysian counterparts,
2. Provision of suitable office for the Work,
3. Provision of tax and duty exemption and
4. Support of obtaining necessary licensing and approvals.

2-3 Discussion and Policy Decision of the Preliminary Test with SATREPS Team

JET discussed several times with the SATREPS study team on the preliminary test and the results of wastewater quality analysis. SATREPS study team examined the way to separate oil from the sterilization process effluent. Although gravity sedimentation, air floating, dissolved air floating, and centrifugation were assumed as candidates, SATREPS study team selected gravity sedimentation as a first test for its simplicity and low implementation cost.

Since SATREPS study team also investigated a wastewater treatment test using methane fermentation technology (anaerobic digestion) and activated sludge, JET visited to a palm oil mill located in peninsula with SATREPS study team and performed instruction regarding sampling to SATREPS study team as well.

Instruction about sampling for the preliminary test

Meeting with SATREPS about preliminary test

2-4 Evaluation of the Preliminary Test Result issued by SATREPS Team

The oil separation test by SATREPS team showed that the gravity sedimentation with suitable temperature control could separate oil from the effluent, and the required retention time was proposed. Design parameters of oil separation facility were determined based on the result of preliminary test. The details are described in **Chapter 5**.

2-5 Site Survey

First site survey during 6th to 8th August, 2014 and second site survey on 15th September, 2014 were carried out. On the first survey, JET confirmed the construction site for the pilot plant and measured water consumption in the mill and generated amount of wastewater. The results were reflected to the design parameters. On the second survey, a time and motion survey around sterilization process was implemented in order to study steam consumption and its fluctuation. A field survey of the existing wastewater treatment facility were also carried out because sludge and final discharge from the existing wastewater treatment plant shall be transferred to the pilot plant. Furthermore, JET discussed with the mill owner about the composting system.

Necessary license, application and/or approval for the pilot plant construction, local laws and regulations regarding environment were studied and the results are described in detail in **Chapter 3**.

Flow measurement (1st site survey)

Time & Motion survey (2nd site survey)

2-6 Examination of Pilot Plant Construction Policy

In view of entire processes and type and characteristics of the facilities and equipment, an appropriate tendering lot was examined. Examination of Procurement lot is described in **Chapter 6**.

2-7 Basic Planning of the Pilot Plant

Following six facilities, 1) Anaerobic and Aerobic Bioreactors, 2) Energy and water recovery system from waste steam (Heat Exchanger), 3) Final effluent polishing system by Engineered Wetland, 4) Rainwater recovery system, 5) Composting (Fertilizer) system and 6) Carbonization system, were planned. Through this on-site survey, 2) Energy and water recovery system from waste steam (Heat Exchanger) and 5) Composting (Fertilizer) system were partially changed.

Existing UPM method and a scoop type composting system were planned to install as a parallel system as 5) Composting (Fertilizer) system. In addition, an EFB press, a shredder, related conveyors and a grinder were also planned.

The detail describes in **Chapter 5**.

Survey of the scoop type composting facility

Survey of EFB press and shredder

2-8 Cost Survey

The materials and equipment cost survey was carried out. JET worked to obtain more than three quotations but some items could be collected from less than three companies. The estimated prices of equipment were

determined in consideration of the discount rate in the accumulation work as to be proper. The prices for construction materials were determined based on the price of quotations from the companies and the published unit costs issued by National Construction Cost Centre (N3C) in Construction Industry Development Board (CIDB).

In consideration of leasing scheme for heavy machines procurement, not only purshasing the leasing cost was also surveyed.

The cost survey result showed that the examined total cost is much over than the budgetary estimate cost. Kyutech therefore finally made the decision that Kyutech Purchased 2) Energy and water recovery system from Japan. Also EFB press, shredder, and related conveyors in 5) Composting (Fertilizer) system were cancelled. SATREPS team decided to purchase shredded EFB from outside of the mill.

2-9 Tendering support

For the bidding implemented by JICA Malaysia office, JET made qualification criteria for the contractor selection, supported for contractor/supplier selection, bidding procedure, evaluation of the bidding results and contract agreements.

Fabrication work of the facility, installation work and related construction work, procurement work for heavy machines for the plant operation were required for the Project.

They were coherent work through fabrication to the installation at the site so that it was undesirable to divide in the view of construction schedule management and quality management. On the other hand, there was no obstacle for dividing construction work and procurement work for heavy machines. Thus, the basic policy for the procurement lot was divided into plant fabrication and construction work lot (LOT1) and equipment procurement lot (LOT2).

JET examined the contractor/supplier selection criteria for each LOT. The contractor selection criteria for the plant fabrication and construction work lot was determined and selection procedure carried out by selective tendering. Equipment procurement work, because of normal purchasing, was carried out by open bidding.

The detail and the tendering results describe in **Chapter 7**.

2-10 Fabrication and construction supervision

JET prepared a plan for fabrication and construction supervision. Based on the plan, the supervision work was carried out until the final inspection and work completion in order to ensure the work schedule and quality.

The construction supervision was carried out by local supervisor to ensure a continuous supervision even if the Japanese supervisor was absent. The supervision team checked the compliance with the safety and health regulation, the wearing of Personnal Protective Equipment (PPE) (including helmets and safety shoes) and holding HSE meeting. The goal was an accident-free construction and it was achieved.

The detail describes in **Chapter 8**.

2-11 Commissioning, Instruction for operation and maintenance

After completion of the construction work, the pilot plant was started for the confirmation of performance. With regard to the operation and maintenance of the facility, in collaboration with the chief advisor, technical

instruction was provided to the stakeholders of the mill and counterparts (C/P). A proper staff organization for the operation and maintenance of the facility was also suggested to the counterparts (C/P).

The commissioning of the facility included: motor check, sequential check, unloading operation (only wastewater treatment facility). For the actual loading operation for the wastewater treatment facility, well-maintained digested sludge and activated sludge were prepared and dosed into the facility. Loading rate was increased in stages in order to accelerate the start-up.

The detail describes in **Chapter 9**.

Chapter 3 Results of Site Survey

3-1 Existing Facility Survey

3-1-1 Access to the Mill

KPOM, which is the surveyed mill, is located about 36km south of Keningau in Sabah and approximately 25km of the road to the mill from Keningau is unpaved and intensely undulating. There is a tide-arch bridge on the Pegalam River near Keningau, the height of the bridge is suitable for the use of heavy vehicles. On the unpaved road to the mill there is a simple wooden bridge on top of the steel I-beam and although its loading capacity is not confirmed the CPO and FFB transport trucks to the KPOM run on this road daily. The road from Keningau to Kota Kinabalu is in relatively good condition.

No adverse issue was found on the logistics for material transportation and construction as well as heavy vehicles access to the site.

FFB truck driven on the unpaved road

Simple bridge on the unpaved road

3-1-2 Outline and Surrounding Environment of the Mill

(1) Outline of the Mill

KPOM has been operating since 2003 and the capacity of the mill is 40 tonnes per hour. The main features of the mill is shown in Table 3-1. The factory was established by the Sabah Land Development Board (hereinafter referred to as "SLDB"); subsequently the management activities were turned over to Yun Fook Plantations Sdn. Bhd. However 51% of the mill stocks still belong to SLDB.

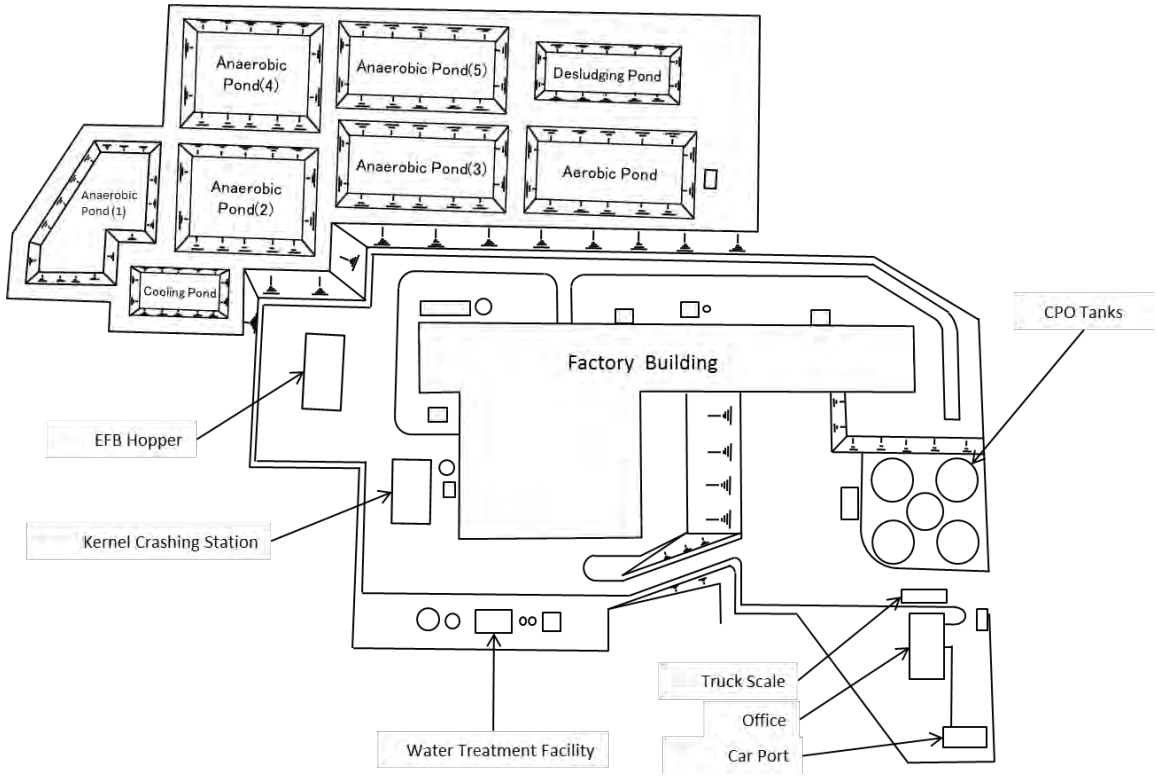
KPOM layout is shown in Figure 3-1. The main factory building is set in the centre of the land, while EFB hopper, Kernel crushing station, CPO tank, water treatment facility, wastewater treatment facility, office building, and truck scale are arranged around the factory building.

Table 3-1 Outline of KPOM

Name	Keningau Palm Oil Mill Sdn. Bhd.(KPOM)
Address	Kg. Belinin, Jalan Ansip-Dalit, P. O. Box 1733, 89008 Keningau, Sabah, Malaysia
latitude/longitude	North Latitude 05°06'30.5", East Longitude 116°05'40.6" (JET survey done at the KPOM office with a *Foretrex 301* GPSmade by Garmin)
Shareholders	Sabah Land Development Board (SLDB) (51%) Yun Fook Plantations Sdn. Bhd.(49%)

Planned capacity	40t-FFB per hour
Operation start	Since 2003
Area	Approximately 50 acres
FFB Supply	Supplied from own plantation named Yun Fook Plantations and purchased approximately 110 thousand tonnes yearly from other plantations (So Green, SLDB Dalit, Kenandung, Sabah Nabawan and some other small plantations)
Number of employees	74

(Source:JET)



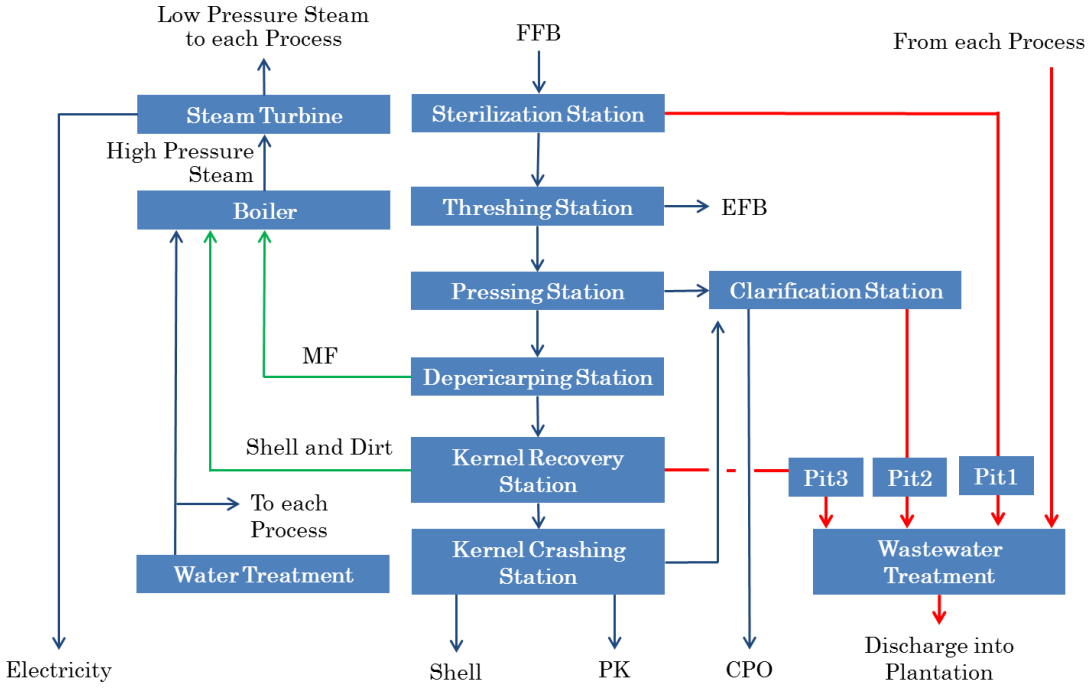
(Source: JET, based on Proposed Layout Drawing owned by KPOM)

Figure 3-1 Layout Drawing of KPOM

The production process of the mill is shown in Figure 3-2. Fresh Fruit Bunch (hereinafter referred to as "FFB") is delivered to the mill, and is steamed at low pressure at the Sterilization Station. Then the Empty Fruit Bunch (hereinafter referred to as "EFB") is removed at the Threshing Station. The remaining mass passing to the digester (hereinafter referred to as "MPD") is separated at the Threshing Station. This is further steamed and accelerated digestion is carried out at the Digester. The liquid fraction is then initially separated from the solid fraction by a Screw Press. From this liquid fraction further solid components are removed by using a Vibration Screen and the resulting liquid is transferred to the Clarification Station.

The separated solid components contain Mesocarp Fibres (hereinafter referred to as "MF") seeds, gravel and so on. The MF and shells are separated from the other solid materials by the Depericarping Station and Kernel Recovery Station and the MF and shells can be utilized as fuel for the boiler. Seeds are

crushed at the Kernel Crushing Station and separated into Palm Kernel (hereinafter referred to as "PK") and shells. One part of the separated shells are utilized for boiler fuel with the MF, and the rest are sold to the market. On the other hand, impurities are removed from the liquid separated at the Clarification Station and the liquid is Crude Palm Oil (hereinafter referred to as "CPO") which is sold to palm oil purification factories like IOI and SEO.



(Source: JET)

Figure 3-2 Process of KPOM

The process water used at the KPOM is mainly rain water, and this rain water is pre-treated at the water treatment facility. A part of the process water is used as boiler water, and the generated steam from the steam turbine which is low pressure steam is used at each process.

Wastewater is generated from each process. The discharged wastewater is treated through an open lagoon system composed by eight ponds comprising a Cooling pond, five anaerobic ponds, an Aerobic pond and a Desludging Pond. Discharged wastewater from some processes in the factory are collected at three POME pits and then transferred to the Cooling Pond. The final discharge is then distributed around the surrounding plantation through the anaerobic ponds and the aerobic pond.

(2) Environmental Management of the Mill

The KPOM has carried out water quality analyses of the final discharges once a month. KPOM entrusts this activity to a Multi-Service Enterprise, and the analytical work is carried out by an analytical agency, namely Chemsain Konsultant Sdn Bhd in Kota Kinabalu. The result of the final discharge quality analysis during January 2013 to March 2014 provided by KPOM is shown in Table 3-2. The KPOM is allowed to discharge effluent having not higher than 1,000 mg/L of BOD but the value in February 2013 exceeded this regulation value. The mill owner and the mill manager have recognized that this is a problem. The values

of TSS, T-N and NH_4^+-N were also relatively high but the Department of Environment (hereinafter referred to as "DOE") conducts administrative checks only for the value of BOD, hence the owner of the factory has low motivation to keep to the regulation values of T-N, TSS and NH_4^+-N. In addition desludging has never been implemented since operation started, so it is hard to say that the wastewater treatment facility is well maintained.

Table 3-2 Final Discharge Quality Analysis Result

Sampling Date	pH(-)	BOD_3(mg/l)	TSS(mg/l)	T-N(mg/l)	NH_4^+-N(mg/l)	O&G(mg/l)	Temp (deg.C)
15/01/2013	8.0	481	18,400	773	208	N.D.	29
19/02/2013	7.3	1,120	1,010	247	132	N.D.	29
14/03/2013	7.4	672	15,400	242	99.6	N.D.	29
18/04/2013	7.6	403	6,650	246	81.1	N.D.	29
19/05/2013	7.7	196	863	142	124	N.D.	29
18/06/2013	8.0	306	2,840	298	137	N.D.	29
21/07/2013	8.2	294	1,710	291	166	N.D.	29
21/08/2013	8.3	393	2,440	382	186	N.D.	29
19/09/2013	8.4	876	10,000	640	159	N.D.	29
23/10/2013	7.8	393	1,890	308	82.1	N.D.	32
22/11/2013	7.9	792	9,430	32	175	N.D.	32
19/12/2013	8.2	834	11,800	783	149	N.D.	31
17/1/2014	8.4	392	10,700	636	200	N.D.	31
20/2/2014	8.5	487	380	375	188	N.D.	29
14/3/2014	8.4	295	637	508	200	N.D.	29
Applied Regulation		< 1,000					

Remarks N.D. : Not Detected

(Source: JET made with KPOM materials)

Biogas (mainly methane) seems to be generated at each of the treatment stages from the wastewater treatment facility which is composed of open lagoon systems. Most of the generated gas escapes into the atmosphere. Only one of the five anaerobic ponds (pond No. 4) has been covered by material which is assumed to be HDPE, but the biogas generated has not been collected from even this pond. In addition there are some facilities which generate exhaust gases such as the steam boiler, power generation and emergency power generation systems in the mill but such facilities are not equipped with any exhaust gas treatment systems. Furthermore, the composition characteristics of the exhaust gases have never been analyzed.

(3) Surrounding Environment of the Mill

The KPOM is surrounded by the palm plantation and while there are some houses used/owned by the factory's staff there are no other residences or buildings in the vicinity.

Although effluent from the KPOM is discharged into the plantation grounds and not directed into the river directly, the KPOM carries out water quality analyses at upstream and downstream locations of the mill in a small river named Sungai Punteh once a month. The results of the river water quality analyses during January 2013 to March 2014, provided by the KPOM, are shown in Table 3-3. Some of the results do not satisfy the National Water Quality Standards Class III at downstream and even upstream locations. Based on the upstream location results it is therefore suspected by the KPOM that the existing pollution might be generated from sources outside the mill.

Table 3-3 Result of River Water Quality Analysis around KPOM

Sampling Date	pH(-)		BOD(mg/l)		TSS(mg/l)		NH_4^+-N(mg/l)		T-N(mg/l)		O&G(mg/l)		TDS(mg/l)	
	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
15/01/2013	7.7	7.4	< 1	< 1	12	44	< 0.2	< 0.2	0.61	0.61	N.D.	N.D.	50	80
19/02/2013	7.5	7.3	< 1	1.98	14	48	1.15	0.58	1.15	5.77	1.6	1.6	60	210
14/03/2013	7.4	7.2	< 1	< 1	16	19	< 0.2	< 0.2	3.05	2.44	N.D.	N.D.	60	180
18/04/2013	7.1	7.3	< 1	< 1	13	15	0.61	0.3	0.91	0.91	N.D.	N.D.	60	120
19/05/2013	7.0	7.4	< 1	< 1	22	19	< 0.2	< 0.2	1.84	1.84	N.D.	N.D.	60	100
18/06/2013	7.1	7.3	< 1	< 1	8	14	< 0.2	< 0.2	0.3	0.3	N.D.	N.D.	50	80
21/07/2013	7.0	7.4	< 1	< 1	17.5	20	< 0.2	< 0.2	2.9	1.74	N.D.	N.D.	60	90
21/08/2013	7.1	7.5	< 1	< 1	8	11	< 0.2	< 0.2	2.6	1.95	N.D.	N.D.	70	100
19/09/2013	7.0	7.6	< 1	< 1	17	18	< 0.2	< 0.2	1.22	< 0.2	N.D.	N.D.	60	90
23/10/2013	7.3	7.5	< 1	< 1	14.5	43	< 0.2	< 0.2	1.22	1.82	N.D.	N.D.	-	-
22/11/2013	7.1	7.5	< 1	1.66	41	51	< 0.2	< 0.2	1.23	1.85	N.D.	N.D.	-	-
19/12/2013	7.2	7.6	< 1	< 1	171	702	< 0.2	< 0.2	0.62	3.08	N.D.	N.D.	-	-
17/1/2014	7.1	7.5	< 1	< 1	10	11	< 0.2	< 0.2	0.64	1.29	N.D.	N.D.	-	-
20/2/2014	6.9	7.4	< 1	< 1	23	68	1.61	1.93	0.64	1.29	N.D.	N.D.	-	-
14/3/2014	7.0	7.3	< 1	< 1	19	13	< 0.2	< 0.2	0.63	0.31	N.D.	N.D.	-	-
Applied Regulation	5.0 - 9.0		< 6.0		< 150		< 0.9		–		N.D.		–	

Remarks US: Upstream, DS: Downstream
N.D. : Not Detected
- : Not Analyzed

(Source: JET made by KPOM materials、National Standard: National Water Quality Standards Class III)

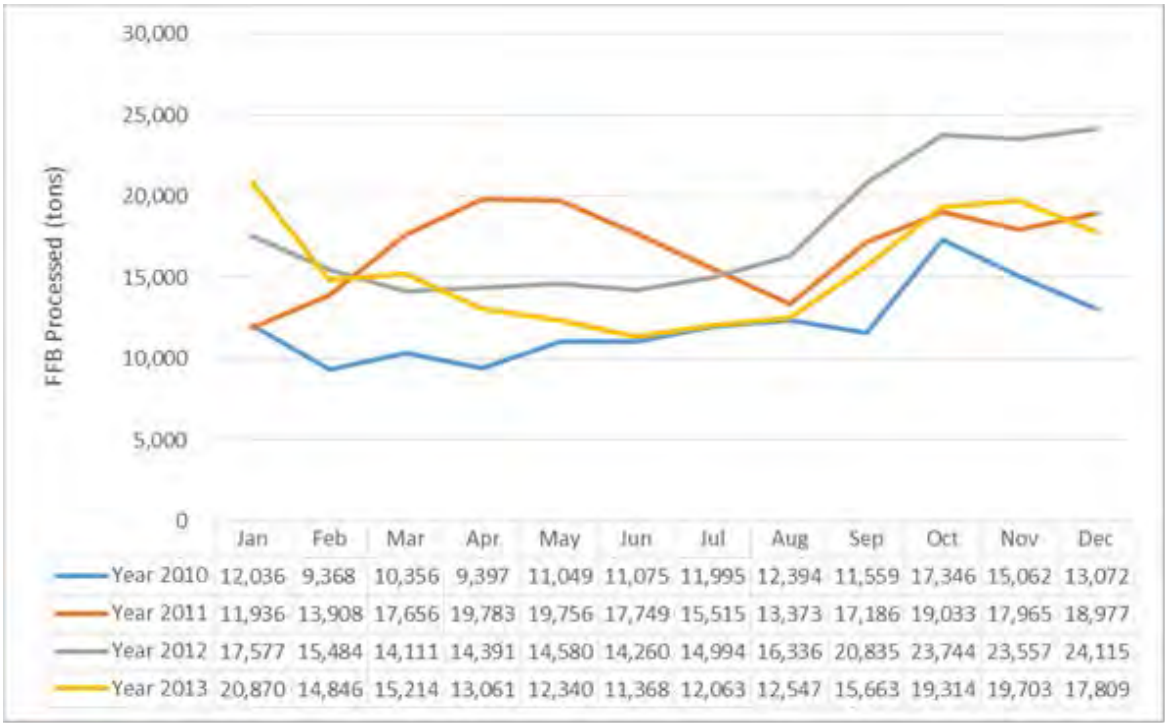
Upstream of the small River

Downstream of the River

3-1-3 Operation Results of the Mill

The records of processed Fresh Fruit Brunch (hereinafter referred to as “FFB”) in the KPOM during January 2010 to December 2013 are shown in Figure 3-3. The annual treatment amount of FFB varies from 144,709 tonnes to 213,984 tonnes and on average it is 186,582 tonnes per year. There is a seasonal fluctuation of the processed FFB, and a trend is seen as the amount is relatively higher from September to January and it is slightly lower from February to August. The minimum monthly amount of processed FFB was 9,368 tonnes in February 2010 and the maximum monthly amount of processed FFB was 24,115 tonnes in December 2012, and in the example where the average monthly processed amount is set at 100, the fluctuation range is between 60 and 155[1].

[1] For example, Department of Environment, “Industrial Processes & The Environment (Handbook No.3), Crude Palm Oil Industry(1999)”



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Year 2010	12,036	9,368	10,356	9,397	11,049	11,075	11,995	12,394	11,559	17,346	15,062	13,072
Year 2011	11,936	13,908	17,656	19,783	19,756	17,749	15,515	13,373	17,186	19,033	17,965	18,977
Year 2012	17,577	15,484	14,111	14,391	14,580	14,260	14,994	16,336	20,835	23,744	23,557	24,115
Year 2013	20,870	14,846	15,214	13,061	12,340	11,368	12,063	12,547	15,663	19,314	19,703	17,809

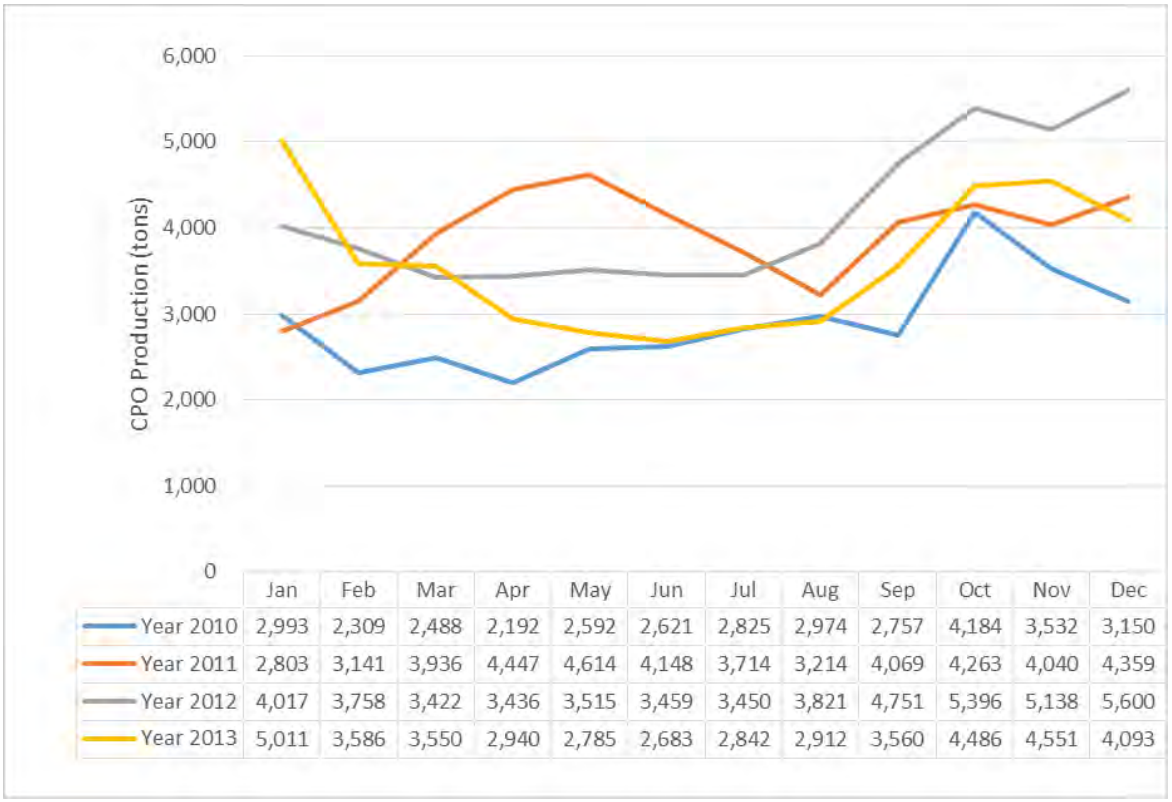
(Source: JET made by KPOM materials)

Figure 3-3 Monthly processed FFB (2010 to 2013

The record of Crude Palm Oil (hereinafter referred to as "CPO") production amount during January 2010 to December 2013 is shown in Figure 3-4. The fluctuation of the CPO production amount is bigger than that of the FFB treatment, and the minimum monthly amount of CPO production was 2,192 tonnes in April 2010 and the maximum monthly amount of CPO production was 5,600 tonnes in December 2012.

The CPO production amount per 1 ton of processed FFB is 233 kg for the whole period, the figure is on average better than the 255 kg per 1 ton FFB of the value to which it is commonly referred.*2

*2 For example, Department of Environment, "Industrial Processes & The Environment (Handbook No.3), Crude Palm Oil Industry(1999)"



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Year 2010	2,993	2,309	2,488	2,192	2,592	2,621	2,825	2,974	2,757	4,184	3,532	3,150
Year 2011	2,803	3,141	3,936	4,447	4,614	4,148	3,714	3,214	4,069	4,263	4,040	4,359
Year 2012	4,017	3,758	3,422	3,436	3,515	3,459	3,450	3,821	4,751	5,396	5,138	5,600
Year 2013	5,011	3,586	3,550	2,940	2,785	2,683	2,842	2,912	3,560	4,486	4,551	4,093

(Source: JET made with KPOM materials)

Figure 3-4 Monthly CPO Production (2010 to 2013)

3-1-4 Effluent Volume Discharged from the Mill

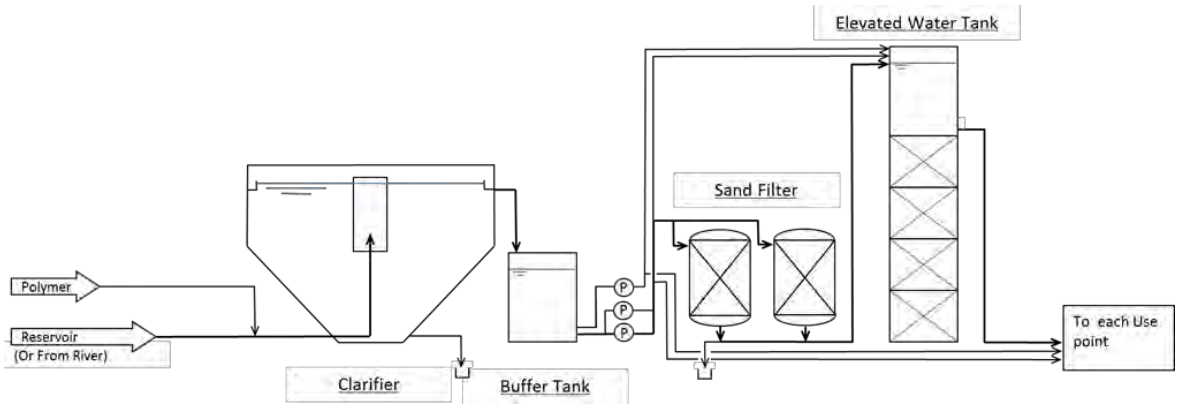
As there is no flowmeter for measuring the intake and drainage water volumes in the KPOM the amount of intake and discharged water cannot be estimated. In order to confirm the mass balance in the factory, the amounts of plant water, boiler water, and wastewater generated from each process were measured by JET, during the site work.

(1) Plant Water

1) Process Water

Purified rainwater and river water have both been used as process water in the KPOM but it mainly uses rainwater. The rainwater in the vicinity is collected in a reservoir and transferred to the water treatment facility in the mill and distributed to each utilization point after purification. The raw water from the reservoir is separated at the clarifier after polymer dosing. The supernatant via the Buffer Tank is filtered by a Sand filter, and transferred to an Elevated Water Tank, and then distributed to each facility. Sediment sludge from the clarifier and backwash water from the sand filter are discharged into a side ditch.

The process flow diagram of the water treatment facility is shown in Figure 3-5.

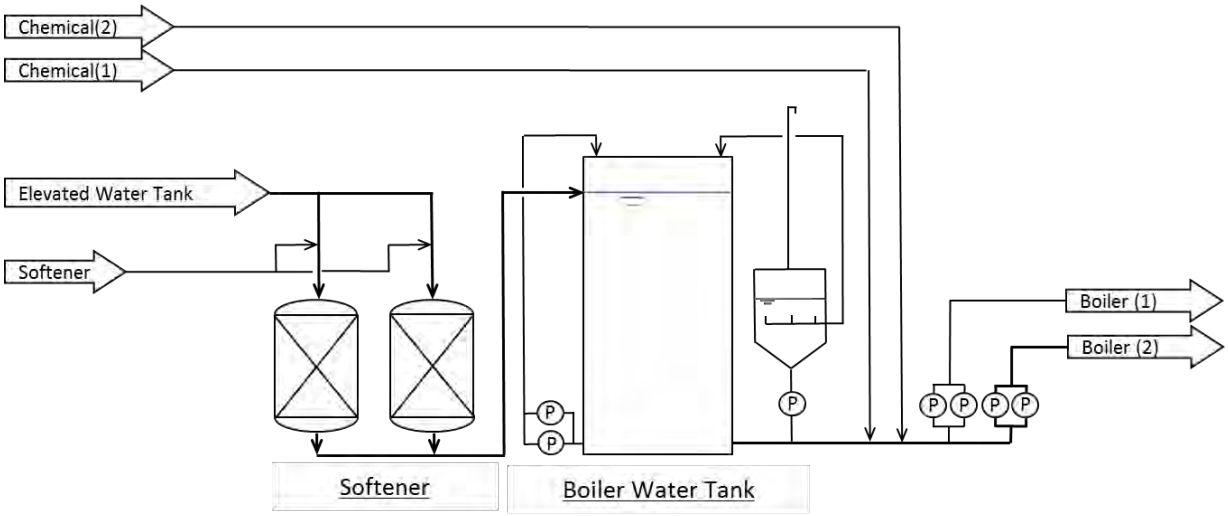


(Source: JET)

Figure 3-5 Process Flow Diagram of Water Treatment Facility

2) Boiler Water

Boiler water is additionally softened and deaerated process water. The process flow diagram of the boiler water treatment facility is shown in Figure 3-6.



(Source: JET)

Figure 3-6 Process Flow Diagram of Boiler Water Treatment Facility

(2) Process Water Consumption

The measurement results of the flow rates of process water and boiler water and estimated water consumption are shown in Table 3-4.

Table 3-4 Water Consumption of Process water and Boiler water

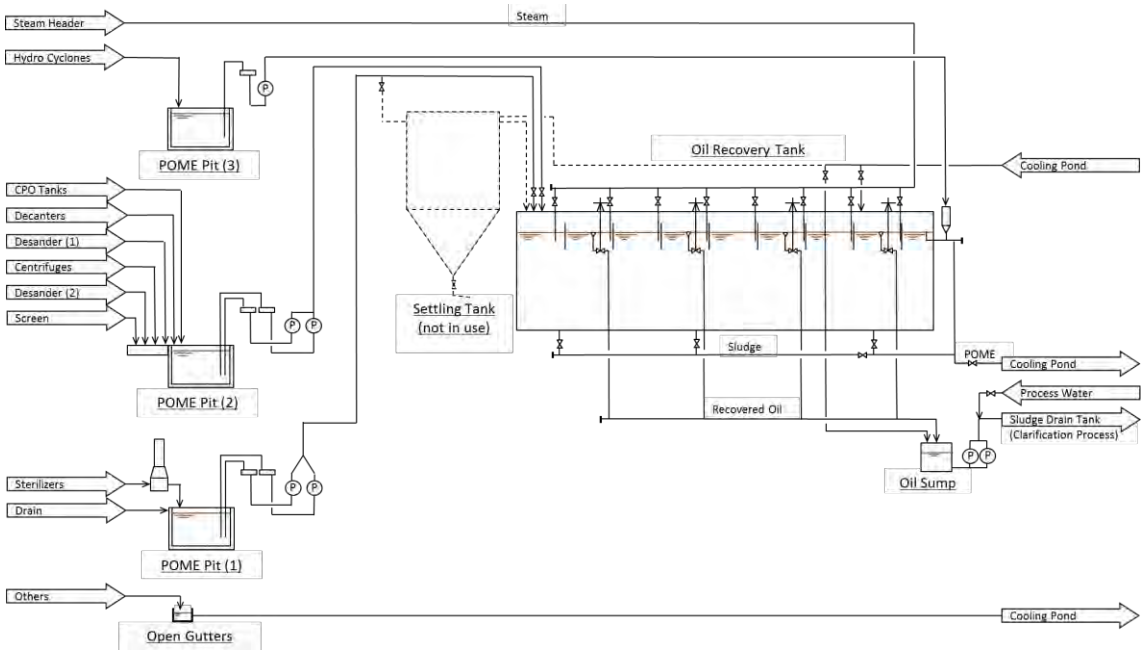
Type of Water	Flow rate	Estimated daily Water Consumption
Process Water	61.9m^3/hr	61.9m^3/hr x 11 hr/day=681m^3/day
Boiler Water	19.0m^3/hr	19.0m^3/hr x 11 hr/day=209m^3/day

(Source: JET)

(3) Wastewater Generation Points

A schematic flow chart of the Palm Oil Mill Effluent (hereinafter referred to as "POME") collection system is shown in Figure 3-7. Effluent generated from each process is collected in three POME pits. Once the steam used at the sterilization station becomes condensate, it is collected at POME pit (1) as wastewater. In the clarification process, discharged wastewater generated from items such as the vibrating screen, desander, centrifuge and sludge decanter are all collected at POME pit (2). Sludge from the CPO tanks is normally not desludged but the transfer line to POME pit (2) has the necessary equipment to do so.

Wastewater generated at the Hydro Cyclone of the Kernel Recovery Station is collected at POME pit (3).



(Source: JET)

Figure 3-7 Schematic Diagram of POME Collection System

(4) Wastewater Generation Amounts

The measurement results of each wastewater flow rate are shown in Table 3-5.

Table 3-5 Wastewater Generation Amount

Location	Flow rate	
Transfer Pump at POME Pit 1	9.5 m^3/hr	(26.0%)
Transfer Pump at POME Pit 2	22.8 m^3/hr	(62.3%)
Screen	*2.7 m^3/hr*	*(7.4%)*
Desander	*2.9 m^3/hr*	*(7.9%)*
Centrifuge	*5.5 m^3/hr*	*(15.0%)*
Sludge decanter	*11.7 m^3/hr*	*(32.0%)*
Transfer Pump at POME Pit 3	4.3 m^3/hr	(11.7%)
Total	36.6 m^3/hr	(100.0%)

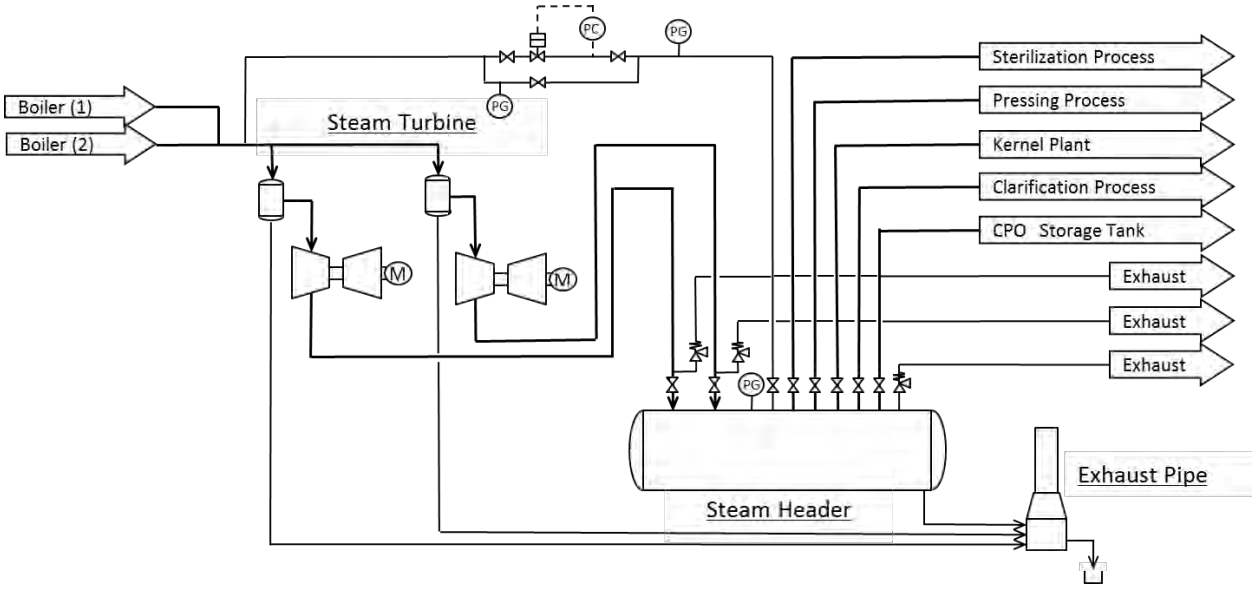
(Source: JET)

3-1-5 Generation of Waste Steam

(1) Usage of Steam

All high-pressure steam generated by the boiler is consumed at the steam turbine for power generation. The low-pressure steam (about 0.3 MPa) discharged from the steam turbine is delivered to the Steam Header and then distributed to each facility, such as the sterilization station, digestion tank of pressing process, clarification process and so on, in the factory as shown in Figure 3-8. Surplus low pressure steam is however discharged into the air as waste steam.

The sterilization station especially consumes much steam, because of its batch operations, and waste steam generation amounts always fluctuate. The pressure of the steam header can however be kept stable by a pressure control valve which opens automatically when the steam pressure declines.



(Source: JET)

Figure 3-8 Schematic Diagram of Steam Line Flow

(2) Sterilization Station

The amounts of generated waste steam depend on the operation of the Sterilization Station. Understanding the operation pattern it is therefore necessary in order to determine the amount of waste steam generated.

1) Specification of the Sterilization Station

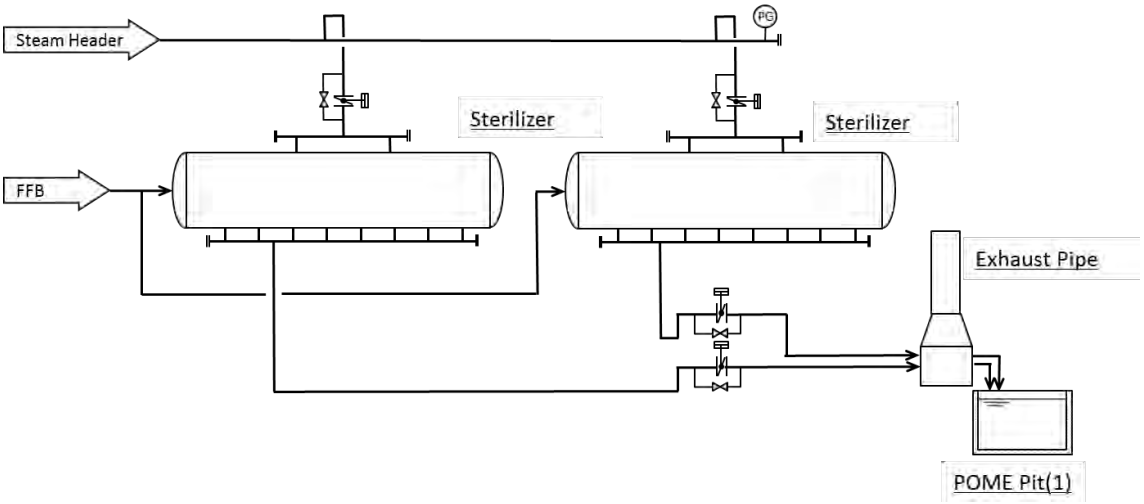
The FFB which is delivered into the mill is loaded on trolley cars at a loading ramp and then sterilized by 0.3 MPa of steam in the Sterilizer. The specifications for the Sterilization Station is shown in Table 3-6 and the schematic process flow is shown in Figure 3-9.

Table 3-6 Specifications of the Sterilization Station

Item	Specification
Equipment Numbers	2
Capacity	8.24m^3
Examined Pressure	525kPa
Design Pressure	350kPa

Waste Steam Pressure	14kPa
Design Temperature	148℃
Number of trolley cars which can be installed	7 cars per one time

(Source: JET)



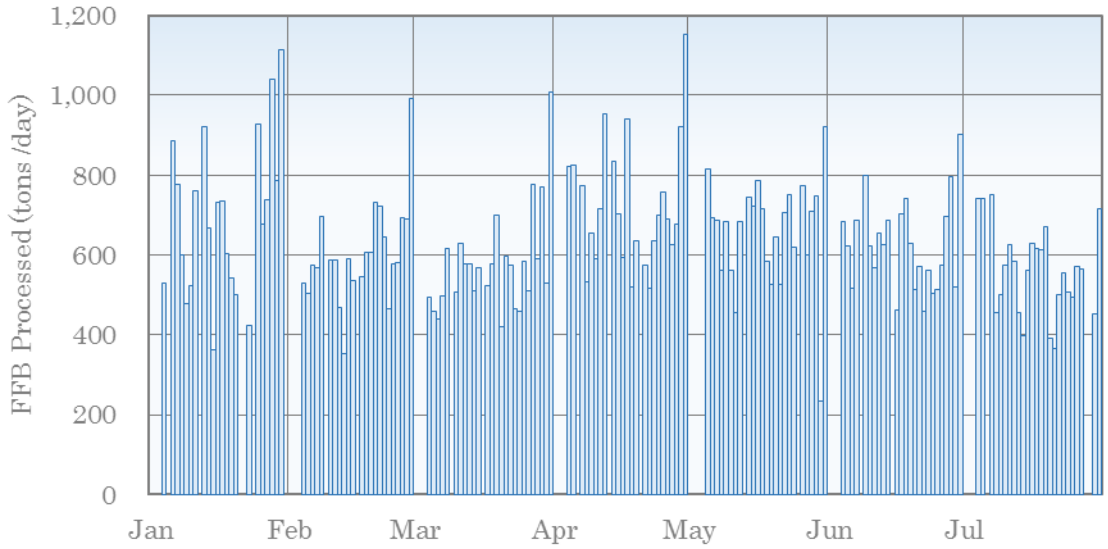
(Source: JET)

Figure 3-9 Schematic Process Flow of the Sterilization Station

2) Operation Record of the Sterilization Station

The operation records of the sterilization station during the 212 days from January 1st to July 31st in 2014 is shown in Figure 3-10. The sterilization station had being operated for 2,508 hours in 170 days, 107,522 tonnes of FFB was processed from 1,850 batches during this period.

The amount of daily processed FFB was 233.8 tonnes to 1,151.6 tonnes and the average was 632.5 tonnes, the batch numbers of amounts processed daily was 4 to 20 times and the average was 10.9 times. The average of daily operation time was 14.75 hours. Thereby, it is calculated that the average processed amount per single batch was 58 tonnes, operation time for one batch was 81 minutes, and the average FFB processed amount per hour was 42.9 tonnes.

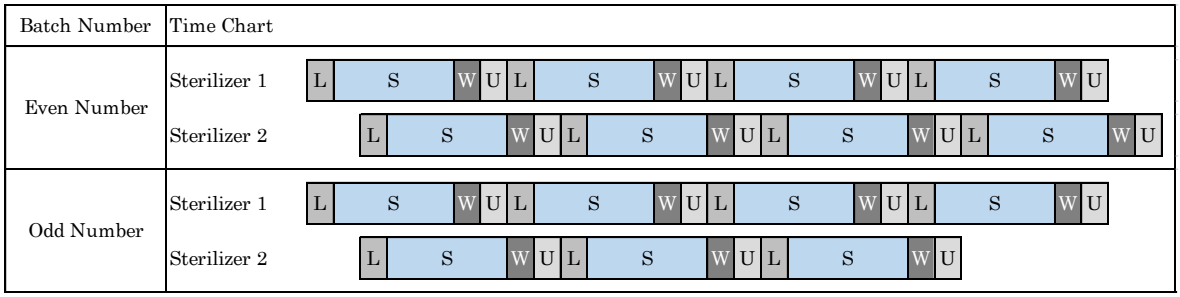


(Source: JET madeby KPOM data)

Figure 3-10 Operation Record of the Sterilization Station (January 1st to July 31st of 2014)

3) Operation Pattern of the Sterilization Station

The standard operation time for sterilization (described as "S") of one batch is based on a 90 minute turn around time frame but the loading time (described as "L") and unloading time (described as "U") are necessary to be factored in as well. In addition, waiting time (described as "W") may be sometimes required in case the next process is experiencing congestion. The operation pattern of the sterilization station is therefore shown in Figure 3-11.



(Source: JET)

Figure 3-11 Operation Pattern of the Sterilization Station

As there are two lines of sterilizers in the mill, one batch operation time can be calculated in case of even number and odd number of batch operations per day by the following formulas;

Even Number: $((L+S+W+U)\times n/2+W+U)/n$

Odd Number: $((L+S+W+U)\times(n+1)/2)/n$

L: Loading time of FFB

S: Sterilization time

W: Waiting time for next process stage (noise)

U: Unloading time of FFB

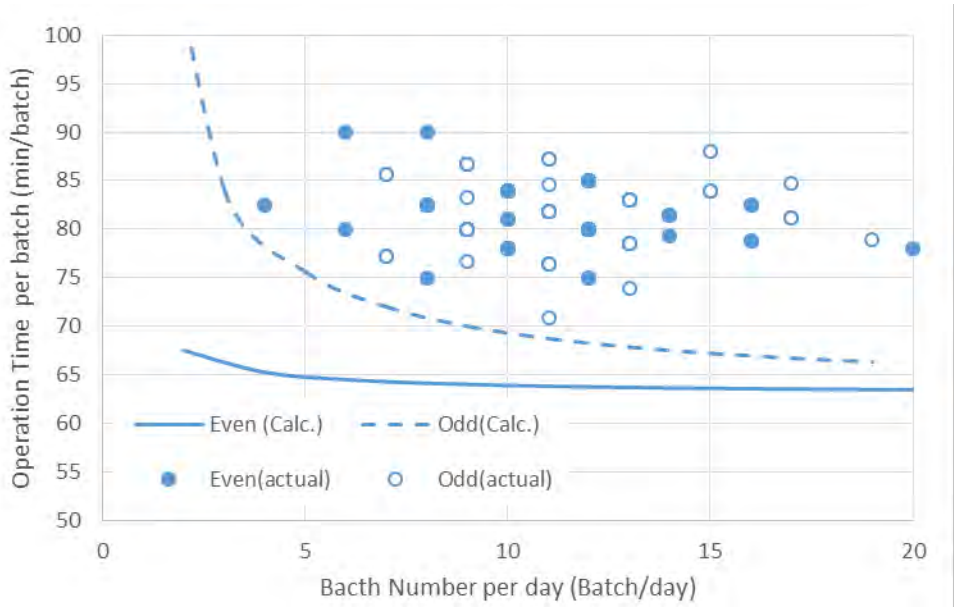
JET carried out a time and motion study in order to measure the actual time for loading of the FFB (L), sterilization (S), and unloading of the FFB (U). The result is shown in Figure 3-12, the result shows that L is 22 minutes, S is 95 minutes, and U is 9 minutes.

Operation time for one batch was calculated by adapting the measured figures pertaining to each in case of even number and odd number of batch operations per day. Comparison between the calculated results and actual result figures is shown in Figure 3-13.

The actual operation time was 70 minutes to 90 minutes per batch and the average was 81 minutes, thus these actual operation times are longer than the calculated figures. This gap seems to be caused by the waiting time due to the congestion time in the next processed batch, 5 minutes to 25 minutes of waiting time was normally generated for one batch.

(Source: JET)

Figure 3-12 Result of Time and Motion Study of the Sterilizer

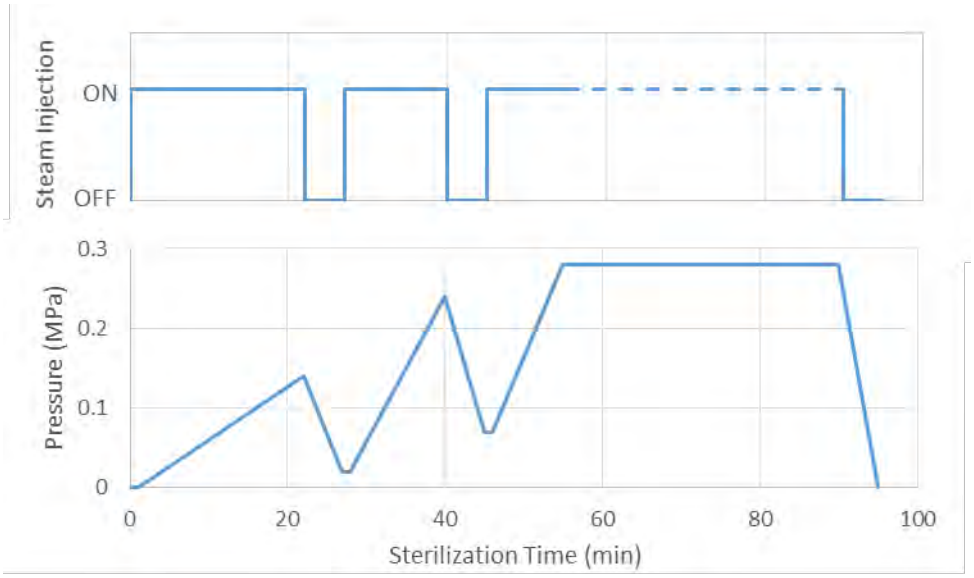


(Source: JET)

Figure 3-13 Relation between Batch Number and One Batch Operation Time

4) Dosing Pattern of Steam into the Sterilizer

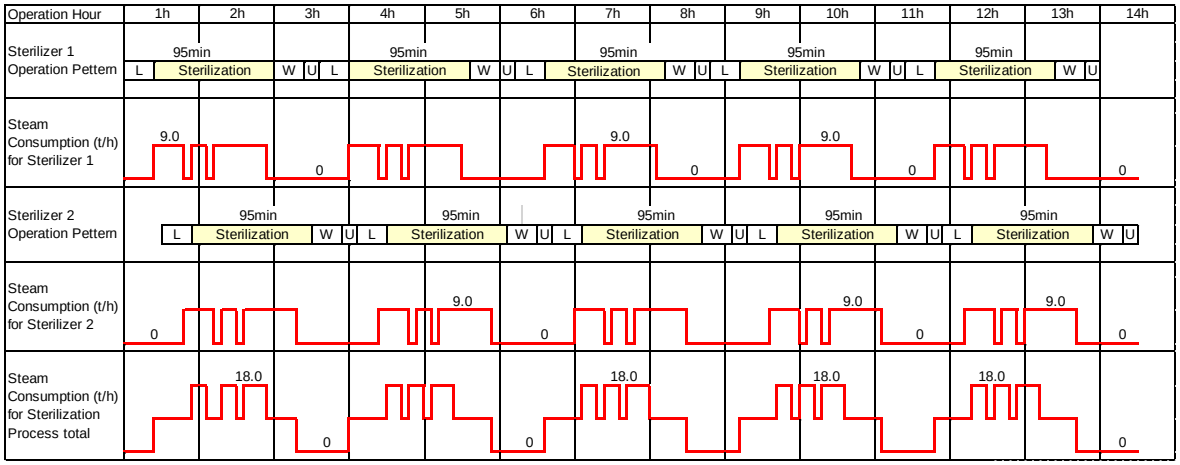
The steam supplied from the steam header is dosed into the sterilizer by a three step pressurization process as shown in Figure 3-14. Initially the sterilizer is pressurized to 20 psi (approximately 0.14 MPa) then decompressed, next it is pressurized to 35 psi (approximately 0.24 MPa) then decompressed again, finally the pressure of the sterilizer is sustained at 40 psi (approximately 0.28 MPa) for a period of 35 minutes. Thus, steam is not dosed during decompression stages even in the sterilization process.



(Source: JET)

Figure 3-14 Steam Dosing Pattern into the Sterilizer

The operation patterns of two series of sterilizers and the fluctuation of steam consumption are shown in Figure 3-15. The steam consumption fluctuates due to the number of operating cycles of the sterilizer. Considering the measured results of the flow rate at the POME Pit (1), the average steam consumption works out to 9.5 tonnes per hour which is the same amount as that of the wastewater. The actual amount of steam used seems to fluctuate between 0 and 18 ton per hour, while the sterilizers are operated.



(Source: JET)

Figure 3-15 Operation Pattern and Steam Consumption in the Sterilizers

3-1-6 Material Balance of KPOM

The hourly material balance of the KPOM based on the survey results is shown in Figure 3-16. The outline of the material balance of the KPOM is described in Table 3-7. The hourly amount of processed FFB is 42.9 tonnes and 10.0 tonnes of CPO is produced. CPO production rate per FFB is 233 kg.

(1) Water Consumption

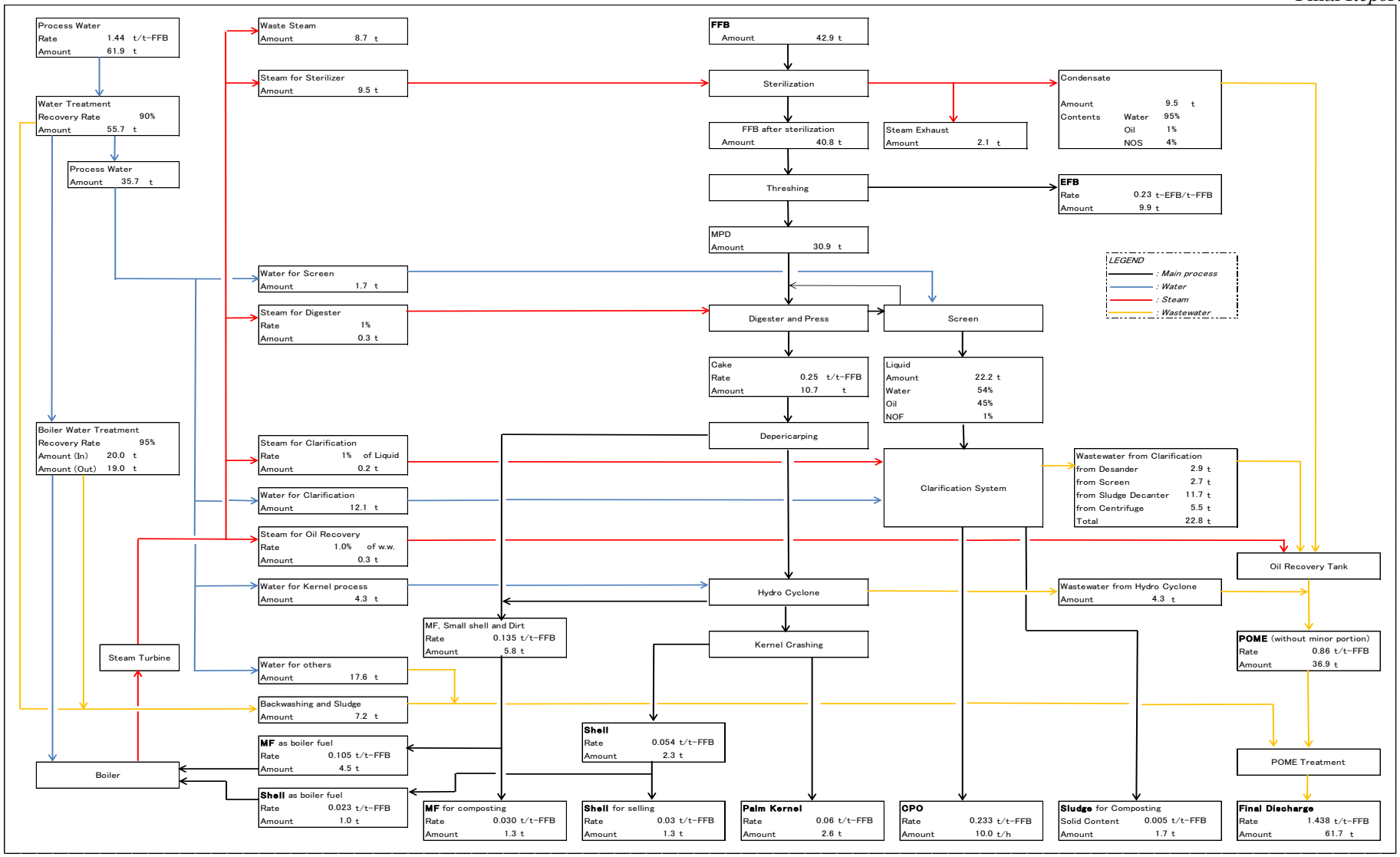
Hourly 61.9 tonnes of water is supplied as process water and 19.0 tonnes is supplied as steam.

(2) Wastewater amount

The effluent (POME) is discharged from the sterilization station, pressing process, and kernel plant. The amount discharged in each case is 9.5m^3, 22.8m^3, and 4.3m^3 per hour and the composition ratio is 26.0%, 62.3% and 11.7% respectively.

(3) Waste steam amount

Of the 19.0 tonnes per hour of generated steam, 9.5 tonnes per hour are consumed at the sterilizer and 0.8 tonnes per hour are used in other processes. 8.7 tonnes per hour or approximately 46 % of the generated steam is discharged into the air. As a result of the fluctuations of the steam consumption in the sterilizer between 0 and 18 tonnes per hour, the volume of direct discharge steam fluctuated between 0.2 ton and 18.2 tonnes per hour.



(Source: JET)

Figure 3-16 Material Balance of KPOM

Table 3-7 Outline of Material Balance

Input (t/h)		Output (t/h)	
FFB	42.9	CPO	10.0
Water	61.9	EFB	9.9
		MF	5.8
		Shell	2.3
		PK	2.6
		Sludge	1.7
		POME	36.9
		Other wastewater	24.8
		Waste Steam	8.7 (0.2～18.2)
		Exhaust from Sterilizer	2.1
Total	104.8	Total	104.8

(Source: JET)

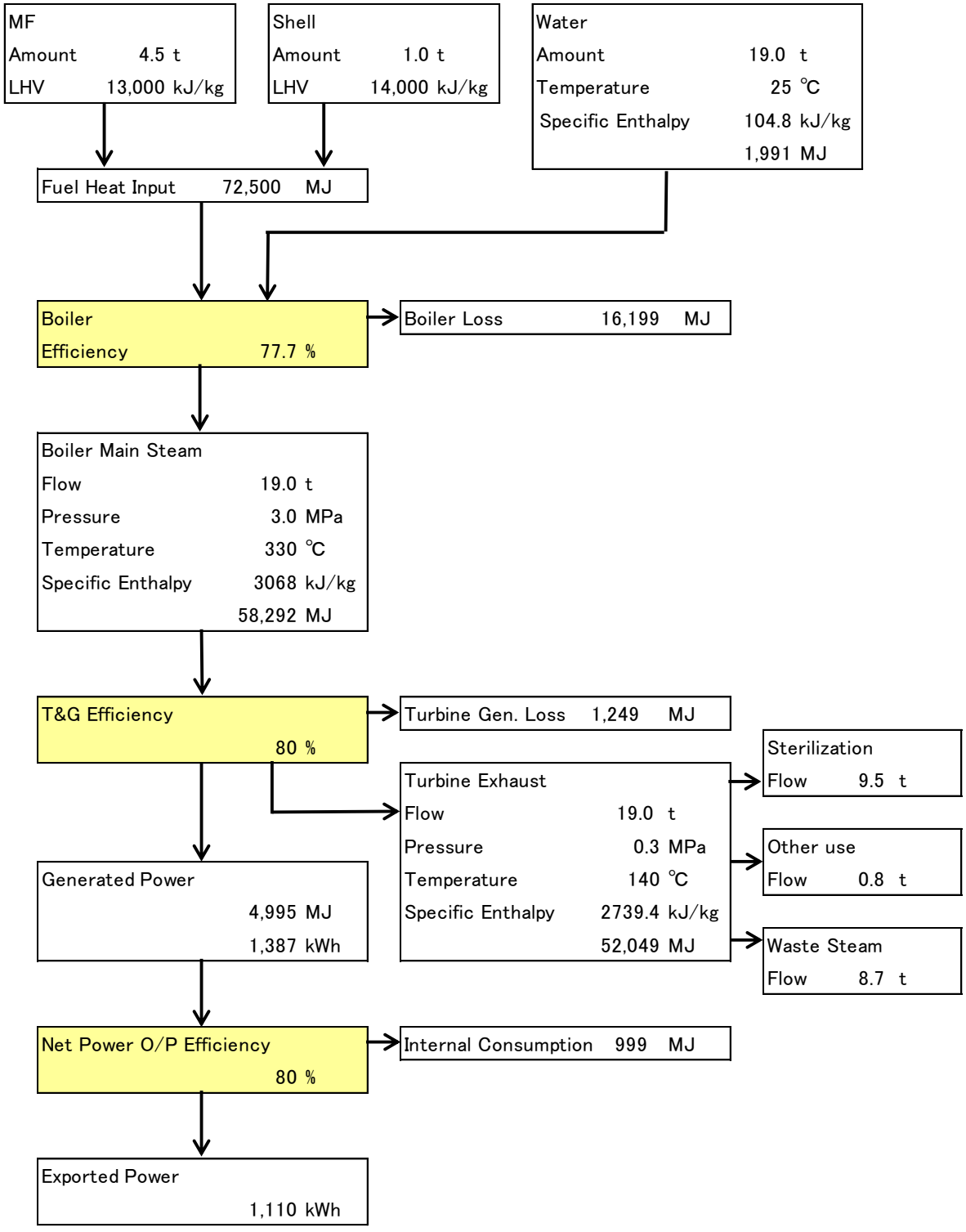
3-1-7 Heat Balance of KPOM

The hourly heat balance of the KPOM based on the survey is shown in Figure 3-17. The heat values of MF and Shell as boiler fuel are adopted from the values indicated in Table 3-8. 19.0 tonnes steam with 3 MPa and at 330 degree Celsius is generated from 4.5 tonnes of MF and 1 ton of Shell hourly, then 1,100 kWh of electrical power is generated by the steam turbine generator. The remaining low-pressure, 0.3MPa steam is consumed at each facility through the steam header, but surplus low pressure steam is discharged into the air.

Table 3-8 Characteristics of the Boiler and Wet Base Lower Heat Value

Type	Unit	MF	Shell
Combustible	%	66	73
Ash	%	4	2
Total Moisture	%	30	25
LHV (Wet Base)	kJ/kg	13,000	14,000

(Source: JET)



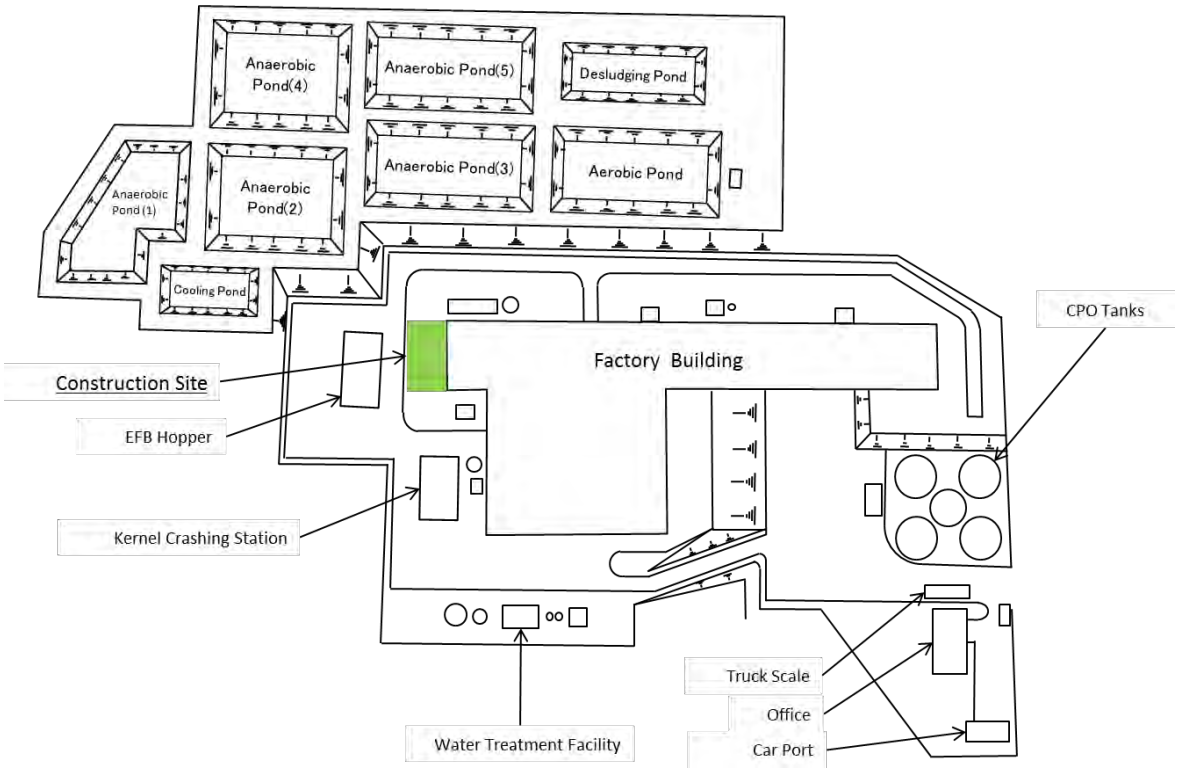
(Source: JET)

Figure 3-17 Heat Balance of KPOM (per hour)

3-1-8 Construction Site

The owner of the factory proposed that land located between main factory building and EFB hopper be used for the pilot plant construction site. The site is rectangular, being 41m wide and 26m long and there

are no obstacles for construction activities. The site was also in a good position for pipe installation to the existing facilities. This land was therefore selected as a suitable site for the construction of the Pilot Plant.



(Source: JET)

Figure 3-18 Pilot Plant Construction Site

Pilot Plant Construction Site

3-2 Related Laws and Regulation for the Pilot Plant Construction

3-2-1 Environmental Quality Act

Environmental regulations in Malaysia are based on the "Environmental Quality Act 1974 (Act127)" (hereinafter referred to as "the Act 127) established in 1974.

This law was established in order to regulate against infringement of admissibility conditions and waste disposal, 38 regulations and orders as shown in Table 3-9 have been legislated. "Environmental Quality (Prescribed Premises) (Crude Palm Oil) Regulations 1977" and "Environmental Quality (Prescribed Premises) (Crude Palm Oil) Order 1977" are directly related to the palm oil mills.

Table 3-9 Regulations and Orders based on Environmental Quality Act 1974

NO.	REGULATIONS/ORDER	P.U. (A)	EFFECTIVE DATE OF ENFORCEMENT
1.	Environmental Quality (Prescribed Premises)(Crude Palm Oil) Regulations 1977	342	1st July, 1977
2.	Environmental Quality (Licensing) Regulations 1977	198	1st October, 1977
3.	Environmental Quality (Clean Air) Regulations 1978	280	1st October, 1978
4.	Environmental Quality (Compounding of Offences) Rules 1978	281	1st October, 1978
5.	Environmental Quality (Prescribed Premises)(Raw Natural Rubber) Regulations 1978	338	1st December, 1978
6.	*Environmental Quality (Sewage and Industrial Effluents) Regulations 1979 *(Revoked by PU(A) 432/2009)*	12	1st January 1981
7.	Environmental Quality (Control of Lead Concentration in Motor Gasoline) Regulations 1985	296	1st August, 1986
8.	Environmental Quality (Motor Vehicles Noise) Regulations 1987	244	1st July, 1987
9.	Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987	362	1st April, 1988
10.	Environmental Quality (Scheduled Wastes) Regulations 1989 *(Revoked by PU(A) 294/2005)*	139	1st May, 1989
11.	Environmental Quality (Prescribed Premises) (Scheduled Wastes Treatment And Disposal Facilities) Order 1989	140	1st May, 1989
12.	Environmental Quality (Prescribed Premises) (Scheduled Wastes Treatment And Disposal Facilities) Regulations 1989	141	1st May, 1989
13.	Environmental Quality (Prescribed Premises) (Crude Palm Oil) Order 1977	199	1st July, 1978
14.	Environmental Quality (Prescribed Premises) (Raw Natural Rubber) Order 1978	250	1st April, 1979
15.	Environmental Quality (Delegation of Powers on Marine Pollution Control) Order 1993	276	24th September, 1993
16.	Environmental Quality (Prohibition on the use of Chlorofluoro-carbons and other Gases as Propellants and Blowing Agents) Order 1993	434	25th October, 1993
17.	Environmental Quality (Delegation of Powers on Marine Pollution Control) Order 1994	537	18th December, 1994

NO.	REGULATIONS/ORDER	P.U. (A)	EFFECTIVE DATE OF ENFORCEMENT
18.	Environmental Quality (Prohibition on the Use of Controlled Substance in Soap, Synthetic Detergent and other Cleaning Agents) Order 1995	115	15th April, 1995
19.	Environmental Quality (Control of Emission from Diesel Engines) Regulations 1996	429	1st September, 1996
20.	Environmental Quality (Control of Emission from Petrol Engines) Regulations 1996	543	1st November, 1996
21.	Environmental Quality (Refrigerant Management) Regulations 1999	451	1st January, 2000
22.	Environmental Quality (Halon Management) Regulations 1999	452	1st Jan, 2000
23.	Environmental Quality (Delegation of Powers) Order 1999 *(Revoked by PU(A) 365/2005)*	501	15th November, 1999
24.	Environmental Quality (Compounding of Offences) (Open Burning) Rules 2000	310	21st August, 2000
25.	Environmental Quality (Delegation Of Powers) (Investigation of Open Burning) Order 2000	311	21st August, 2000.
26.	Environmental Quality (Delegation of Power) (Halon Management) Order 2000	490	29th December 2000
27.	Environmental Quality (Delegation of Powers) (Perbadanan Putrajaya) Order 2002	233	2ndJune 2002
28.	Environmental Quality (Appeal Board) Regulations 2003	115	21st April 2003
29.	Environmental Quality (Declared Activities) (Open Burning) Order 2003	460	1st January 2004
30.	Environmental Quality (Control of Emissions From Motorcycles) Regulations 2003	464	1st January 2004
31.	Environmental Quality (Dioxin and Furan) Regulations 2004	104	1st May 2004
32.	Environmental Quality (Prescribed Conveyance) (Scheduled Wastes) Order 2005	293	15th August 2005
33.	Environmental Quality (Scheduled Wastes) Regulations 2005	294	15th August 2005
34.	Environmental Quality (Delegation of Powers) Order 2005	365	2nd September 2005
35.	Environmental Quality (Control of Petrol And Diesel Properties) Regulations 2007	145	1st April 2007
36.	Environmental Quality (Sewage) Regulations 2009.	432	10th December 2009
37.	Environmental Quality (Control of Pollution From Solid Waste Transfer Station and Landfill) Regulations 2009	433	10th December 2009
38.	Environmental Quality (Industrial Effluent) Regulations 2009;	434	10th December 2009

(Source：DOE, Environmental Requirements: A Guide For Investors, 2010)

3-2-2 Regulations for the Palm Mill Factory

Based on the section 51 of the Act 127, "Environmental Quality (Prescribed Premises) (Crude Palm Oil)

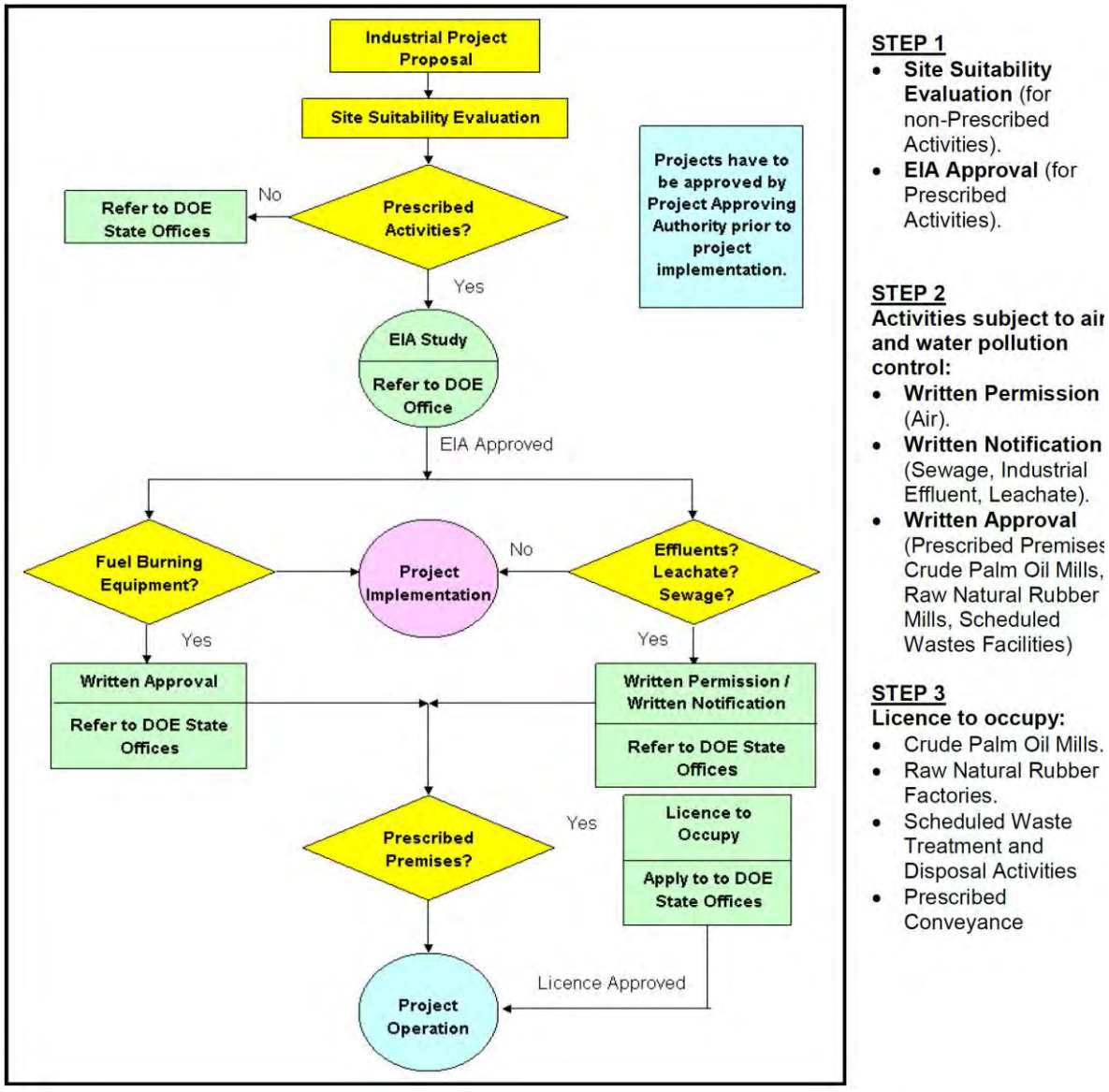
Regulation 1977" (hereinafter referred to as "the Regulation") were made as relating to palm oil mills, and the discharge wastewater quality standards for palm oil mills was established. In the case of the KPOM, because it discharged the final effluent from the mill into the palm oil plantation grounds, the discharge needed to comply with the standard values of the article 13 in the Regulation, "Limits for parameters of effluent to be discharged onto land".

According to the Regulation, discharge quality standards are set only for BOD. The standard value of BOD is 5,000 mg/L for facilities licensed after July 1st 1979. However stricter values are able to be set as necessary. Consequently the limit value of BOD of KPOM was set at 1,000 mg/L instead of the 5,000 mg/L prevailing previously. Furthermore, based on the section 18 of the Act 127, "Environmental Quality (Prescribed Premises) (Crude Palm Oil) Order 1977" (hereinafter referred to as "the Order") it is prescribed that palm oil mills shall obtain a business license.

3-2-3 Regulations for Environmental Impact Assessment

Environmental requirement procedures to start a business in Malaysia is shown in Figure 3-19. In case of the businesses that do not require an Environmental Impact Assessment (hereinafter referred to as "EIA"), "non-Prescribed Activities" is carried out only with regard to site suitability evaluation. In case of businesses that require an EIA, all necessary activities can be carried out after obtaining EIA approval.

Businesses requiring an EIA are limited to 19 industries whose activities are prescribed under "the Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987", legislated based on the section 34A of the Act. (Refer to Table 3-10)



(Source：DOE, Environmental Requirements: A Guide For Investors, 2010)

Figure 3-19 Application Procedure for Environmental Requirements in Malaysia

Table 3-10 Prescribed Activities (EIA required industries and the conditions)

No	Industry	Conditions that to be required EIA
1	Agriculture	(a) Land development schemes covering an area of 500 hectares or more to bring forest land into agriculture production. (b) Agriculture programs necessitating the resettlement of 100 families or more. (c) Development of agricultural estates covering an area of 500 hectares or more involving changes in type of agricultural use.
2	Airport	(a) Construction of airports (having an airstrip of 2,500 metres or longer). (b) Airstrip development in state and national parks.
3	Drainage and Irrigation	(a) Construction of dams and man-made lakes and artificial enlargement of lakes with surface areas of 200 hectares or more. (b) Drainage of wetland, wild-life habitat or of virgin forest covering an area of 100 hectares or more. (c) Irrigation schemes covering an area of 5,000 hectares or more.
4	Land Reclamation	Coastal reclamation involving an area of 50 hectares or more.
5	Fisheries	(a) Construction of fishing harbours.

No	Industry	Conditions that to be required EIA
		(b) Harbour expansion involving an increase of 50 per cent or more in fish landing capacity per annum. (c) Land based aquaculture projects accompanied by clearing of mangrove swamp forests covering an area of 50 hectares or more.
6	Forestry	(a) Conversion of hill forest land to other land use covering an area of 50 hectares or more. (b) Logging or conversion of forest land to other land use within the catchments area of reservoirs used for municipal water supply, irrigation or hydropower generation or in areas adjacent to state and national parks and national marine parks. (c) Logging covering an area of 500 hectares or more. (d) Conversion of mangrove swamps for industrial, housing or agricultural use covering an area of 50 hectares or more. (e) Clearing of mangrove swamps in islands adjacent to national marine parks.
7	Housing	Housing development covering an area of 50 hectares or more.
8	Industry	(a) Chemical - Where production capacity of each product or of combined products is greater than 100 tonnes / day. (b) Petrochemicals - All sizes. (c) Non-ferrous - Primary smelting: Aluminium - all sizes Copper - all sizes Others -producing 50 tonnes/day and above of product. (d) Non-Metallic - Cement - for clinker through put of 30 tonnes/hour and above. - Lime - 100 tonnes/day and above burnt lime rotary kiln or 50 tonnes/day and above vertical kiln. (e) Iron and Steel - Require iron ore as raw materials for production greater than 100 tonnes/ day; or Using scrap iron as raw materials for production greater than 200 tonnes/day (f) Shipyards - Dead Weight Tonnage greater than 5000 tonnes. (g) Pulp and Paper Industry - Production capacity greater than 50 tonnes/day.
9	Infrastructure	(a) Construction of hospitals without fall into beachfronts used for recreational purposes. (b) Industrial estate development for medium and heavy industries covering an area of 50 hectares or more. (c) Construction of expressways. (d) Construction of national highways. (e) Construction of new townships.
10	Ports	(a) Construction of ports (b) Port expansion involving an increase of 50 per cent or more in handling capacity per annum.
11	Mining	(a) Mining of minerals in new areas where the mining lease covers a total area in excess of 250 hectares. (b) Ore processing, including concentrating for aluminum, copper, gold or tantalum. (c) Sand dredging involving an area of 50 hectares or more.
12	Petroleum	(a) Oil and gas fields development. (b) Construction of off-shore and on-shore pipelines in excess of 50 kilometres in length. (c) Construction of oil and gas separation, processing, handling, and storage facilities. (d) Construction of oil refineries. (e) Construction of product depots for the storage of petrol, gas or diesel (excluding service stations) which are located within 3 kilometres of any commercial, industrial or residential areas and which have a combined storage capacity of 60,000 barrels or more.
13	Power Generation and Transmission	(a) Construction of steam generated power stations burning fossil fuels and having a capacity of more than 10 megawatts. (b) Dams and hydroelectric power schemes with either or both of the following: (i) dams over 15 metres high and ancillary structures covering a total area in excess of 40 hectares; (ii) reservoirs with a surface area in excess of 400 hectares. (c) Construction of combined cycle power stations. (d) Construction of nuclear-fueled power stations.
14	Quarries	Proposed quarrying of aggregate, limestone, silica quartzite, sandstone, marble and decorative building stone within 3 kilometres of any existing residential, commercial or industrial areas, or any area for which a licence, permit or approval has been granted for residential,

No	Industry	Conditions that to be required EIA
		commercial or industrial development.
15	Railways	(a) Construction of new routes. (b) Construction of branch lines.
16	Transportation	Construction of Mass Rapid Transport projects.
17	Resort and Recreational Development	(a) Construction of coastal resort facilities or hotels with more than 80 rooms. (b) Hill station resort or hotel development covering an area of 50 hectares or more. (c) Development of tourist or recreational facilities in national parks. (d) Development of tourist or recreational facilities or islands in surrounding waters which are gazetted as national marine parks.
18	Waste Treatment and Disposal	(a) Toxic and Hazardous Waste (i) Construction of incineration plant (ii) Construction of recovery plant (off-site) (iii) Construction of wastewater treatment plant (off-site) (iv) Construction of secure landfill facility (v) Construction of storage facility (off-site) (b) Municipal Solid Waste (i) Construction of incineration plant (ii) Construction of composting plant (iii) Construction of recovery/recycling plant (iv) Construction of municipal solid waste landfill facility (c) Municipal Sewage (i) Construction of wastewater treatment plant (ii) Construction of marine out fall.
19	Water Supply	(a) Construction of dams, impounding reservoirs with a surface area of 200 hectares or more. (b) Groundwater development for industrial, agricultural or urban water supply of greater than 4,500 cubic metres per day.

(Source: Environmental Quality (Prescribed Activities)(Environmental Impact Assessment) Order, 1987)

The project was composed of a construction comprising six facilities, 1) Anaerobic and aerobic bioreactors, 2) Energy and water recovery system from waste steam (Heat Exchanger), 3) Final effluent polishing system by Engineered Wetland, 4) Rainwater recovery system, 5) Compost (Fertilizer) production system, and 6) Flatbed carbonization system. Items in each facility that may be relevant to the above table and the self-evaluation results are shown in Table 3-11. Thus, this project was ultimately evaluated as not requiring an EIA.

Table 3-11 Self-Evaluation Result of Necessity of EIA for the pilot plant construction

Facility to be constructed	Items that may be relevant to EIA	Evaluation Result
1） Anaerobic and aerobic bioreactors	18. Waste Treatment and Disposal (c) Municipal Sewage (i) and (iii)	A target of this project is not municipal sewage, so this item does not correspond to EIA requirements
2） Energy and water recovery system from waste steam (Heat Exchanger)	8.Industry (a) Chemical	The capacity of the project is 100 kg/h and smaller than the standard, so this item does not correspond to EIA requirements
3） Final effluent polishing system by engineered Wetland	3. Drainage and Irrigation	The purification method is by artificial wetland and the treatment volume is small, so this item does not correspond to EIA requirements.
4） Rainwater recovery system	3 Drainage and Irrigation	The facility is a rainwater recovery system from the roof, so this item does not correspond to EIA requirements.
5） Compost (Fertilizer) production system	18. Waste treatment and Disposal (b) Municipal Soil Waste (ii)	The target is not municipal solid waste, so this item does not correspond to EIA requirements.
6） Flatbed carbonized system.	18. Waste treatment and Disposal (b) Municipal Soil Waste (i)	The target is not municipal solid waste, so this item does not correspond to EIA requirements.

(Source: JET)

To get this confirmation, C/P had to make an inquiry from the DOE Sabah branch, by submission of AS PAT 1-12 FORM (Preliminary Site Assessment For Development Project).. The relevant documents were therefore submitted at the end of September 2014 and official approval for the construction was obtained in February 2015. However DOE Sabah requested the submission of analytical data of exhaust gases generated from the flatbed carbonized system because it falls into the category of a fuel burning equipment classified under Environmental Quality (Clean Air) Regulations, 1978. Based on the submitted data, the SATREPS team will discuss with DOE Sabah whether any exhaust gas treatment system needs to be installed or not.

3-2-4 Regulations for Facility Construction[1]

The Construction Industry Development Board of Malaysia (hereinafter referred to as "CIDB") established in 1994 under "Construction Industry Development Board Act, 1994 (Act 520) (hereinafter referred to as "CIDB act"). The CIDB act exercises jurisdiction over the development and regulation of construction in Malaysia.

In the CIDB act, the meaning of construction works are defined. These include the construction, extension, installation, repair, maintenance, renewal, removal, renovation, alteration, dismantling, or demolition regarding specified items, and includes any works which form an integral part of, or are preparatory to or temporary for the works described in paragraphs (a) to (e), including site clearance, soil investigation and improvement, earthmoving, excavation, laying of foundation, site restoration and landscaping.

① Building, erection, edifice, structure, wall, fence or chimney, whether constructed wholly or partly above or below ground level;
② Road, harbour works, railway, cableway, canal or aerodrome;
③ Drainage, irrigation or river control works;
④ Electrical, mechanical, water, gas, petrochemical or telecommunication works; or
⑤ Bridge, viaduct, dam, reservoir, earthworks, pipeline, sewer, aqueduct, culvert, drive, shaft, tunnel or reclamation works,

Every enterprise, local or international, must be registered to the CIDB before starting construction work in Malaysia. There are two types of CIDB registration as shown in Table 3-12.

Table 3-12 Type of CIDB Registration

Registration Type	Capital Structure
Registration as Local Contractor	・Local firms where more than 70 % of the capital is of Malaysian origin ・Local firms where more than 49 % of the capital is Malaysian and if capital is of ASEAN origin is lower than 51%
Registration as Foreign Contractor	・Local firm that have more than 30 % of the capital from foreign countries ・Branch of an international firm

(Source: Japan External Trade Organization, "International System Survey Report 2013 - System of Construction in Malaysia-")

One of the major differences between local and foreign contractors is the term of validity. Local

[1] Japan External Trade Organization, "International System Survey Report 2013 -System of Construction in Malaysia-"

contractors are able to have one to three years of registration validity but foreign contractors must register on a per project basis. The other is that local contractors have limitations imposed by the grade of registration based on its particular field of expertise but foreign contractors have no such limitations.

However, any foreign contractor who is willing to participate in a tender must register with CIDB (as a provisional registration) but setting up of an establishment in Malaysia is not required at this time for this activity.

After a foreign contractor makes a successful tender and contract, the contractor must register with the CIDB as a foreign contractor. The foreign contractor must establish a branch office or a local company registered with the Companies Commission of Malaysia (hereinafter referred to as "CCM"). That is, any foreign contractor is not permitted to carry out any construction work with setting up only a project office or a site office in Malaysia.

The CIDB registration is necessary for the contractor selection for this project.

Furthermore, based on Registration of Engineers Act, 1967 (Revised 2002), a person who submits any drawings or technical documents to the related organization is limited to an engineer who is registered to the Board of Engineers (hereinafter referred to as "BEM"). It is necessary that the selected contractor employ a registered engineer or have a contract with a registered engineer, then all drawings and technical documents can be approved through the registered engineer.

3-2-5 Regulations for Equipment Installation

The Department of Occupational Safety and Health (hereinafter referred to as "DOSH") is responsible for ensuring the safety, health and welfare of the work force as well as protecting other people from safety and health hazards. The Occupational Safety and Health Act (Act 514) (hereinafter referred to as "OSHA") was therefore established in 1994 and the Factory and Machinery Act1967 (Act 139) (hereinafter referred to as "Act 139") was also established in 1967 with relevant regulations and orders.

Act 139 requires that design of equipment specified and defined by the law must be approved prior to installation. This equipment includes steam boilers, non-heated pressure vessels, whist devices, and gas holders. Energy and water recovery systems from waste steam (Heat Exchanger) procured by Kyutech recovers clear treated water by evaporation and concentration from wastewater, connecting with the existing steam pipeline. The superheated steam generating device supplied by SATREPS also needs to connect with the steam pipeline. These items of equipment using steam correspond to the non-heated pressure vessel; they need to be approved based on Act 139. The inspection of system of Energy and water recovery system from waste steam (Heat Exchanger) were carried out by DOSH on 22nd October 2015.

In addition an elevating device installing with flatbed carbonization systems corresponds to whist device.

On the other hand, a gas holder was installed as a part of the anaerobic and aerobic bioreactors but the structure is different from the type of bell-shaped structures floating in a tank of water defined in Act 139, consequently the gas holder does not need to be used.

Prior to the start of operation of the pilot plant, the whole facility needed to have DOSH approval, the application was submitted by SATREPS team through the Contractor, then the final inspection by DOSH was carried out on 23rd November 2015, resulting in the application being officially approved.

Chapter 4 Environmental and Social Considerations

Based on JICA Guidelines for Environmental and Social Considerations (April 2010), environmental and social considerations regarding the construction work were confirmed as follows.

4-1 Permits and Explanations

Checked items and results of evaluation related to "permits and explanations" are shown in Table 4-1.

Table 4-1 Checked Items and Results of Evaluation Related to "Permits and Explanations"

Category	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a)Y (b)－ (c)－ (d)－	(a) EIA is not required AS PAT 1-12 FORM (Preliminary Site Assessment For Development Project) was submitted and approved (b) Not applicable (c) Not applicable (d) Not applicable (e) Not applicable
(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a)Y (b)-	(a) Explanation of the Project was made to the stakeholders for their comprehension (b) There are no residents around the project site
(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a)－	(a) Not applicable

(Source: Main check items are based on JICA guidelines for environmental and social considerations, "Environmental checklist for other infrastructures")

4-2 Pollution Control

The items identified and results of their evaluation relating to "pollution control" are shown in Table 4-2. Exhaust gas quality shall comply with Standard C classified under the National Environmental Quality (Clean Air) Regulations, 1978. Table 4-3 shows the effluent standards. Other than these effluent standards, in order to reduce emission of air pollutants, the regulation requires that the best practice means (BPM) for process, operation, material selection, of treatment facility be followed. Specific numerical standards have not been set under the regulations but the owner of the facility is required to introduce an appropriate way for pollutant reduction, should the Director-General of DOE consider that the discharge of air pollutants would affect public health.

The flatbed carbonization system is a fuel burning item of equipment operated under low oxygen concentrations. Thus, other than the standards described in the table below, carbon monoxide (CO), methane (CH_4) and hydrogen (H_2) will also be discharged. These parameters shall also be measured for subsequent discussion with DOE Sabah.

Table 4-2 Checked Items and Results of Evaluation related to "Pollution Control"

Category	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
(1) Air Quality	(a) Do air pollutants, (such as sulphur oxides (SOx), nitrogen oxides (NOx), and soot and dust) emitted from the proposed infrastructure facilities and ancillary facilities comply with the country's emission standards and ambient air quality standards? Are any mitigating measures taken? (b) Are electric and heat sources at accommodation used fuel which emission factor is low?	(a) Unknown (b)-	(a) Carbonization system may apply. The SATREPS team will investigate the exhaust gases, and have discussions with DOE Sabah relating to the results obtained. (b) Not applicable
(2) Water Quality	(a) Do effluents or leachates from various facilities, such as infrastructure facilities and the ancillary facilities comply with the country's effluent standards and ambient water quality standards?	(a)-	(a) Not applicable because of zero-discharge
(3) Wastes	(a) Are wastes from the infrastructure facilities and ancillary facilities properly treated and disposed of in accordance with the country's regulations?	(a)-	(a) No waste is generated. Delivery sites for products of compost and carbonization shall be considered.
(4) Soil Contamination	(a) Are adequate measures taken to prevent contamination of soil and groundwater by the effluents or leachates from the infrastructure facilities and the ancillary facilities?	(a)Y	(a) Water proof sheets will be installed on the green land surfaces where final effluent will be discharged
(5) Noise and Vibration	(a) Do noise and vibrations comply with the country's standards?	(a)Y	(a) No facility in the project generates any large noise or cause vibrations
(6) Subsidence	(a) In the case of extraction of a large volume of groundwater, is there a possibility that the extraction of groundwater will cause subsidence?	(a)-	(a) Not applicable
(7) Odour	(a) Are there any odour sources? Are adequate odour control measures taken?	(a)	(a) Odours will be emitted in the Anaerobic tank but it will not escape because the tank will have sealing structures installed

(Source: Main check items are based on JICA guidelines for environmental and social considerations, "Environmental checklist for other infrastructures")

Table 4-3 Applied Exhaust Gas Standards for the Flatbed Carbonization System

Parameter	Limit（Standard C）
Dark Smoke	To be shade Ringelmann Chart No.2
Solid Particles	Not exceed 0.4 g/m^3_N
Sulphuric Acid mist or Sulphur Trioxide or both	Not exceed 0.2 $g\text{-}SO_3/m^3_N$
Chlorine Gas	Not exceed 0.2 $g\text{-}HCl/m^3_N$
Fluorine, Hydrofluoric Acid, or In-organic Fluorine Compounds	Not exceed 0.02 $g\text{-}HF/m^3_N$
Hydrogen Sulphide	Not exceed 5.00 ppm
Oxides of Nitrogen	Not exceed 2.0 $g\text{-}NOx/m^3_N$

(Source: Environmental Quality (Clean Air) Regulations, 1978)

4-3 Natural Environment

Checked items and results of evaluation related to the "Natural Environment" are shown in Table 4-4.

Table 4-4 Checked Items and Results of Evaluation Related to "Natural Environment"

Category	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
(1) Protected Areas	(a) Is the project site or discharge area located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a)-	(a) The project site is an existing palm oil mill.
(2) Ecosystems	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) Is there a possibility that changes in localized micro-meteorological conditions, such as solar radiation, temperature, and humidity due to a large-scale timber harvesting will affect the surrounding vegetation? (d) Is there a possibility that the amount of water (e.g., surface water, groundwater) used by the project will adversely affect aquatic environments, such as rivers? Are adequate measures being taken to reduce the impacts on aquatic environments, and aquatic organisms?	(a) N (b) N (c) N (d) N	(a) – (c) The project site is an existing palm oil mill. (d) The main water source of this project is rain water and the quantity is minimal. Final effluent discharge is made to the existing treatment facility so an impact to aquatic organisms need not be considered.
(3) Hydrology	(a) Is there a possibility that hydrologic changes due to the project will adversely affect surface water and groundwater flows?	(a) N	(a) Not applicable
(4) Topography and Geology	(a) Is there a possibility that the project will cause large-scale alteration of the topographic features and geologic structures in the project site and surrounding areas?	(a) N	(a) No change to topography or geology is envisaged

(Source: Main check items are based on JICA guidelines for environmental and social considerations, "Environmental checklist for other infrastructures")

4-4 Social Environment

Checked items and results of evaluation related to "Social Environment" are shown in Table 4-5.

Table 4-5 Checked Items and Results of Evaluation Related to "Social Environment"

Category	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement?	(a)-	(a) This project site is an existing palm oil mill so this project will not cause or require any resettlement. Thus items (b) to (j) are not applicable

Category	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(d) Are compensations going to be paid prior to the resettlement? (e) Is the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, and people below the poverty line, and does it also include ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Has a grievance redress mechanism been established?		
(2) Living and Livelihood	(a) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary?	(a) N	(a) The Project site is in an existing palm oil mill. Therefore, there will be no significant changes to the living conditions of any inhabitants.
(3) Heritage	(a) Is there a possibility that the project will damage the local archaeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a) N	(a) No cultural heritage sites were identified in the project site.
(1) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken? (b) Is there a possibility that landscape is spoiled by construction of high-rise buildings such as huge hotels?	(a) N (b) N	(a)& (b) The Project site is in an existing palm oil mill. Therefore, there will be no significant impact on the existing landscape.
(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources respected?	(a) N (b) N	(a) & (b) The project site is an existing palm oil mill. Therefore, these items are not applicable to this Project.
(6) Working Conditions	(a) Is the project proponent violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and safe management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health programme, and adequate safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures being taken to ensure that security guards involved in the project do not	(a) Y (b) Y (c) Y (d) Y	(a) – (d) The contractor shall comply with relevant regulations especially those in OSHA.

Category	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	violate safety of other individuals involved, or any local residents?		

(Source: Main check items are based on JICA guidelines for environmental and social considerations, "Environmental checklist for other infrastructures")

4-5 Others

Checked items and results of the evaluation related to "Others" are shown in Table 4-6. The details of the method of monitoring will be finally decided upon by the SATREPS team, but features of the proposed monitoring plan are shown in Table 4-7**,** Table 4-8**,** Table 4-9**,** Table 4-10**,** Table 4-11**,** and Table 4-12**.**

The result of exhaust gas quality discharged from the flatbed carbonization system needs to be submitted to DOE Sabah in order to obtain directions regarding the possible necessity of additional exhaust gas treatment systems, thus, the SATREPS team is required to measure the exhaust gas quality without delay. The proposed organizational structure for monitoring is shown in Figure 4-1**.**

Operations shall be carried out by a number of operators with a point of view towards increased safety.

Table 4-6 Checked Items and Results of Evaluation Related to "Others"

Category	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
(1) Impact during Constriction	(a) Are adequate measures being considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures being considered to reduce impacts? (c) If construction activities adversely affect the social environment, are adequate measures being considered to reduce impacts?	(a) Y (b) N (c) N	(a) The main items of equipment were fabricated in factories to reduce site work volume. Antipollution measures were required in the tender documents and detailed methods were described in the construction work plan. (b) ,(c) The Project site is in an existing palm oil mill. Consequently, there will be no significant negative impact to the natural and social environments.
(2) Monitoring	(a) Does the proponent develop and implement a monitoring programme for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring programme? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget) to sustain the monitoring framework? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a) Y (b) - (c) - (d) N	(a) – (c) Final methodology will be decided during the project duration by SATREPS. (d) The object of the facility is to conduct research so this project is not required to submit any reports.

(Source: Main check items are based on JICA guidelines for environmental and social considerations, "Environmental checklist for other infrastructures")

Table 4-7 Proposed Monitoring Plan (Anaerobic and Aerobic Bioreactor)

Monitoring Parameter	Monitoring Method	Organization and Budget
Oil Concentration, Amount of Recovered Oil	Analyzed oil concentration at POME Pit (1) and Effluent of Oil Separator once a week. Amount of recovered oil was measured every day.	Implemented by SATREPS Study Team with budget borne by C/P
Flow Rate, pH, BOD, COD, TSS, T-N, T-P	Analyzed pH, BOD, COD, TSS, T-N and T-P at Influent (POME),also Effluent from Anaerobic Reactor and Aerobic Reactor analysed once a week Each flow rate was measured every other day.	Implemented by SATREPS Study Team with budget borne by C/P
Biogas Production, Methane Concentration	Biogas flow rate was measured continuously by Equipped flow meter. Methane concentration was measured by gas detector tube.	Implemented by SATREPS Study Team with budget borne by C/P

(Source: JET)

Table 4-8 Proposed Monitoring Plan: Energy and Water Recovery System from Waste Steam (Heat Exchanger)

Monitoring Parameter	Monitoring Method	Organization and Budget
pH, BOD, COD, TSS, T-N, T-P	pH, BOD, COD, TSS, T-N, T-Pat Raw Water and Condensate was analysed once a week.	Implemented by SATREPS Study Team with budget borne by C/P

(Source: JET)

Table 4-9 Proposed Monitoring Plan: Final Effluent Polishing System by Engineered Wetland

Monitoring Parameter	Monitoring Method	Organization and Budget
Flow Rate, pH, BOD, COD, TSS, T-N, T-P	pH, BOD, COD, TSS, T-N, T-Pat final discharge was analysed once a week. flow rate was measured every other day.	Implemented by SATREPS Study Team with budget borne by C/P
Yield of Napier Grass	This was measured at the time of harvest	Implemented by SATREPS Study Team

(Source: JET)

Table 4-10 Proposed Monitoring Plan: Rainwater Recovery System

Monitoring Parameter	Monitoring Method	Organization and Budget
Rainfall	Rainfall was measured by a simple ombrometer	Implemented by SATREPS Study Team with budget borne by C/P

(Source: JET)

Table 4-11 Proposed Monitoring Plan: Composting (Fertilizer) System

Monitoring Parameter	Monitoring Method	Organization and Budget
Amounts of Raw material and Product	Measured at the time of startup and completion	Implemented by SATREPS Study Team

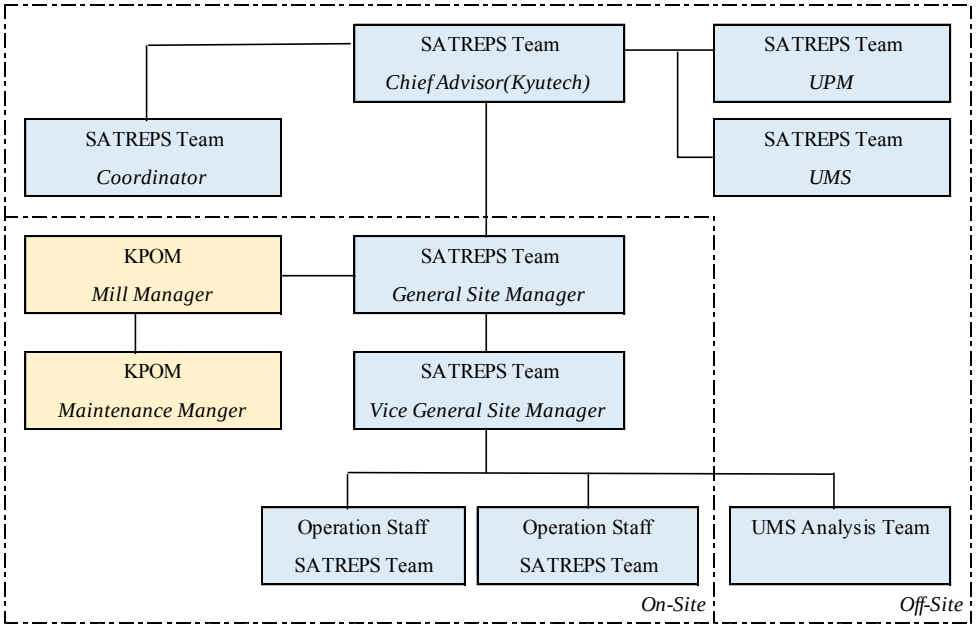
VS, MC, Ash in Raw material and Product, N, P, K in Product	Analysis of raw material and product	Implemented by SATREPS Study Team with budget borne by C/P

(Source: JET)

Table 4-12 Proposed Monitoring Plan: Carbonization System

Monitoring Parameter	Monitoring Method	Organization and Budget
Exhaust Gas (O_2, CO, CO_2, CH_4, H_2 and parameters described in Table 4-3)	Measured during operation	Implemented by SATREPS Team with budget borne by C/P
Amount of Raw Material and Product	Measured at the time of startup and completion	Implemented by SATREPS Study Team
VS, MC, Ash in Raw material and Product	Analysis of raw material and product	Implemented by SATREPS Study Team with budget borne by C/P

(Source: JET)



(Source: JET)

Figure 4-1 Proposed Organization Structure for Monitoring

4-6 Note

Checked items and results of evaluation related to "Note" are shown in Table 4-13.

Table 4-13 Checked Items and Results of Evaluation Related to "Note"

Category	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Roads, Railways and Bridges checklist should also be checked (e.g., projects including access roads to the infrastructure facilities). (b) For projects, such as installation of telecommunication cables, power line towers, and submarine cables, where necessary, pertinent items described in the Power Transmission and Distribution Lines checklists should also be checked.	(a) - (b) -	(a) Not applicable (b) Not applicable
Note on Using Environmental Checklist	(a) If necessary, the impacts to transboundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a) -	(a) Not applicable

(Source: Main check items are based on JICA guidelines for environmental and social considerations, "Environmental checklist for other infrastructures")

Chapter 5 Facility Design

5-1 Anaerobic and Aerobic Bioreactors

5-1-1 Configuration Process

The targeted wastewater in both anaerobic and aerobic bioreactors is mainly discharged from six (6) points and collected in three existing POME pits. The characteristics of each type of wastewater, which are shown in Table 5-1, are totally different from one another.

Table 5-1 Qualitative Characteristics and Collection Point of Wastewater Discharged from each Process in KPOM

No	Current Collection	Origin	Process generated	Characteristics	Rate
1	POME Pit (1)	Sterilizer	Sterilization Station	- High Temperature (more than 90℃) - High Concentration - Contaminated much oil but not emulsified	26%
2	POME Pit (2) via open gutter	Vibration Screen	Clarification Station	- High Temperature (around 90℃) - Low TSS contaminated - Not much oil contaminated	7.4%
3	POME Pit (2) via open gutter	Desander	Clarification Station	- Normal Temperature (around 30℃) - Low TSS contaminated - Not much oil contaminated	7.9%
4	POME Pit (2)	Sludge Decanter	Clarification Station	- High Temperature (around 90℃) - Moderate Concentration - Contaminated oil (emulsified)	32.0%
5	POME Pit (2) via open gutter	Centrifuge	Clarification Station	- High Temperature (around 90℃) - Moderate Concentration - Contaminated oil (emulsified)	15.0%
6	POME Pit (3) through open gutter	Hydro Cyclone	Kernel Recovery Station	- Normal Temperature (around 30℃) - Low TSS contaminated - Not much oil Contaminated	11.7%
Total					100.0%

(Source : JET)

Wastewater collected at POME pit (1) generated from the sterilization system contains highly concentrated oil. Four types of wastewater discharged from the clarification process are collected at POME pit (2). Wastewater discharged from Centrifuge and Sludge Decanter contains emulsified oil of intermediate concentration. On the other hand, the TSS and oil concentrations of wastewater generated from Screen and Desander are low. Wastewater discharged from the hydro cyclone in the kernel recovery process is collected at POME pit (3) and its TSS & oil concentrations are also low.

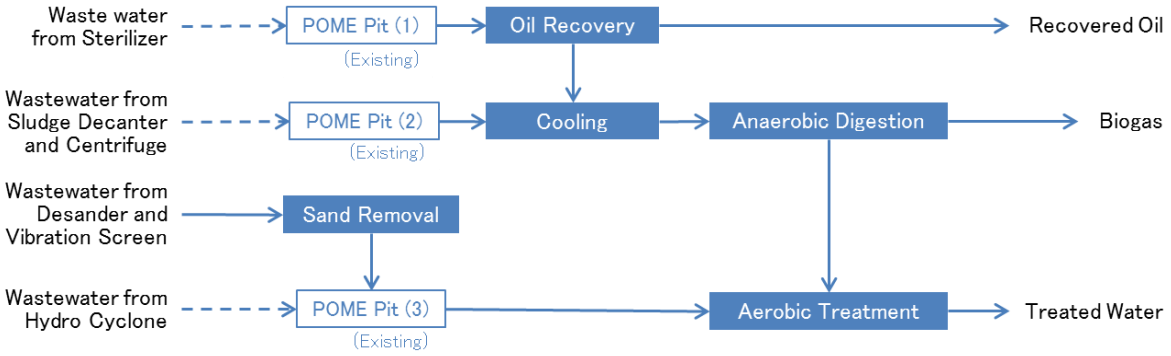
Wastewater collection system was studied as basic process design based on the differences of wastewater characteristics. In the four collected wastewaters discharged to POME pit (2), characteristics of wastewater discharged from screen and desander are similar to the wastewater from the hydro cyclone in the kernel recovery system. From low concentrated wastewater, even if it is treated by anaerobic digestion process, much biogas generation cannot be expected. From the aspect of downsizing of the system, it is efficient to transfer wastewater to aerobic treatment directly without anaerobic treatment. Thus, the

wastewater collection point of screen and desander was changed to POME pit (3) from POME pit (2). A new fine sand remover was planned to be added in front of POME pit (3) because fine sand removes contaminates in wastewater from the screen and desander.

Wastewater from POME pit (1) contains high concentration of oil but is not emulsified. In case this wastewater is fed directly into the anaerobic reactor, oil floats up and scum forms on the top of the reactor, and this may have a deleterious influence on the process. On the other hand, it is to be expected that CPO production in the palm oil mill improves by separating contaminated oil from the wastewater stream. Thus, wastewater coming through POME pit (1) was planned to be treated anaerobically after oil recovery.

When the collection pit for wastewater generated from screen and desander was changed to POME pit (3), only wastewater generated from the centrifuge and sludge decanter collected at POME pit (2). These wastewaters are contaminated with a small amount of oil but is emulsified. It is difficult to remove this emulsified oil without utilizing chemicals which emulsion break the emulsion. It is however possible to remove the emulsified oil by anaerobic digestion because as the contaminated oil is emulsified it does not float to the top of the reactor.

High temperature is seen in wastewaters transferred from POME Pit (1) and POME pit (2), so that this wastewater cannot be directly fed into the anaerobic digester. Therefore, the temperature of the wastewater needs to be reduced by heat exchange until it reaches a suitable temperature for anaerobic treatment. Treated liquor by anaerobic digestion is mixed with the wastewater transferred from POME pit (3) and then treated by aerobic process. The process is shown in Figure 5-1.



(Source: JET)

Figure 5-1 Schematic Configuration Process of Anaerobic and Aerobic Bioreactors

5-1-2 Oil Recovery from Wastewater generated from Sterilization Process

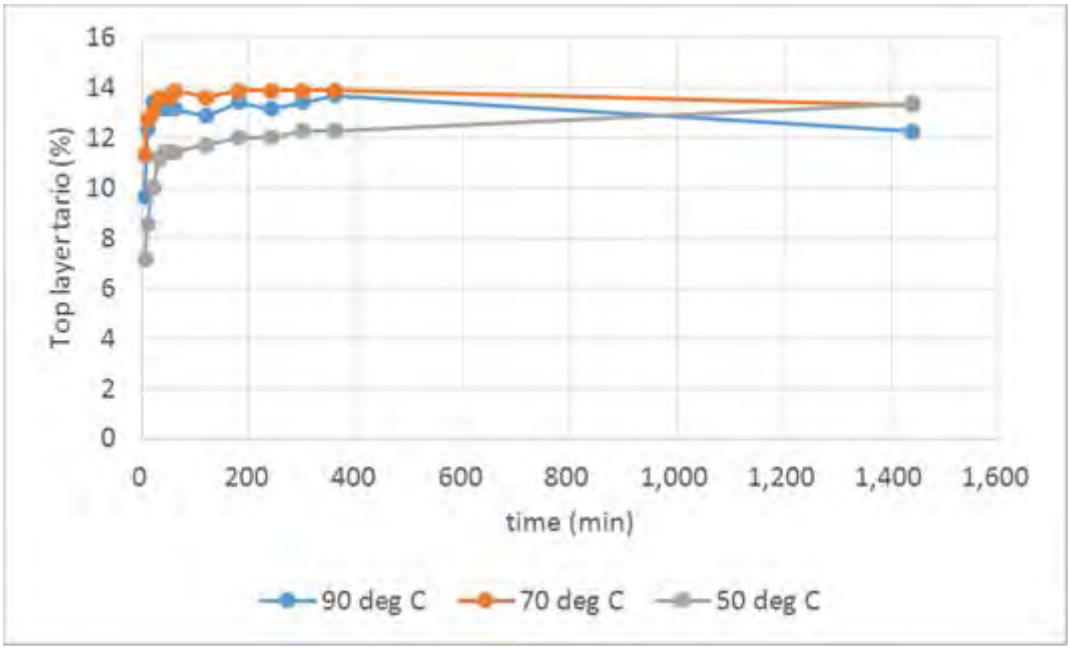
For the oil recovery system for wastewater collected at POME pit (1), ordinary pressure floatation, dissolved air floatation and centrifugal separation methods were all studied. Initially, oil separation by ordinary pressure floatation, which is the simplest system with cheapest construction and operational costs, was considered.

Three samples were taken from POME pit (1) in KPOM, and the operation temperature was kept at 50 degrees Celsius, 70 degrees Celsius and 90 degrees Celsius respectively, and SVI was measured. The test

was conducted by the SATREPS study team.

The result of the test as shown in Figure 5-2, apparent differences between samples maintained at more than 70 degrees Celsius and at 50 degrees Celsius with regard to the separation boundary. It was easy to separate the sample when temperature setting was more than 70 degrees Celsius.

A long retention time is not required for formation of a separation boundary, reaching equilibrium conditions within one hour. Thus, the practicality of oil recovery by ordinary pressure floatation was confirmed.



(Reference: SATREPS Team)

Figure 5-2 Oil Recovery Test Result for Wastewater Generated from Sterilization Process by Ordinary Pressure Floatation

5-1-3 Anaerobic treatment method

In many cases Palm Oil Mill Effluent (POME) treatment systems are open lagoon systems. Most of the POME treatment systems use anaerobic digestion at anaerobic ponds after cooling down the effluent at a cooling pond. Generated biogas through the anaerobic process is discharged into the air, but recently in some instances it can be seen where covered anaerobic ponds (by HDPE sheets) are used in order to collect the biogas produced for power generation. These systems are able to be constructed at low cost, but required extensive land area due to the long retention times required for treatment, and also it is observed that the final wastewater discharge quality is insufficient. The water depth of an aerobic pond in general is about 5 metres and is has a large water surface area, and is shallow when compared to other systems. Therefore maintaining anaerobic condition is hard because much air dissolves into the pond from the water surface. Also since the pond contents are essentially not mixing, efficient treatment cannot be expected.

On the other hand, there are some examples in which utilize tanks instead of anaerobic ponds but most of them are open top tanks. Air dissolution from the water surface of the tank is seen to be much the same

as in anaerobic ponds but treatment efficiency is better than the anaerobic pond because the water depth is generally deeper than in the pond. The system with a covering for biogas collection is consequently being considered as well.

For this project, conventional anaerobic digestion by closed tank type was adopted. In addition, dual tanks system with a settler for controlling sludge concentration was utilized. This method is widely being utilized for sewage treatment.

For operating temperatures in anaerobic treatments, there are two temperature ranges. One is mesophilic where the operating temperature is around 38 degrees Celsius, and the other is thermophilic which operates at around 55 degrees Celsius. In thermophilic digestion, organic removal rate is higher and amount of biogas generation is a little bit higher than in mesophilic digestion, but careful operation management is required due to increases in ammonium concentration.

Aerobic treatment is applied after anaerobic treatment in this facility. Aerobic treatment cannot be performed under the range of thermophilic digestion. In case of adoption for of thermophilic digestion, installing of a cooling facility after anaerobic treatment is required. Therefore, mesophilic, where operation is easy and the system component is simple, was adopted in this project.

Anaerobic treatment methods such as UASB (Upflow Anaerobic Sludge Blanket) is also popular in the other fields of industrial wastewater treatment. This method can be operated under high loading rate, and downsizing of the facility is possible. However, this method is not suitable for POME treatment because of the limitation of solid concentration in the wastewater.

5-1-4 Aerobic treatment method

Activated Sludge (AS) method, Oxidation Ditch (OD) method and Sequential Batch Reactor (SBR) method were also considered as aerobic treatments in this project. Since this facility is small Sequential Batch Reactor method is the simplest and most suitable. However, considering the goal in realization of a commercial based capacity, the activated sludge method which is utilized in such instances in general was applied. This system mainly consists of an air blower, aeration tank which is aerated by the air blower, clarifier which is for sedimentation of the activated sludge and return pump which is for returning the settled sludge.

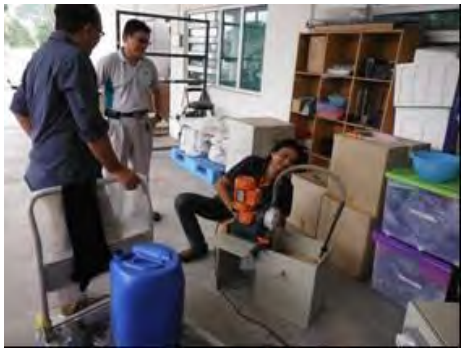
Returned sludge is utilized for biogas scrubbing by counter flow methods. Returned sludge after scrubbing, and anaerobic sludge are treated by contact oxidation at a biomass filter set up prior to the aeration tank. This biomass filter was planned so as to utilize shredded oil palm leaves.

5-1-5 Pump type

The planned capacity of the facility 1t/day(＝1m^3/day) makes it difficult to adopt ordinal pumps utilized in commercial based wastewater treatment facility such as centrifugal pump due to small scale of the facility. This is pilot plant facility which requires a stable flow rate, therefore diaphragm or plunger type pumps may be possible to be adopted. However, clogging problems at the pump was a concern, due to the wastewater containing residual matter. Wastewater was sampled from an operating palm oil mill (FELDA Serting Hiller mill) and pumping tests were carried out using 2 types of diaphragm pumps provided by two

pump manufacturers. The results of two pumps were satisfactory, confirmed that no clogging was taking place and stable flow rates could be maintained.

At the same time a study was done by surveying the amount of residual matter in wastewater, no particular problem caused by residual matter contamination of the wastewater was found.



Pumping test(1)

Pumping test(2)

5-1-6 Design Calculation

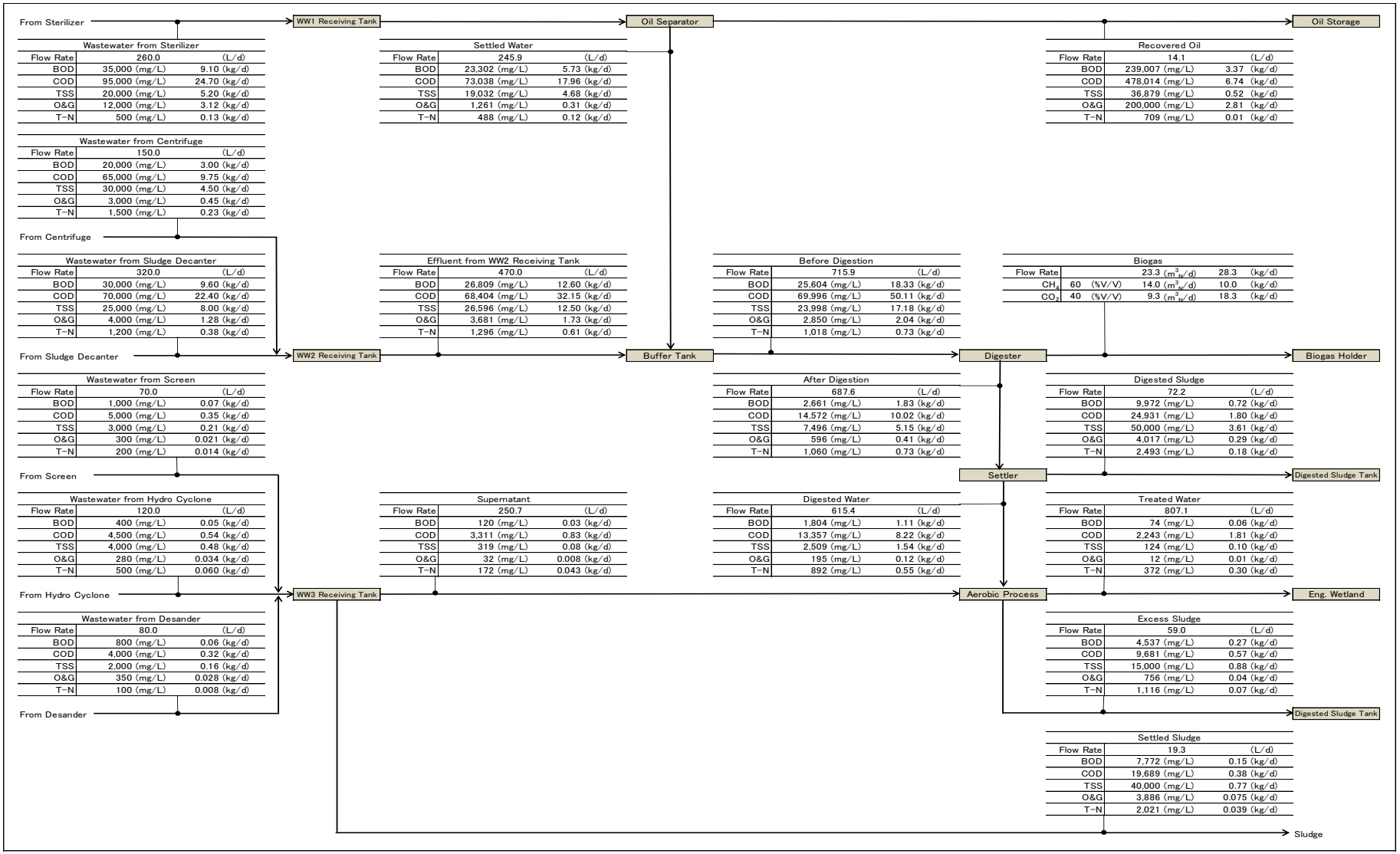
In conducting the capacity calculation for this system, prerequisite wastewater quality analysis data was not obtained. Each wastewater quality was set based on the current knowledge. The material balance was made as shown in Figure 5-3.

The major design criteria of each facility as adopted is shown in Table 5-2.

Table 5-2 Major design criteria for Anaerobic and Aerobic Bioreactor

Process	Major Design Criteria	Adopted Figure
Oil Recovery	Retention Time	8hours
	Temperature in the tank	90°C
Anaerobic Digestion	Feeding Temperature	38°C
	Retention time of Digester	10days
	COD Loading rate of Digester	6kg-COD/m^3/day
	Retention time of Settler	10days
	Surface loading rate of Settler	1m^3/m^2/day
	COD removal rate	80%
	CH_4 conversion rate	0.34m^3_N-CH_4/kg-COD removed
Aerobic Treatment	BOD Loading rate of Aeration Tank	0.14kg-BOD/kg-MLSS/day
	MLSS in Aeration Tank	6,000mg/L
	Retention time of Clarifier	9hours
	Surface Loading rate of Clarifier	5 m^3/m^2/day

(Source: JET)



(Source : JET)

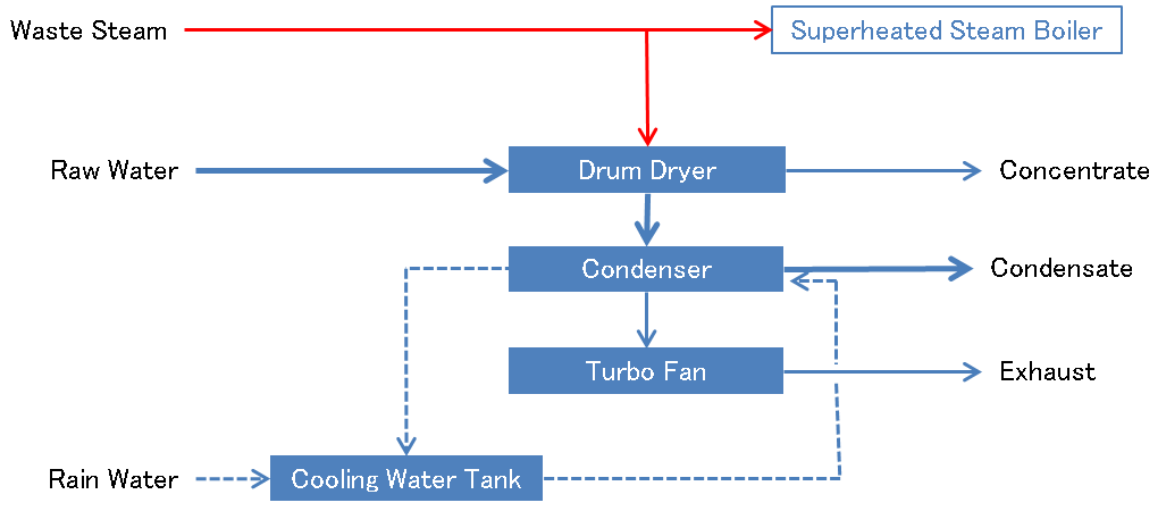
Figure 5-3 Material Balance of Aerobic and Anaerobic Bioreactor

5-2 Energy and Water Recovery System from Waste Steam (Heat Exchanger)

5-2-1 System Summary

In KPOM, 19t/h of high pressure steam is generated and the resulting low pressure steam after power generation is utilized in the sterilization process and other facilities. On the other hand, 8.7t/h of generated steam, which equals 46% of the total generated steam, is discharged into the air. Steam consumption at the sterilization process fluctuates between 0 and 18t/h due to operational conditions of the process, and the amount of waste steam corresponds to fluctuations in the range of 0.2 to 18.2t/h. This system is installed to show the effective utilization for a new biomass industry by the efficient use of waste steam after power generation in the palm oil mill.

A drum dryer in this system is the major equipment which recycles process water from treated water discharged from Anaerobic and Aerobic Bioreactors, utilizing waste steam. The SATREPS team has also planned to install a superheated steam boiler as a biomass refinery system for the purpose of production of biomass composite plastics (this was not included in this construction work). These two systems are ways of efficient utilization of waste steam. Figure 5-4 shows system component.



(Source: JET)

Figure 5-4 Energy and Water Recovery System from Waste Steam

Waste steam is supplied to the drum dryer and to the superheated steam generation system. The drum dryer is the system which supplies steam into a rotated drum, then raw water is fed onto surface of the heated drum in order to effect concentration. Generated vapour is vacuumed by a turbo fan, and then condensed at a condenser. Collected rainwater by a rainwater collecting system is utilized for cooling at the condenser. On the other hand, the concentrate is discharged to outside environment.

The raw water for the system is composed of treated water from Anaerobic and Aerobic Bioreactors. Alternatively, the system was planned to further treat both the treated water from the Final Effluent Polishing System (Engineered Wetland) and effluent from the existing open lagoon system.

The system was initially planned to utilize an evaporation method. The method using the drum dryer was also accepted by the technical evaluation made by Kyutech when the tender was implemented. Subsequent to the tendering result, the drum dryer was finally adopted.

5-2-2 System Design

The system (Drum Dryer) was procured by Kyutech. Table 5-3 shows adopted raw water quality.

Table 5-3 Characteristics of Raw Water

Parameter	Adopted Figure
Temperature	25-30°C
pH	7.0 – 7.5
Biological Oxygen Demand (BOD)	70 – 200 mg/L
Chemical Oxygen Demand (COD)	1,000 – 3,000 mg/L
Total Suspended Solids (TSS)	120 – 500 mg/L
Total Dissolved Solids (TDS)	1,000 – 7,000 mg/L
Total Nitrogen (T-N)	150 - 400 mg/L
Ammonia Nitrogen (NH_4+-N)	30 - 100mg/L
Oil and Grease (O&G)	Not Detected

(Source: Specification prepared by Kyutech)

Table 5-4 shows the necessary steam and cooling water conditions for the operation. Table 5-5 shows the major design criteria and specifications of the equipment.

Table 5-4 Necessary Steam and Cooling Water Condition

Type of Utility	Parameter	Adopted Figure
Steam	Pressure	0.2-0.3MPa(abs.)
	Temperature	133-143°C
Cooling Water	Temperature	29-32°C

(Source: Specification prepared by Kyutech)

Table 5-5 Major Design Criteria and Specifications

Parameter	Adopted Figure
Equipment Capacity	Not less than 3kg/h
Concentration Rate	Not less than 10 times
Continuous Operation	Not less than 5 hours
Heat Transfer Area of Drum Dryer	0.62m^2
Heat Transfer Area of Condenser	3 m^2

(Source: Specification prepared by the manufacturer)

5-3 Final Effluent Polishing System by Engineered Wetland

5-3-1 Summary of Engineered Wetland

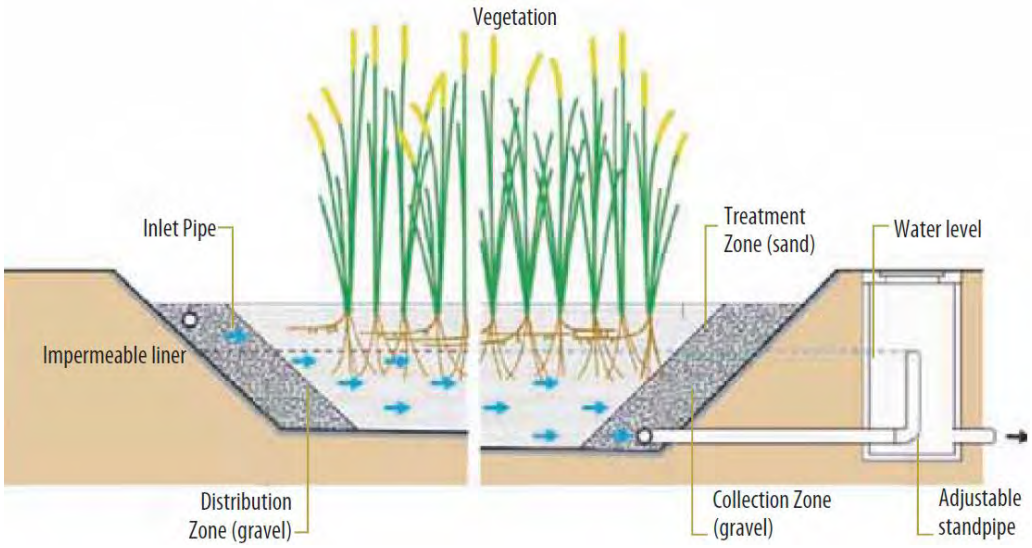
This system is generally called a 'Constructed Wetland' or 'Engineered Wetland' and industrially duplicates the fundamentals of wetland. This treatment technology is that wastewater feeds into planted land which has an impermeable liner sheet as an underlay. Hereafter, this technology will be referred to as

an Engineered Wetland.

In this facility, the final discharge from both Anaerobic and Aerobic Bioreactor is used as raw water. The land was planned shielded by a HDPE sheet and having some planted Napier Grass. The grass is regularly harvested and utilized for composting material. In the process of plant growth, the value of produced compost increases, because the amount of nitrogen in the produced compost increases due to the growing grass absorbing nitrogen from the air.

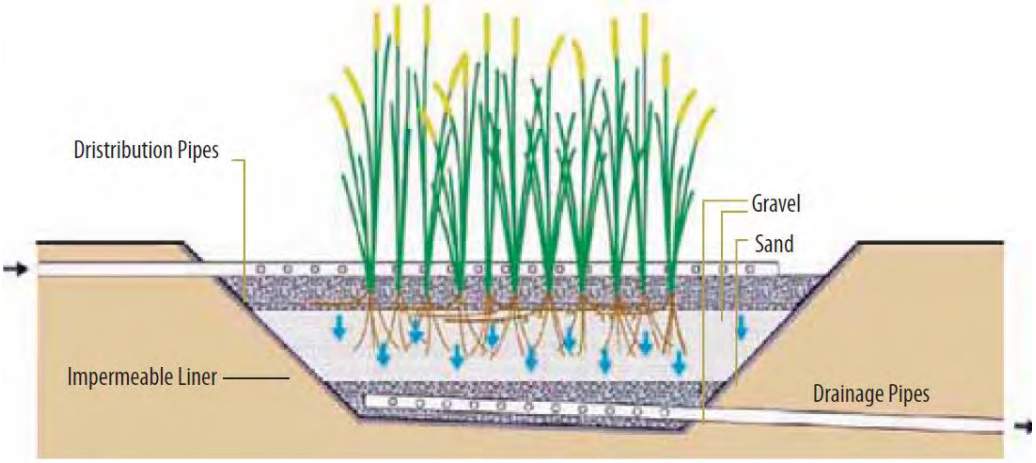
Design for the Engineered Wetland is described in detail in the publication "Constructed Wetlands Manual", put out by UH-HABITAT and issued in 2008. According to this manual, industrialized wetlands are categorized by 2 types, namely, horizontal flow type (HF type) and vertical flow type (VF type). The HF type treatment method shown in Figure 5-5 is that raw water flows into the edge of the wetland, and secondarily, this water spreads horizontally into water shielding areas and then, the water is discharged from the opposite side of the inflow edge. BOD, COD and TSS are removed effectively. However, it needs to be noted that the nutrient removal effect is not as high in comparison to the VF type mentioned subsequently due to limitations in amounts of oxygen transportation within the water shield area.

On the other hand, the VF type treatment method as shown in Figure 5-6 involves a process where the raw water is distributed onto the surface of whole water shield area and the settled water is collected through an effluent pipe laid on the bottom of the wetland. Not only do high rates of removal of BOD and COD take place but also the nutrient removal effect is high because of oxygen supply takes place from the whole surface area. This method utilizes the whole water shield area effectively. Therefore, the surface area needed for the VF type treatment method can be made smaller than for the HF type. In recent times practical examples where VF type treatment methods are being increasingly used stem from these advantages.



(Source: UN-HABITAT, "Constructed Wetlands Manual(2008)")

Figure 5-5 Schematic Diagram of Horizontal Flow (HF) typed wetland



(Source: UN-HABITAT, "Constructed Wetlands Manual(2008)")

Figure 5-6 Schematic Diagram of Vertical Flow (VF) typed wetland

The VF type treatment method has a disadvantage in case raw water containing high TSS concentration is used, due to possibility of clogging in the area. To deal with this issue, Hybrid type engineered wet lands, which are a combination of both the HF type and the VF type, are being developed.

5-3-2 Adopted technology

The targeted water, which is essentially treated raw water in the wetland, is the final discharge from Anaerobic and Aerobic Bioreactors. Most of the BOD will have been removed at the Anaerobic and Aerobic Bioreactors and the expected major treatment objectives in the engineered wetland are nutrient removal such as nitrogen and phosphorus. Consequently, it is preferable to adopt only a VF type for this facility.

The clogging issue, which is a disadvantage of the VF type does not need to be considered because most of the TSS in raw water would have been removed during the previous stages.

5-3-3 Design calculation

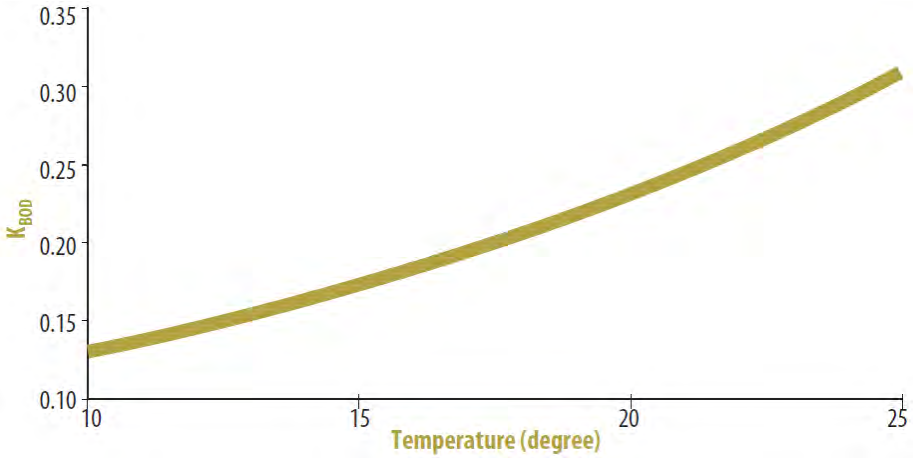
(1) Required surface area

The formula to calculate the required surface area for the engineered wetland is shown in the Constructed Wetlands Manual (2008). In designing this facility, the required area for the engineered wetland was calculated using the following formula.

$$A_h = \frac{Q_d (\ln C_i - \ln C_e)}{K_{BOD}}$$

- A_h = Surface area of bed (m^2)
- Q_d = average daily flow rate of sewage (m^3/d)
- C_i = influent BOD_5 concentration (mg/l)
- C_e = effluent BOD_5 concentration (mg/l)
- K_{BOD} = rate constant (m/d)

The value of $Q_d = 1.0$ (m^3/day) was set. From a conservative point of view, C_i=100(mg/L) and C_e=10(mg/L) were set for calculation. K_{BOD} is the constant number depending on temperature, and K_{BOD} for the VF type was obtained as shown in Figure 5-7. Based on this chart, K_{BOD} is determined as 0.30(m/day) at 25℃.

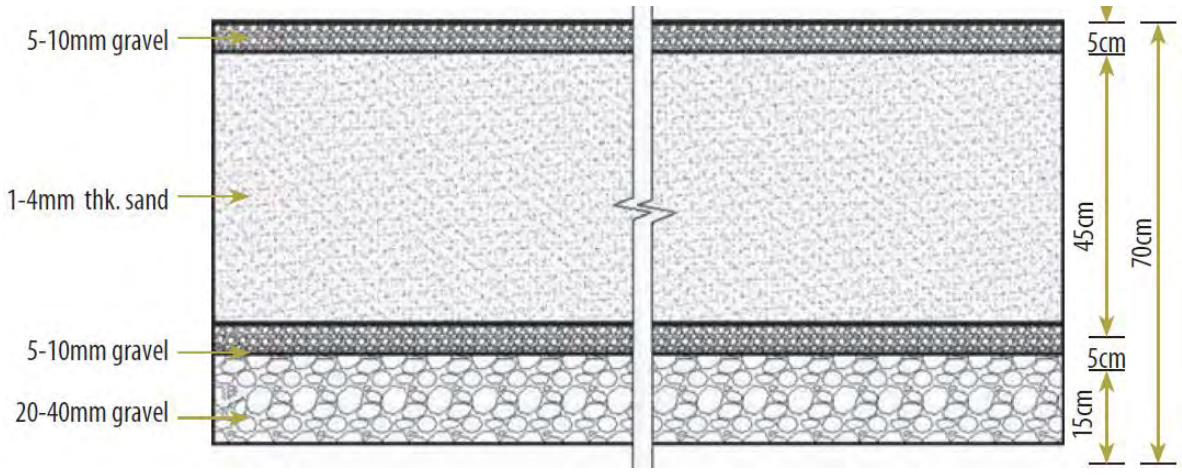


(Source: UN-HABITAT, "Constructed Wetlands Manual(2008)")

Figure 5-7 K_{BOD} from VF type Treatment Method

(2) Required Soil Depth

In the Constructed Wetlands Manual (2008), it is recommended that the VF type treatment method adopt 70cm depth for water shield area for optimal organic matter removal in addition to nitrogen removal. Thus, 70 cm depth of soil is adopted for this facility and the facility was planned to be built with the layers as given by Figure 5-8 below.



(Source: UN-HABITAT, "Constructed Wetlands Manual(2008)")

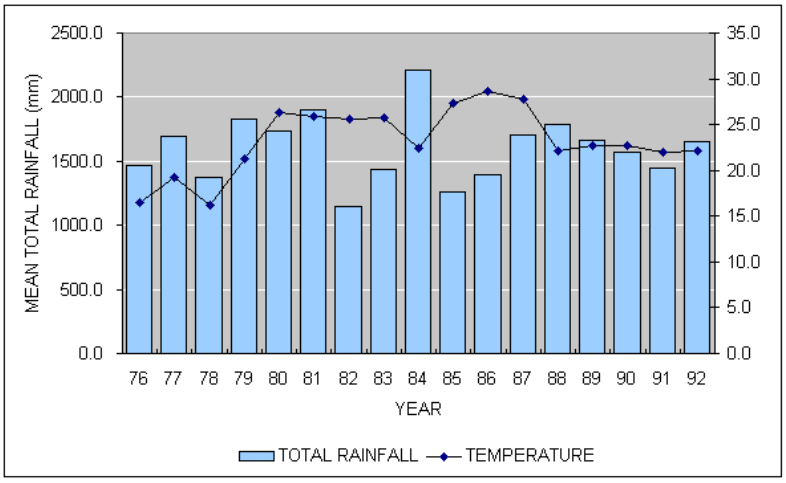
Figure 5-8 Layers on VH type Treatment Method

5-4 Rainwater Recovery System

5-4-1 Setting for the Amount of Rainfall

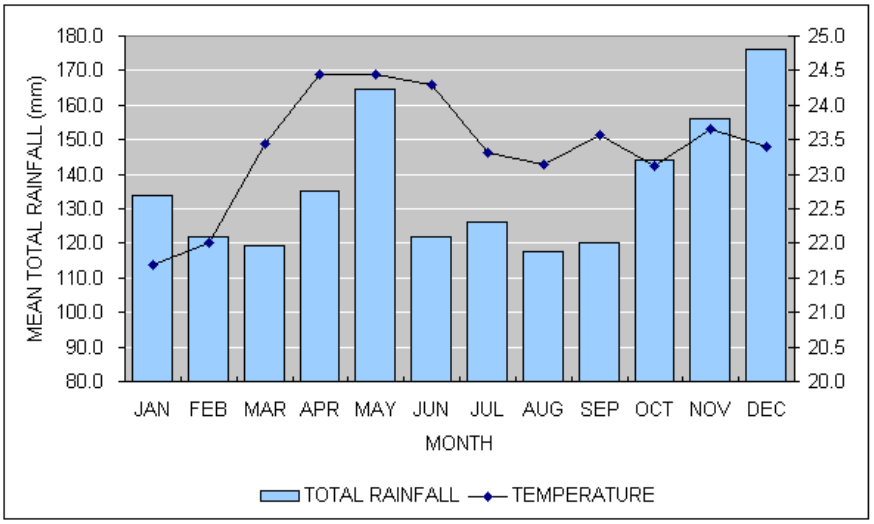
The transition of annual rainfall in Keningau, Sabah State is, as shown in Figure 5-9, is approximately 1,200mm to 2,300mm. As indicated by monthly rainfall, the most amount of rainfall ranging from 160mm to 180mm, are observed in May and December, and a lesser amount of appproximately 120mm, is seen in

Febraury to March and June to September. (refer to Figure 5-10).



(Source: State of Sabah web site; http://www.sabah.gov.my/htan_caims/Climatic%20information/Stations/keningau5.htm)

Figure 5-9 Transition of Annual Rainfall in Keningau (year 1976 to 1992)



(Source: State of Sabah web site; http://www.sabah.gov.my/htan_caims/Climatic%20information/Stations/keningau5.htm)

Figure 5-10 Monthly Average of Rainfall in Keningau (Average on Year 1976 to 1992)

5-4-2 Design Calculation

Rainwater is collected from the roofs of the installed pilot plant. The roof for the Anaerobic and Aerobic Bioreactors, carbonization system, Energy and Water recovery system from waste steam (Heat Exchanger), and final effluent polishing system by engineered wetland (Roof No1), and the roof for composting (fertilizer) system (Roof No2) were planned to build and collected rainwater which expected amount of 180mm/ month.

5-5 Composting (fertilizer) System

5-5-1 Summary of composting technology

Planned composting system in this facility produces fertilizer from pressed and shredded EFB, sludge generated from wastewater treatment facility, and Napier Grass harvested from the engineered wetland.

The system consists of (1) main treatment facility of producing fertilizer and (2) grinding system as post treatment of produced compost. Previously, a screw press and shredder of EFB was planned to install, but the plan was changed that pressed and shredded EFB would be procured because of over construction cost in the result of quantity survey. Pressed and shredded EFB is procured from a palm oil mill located near KPOM by SATREPS team.

Two types of equipment were planned to install as main treatment facility producing fertilizer. The one is the method applied in UPM and the other is the method called scoop type which KPOM owner applies for the production of compost by cow manure. Each type has unique character and Table 5-6 shows the comparison of two types.

Table 5-6 Two types of Adopted compost (fertilizer) production system

Method	UPM method	Scoop method
Example of installation		
Addition of raw material	EFB is supplied once a month (batch operation). Sludge is sprayed regularly maintaining the moisture content in the composting process.	Continuous operation with the adding of EFB and Sludge regularly. By mixing the compost, fermenting processed material is moved and fertilizer is discharged from the opposite side of the material inlet.
Mixing method of compost	Can be mixed by heavy machinery called compost turners. Only manual operation is possible at present.	Compost is mixed by Scooping machine which is set on the wall of compost building. It is possible to set the machine to automatic operation.
Feature	Simple equipment. Surface on compost raw material is large so that heat dissipation is also large. However, it is possible to add much sludge against EFB comparing to scoop type because the sludge is dried by wind.	It is possible to conserve the space due to securing the material loading height. It is also easy for keeping the fermenting temperature. Easy for increasing in size.

(Source: JET)

5-5-2 Design Calculation

Table 5-7 (below) shows main design specifications for the system.

Table 5-7 Major Design Criteria for Composting (Fertilizer) System

Process	Major Design Criteria	Adopted Figure
Overall	EFB amount to be processed	10tonnes/month/unit
	Sludge amount to be processed	10tonnes/month/unit

	VS Reduction rate of EFB	2 % per day
	VS Reduction rate of Sludge	1% per day
Pre-treatment	Capacity	3tonnes per hour or more
Composting Process (UPM Type)	Retention Time	30 days
Composting Process (Scoop Type)	Retention Time	30 days
Post-treatment	Operation Hour	10hours per month or less

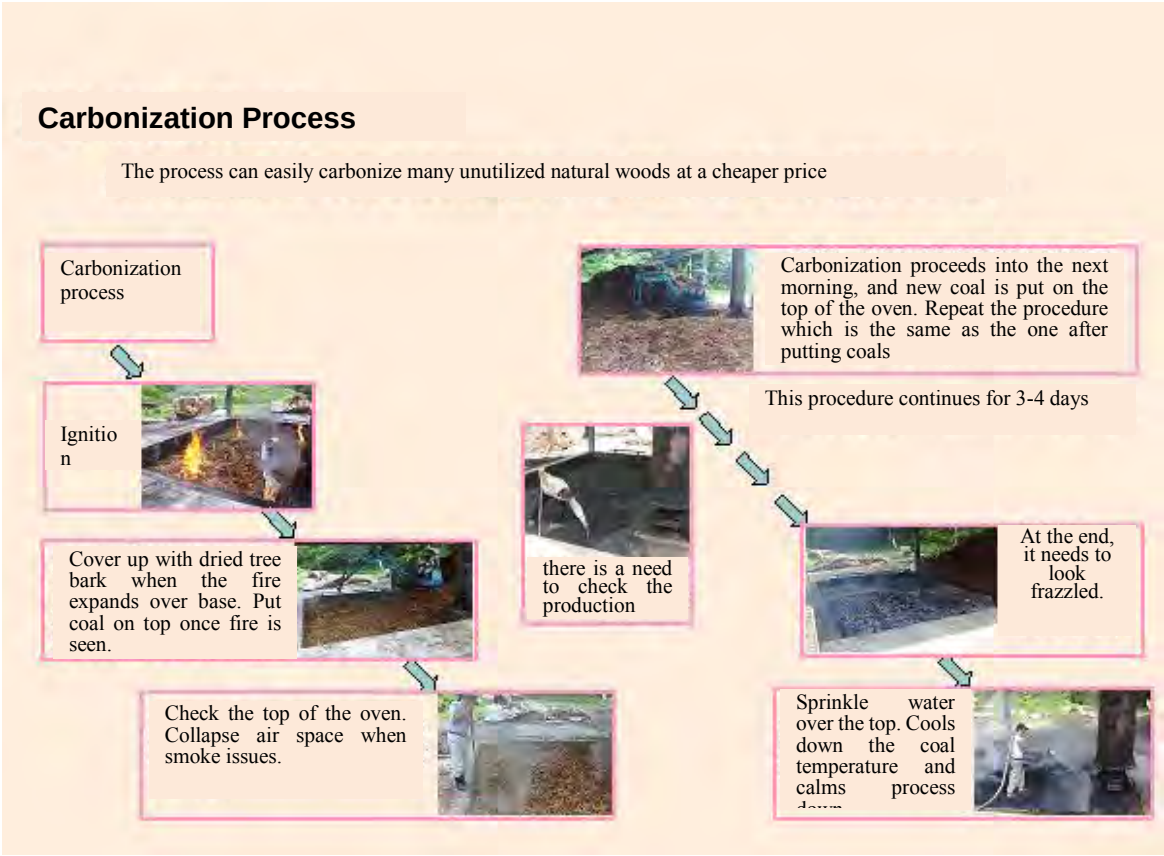
(Source: JET)

5-6 Flatbed Carbonization System

5-6-1 Summary of Carbonization System

The carbonization system in this project utilizes the Yamasen pool typed carbonization flat oven developed by Yamamoto Funtan Kogyo (Main office located in Masuda, Shimane, Japan). This technology is that material is laid in the bed of the oven at first. This is then ignited and then covered by additional moist material when the fire reaches the material.

By covering with additional moist material, adequate water is supplied to the bed material (carbonized material) and also limited air flows to the bottom, reductive conditions result and carbonization progresses (refer to Figure 5-11).



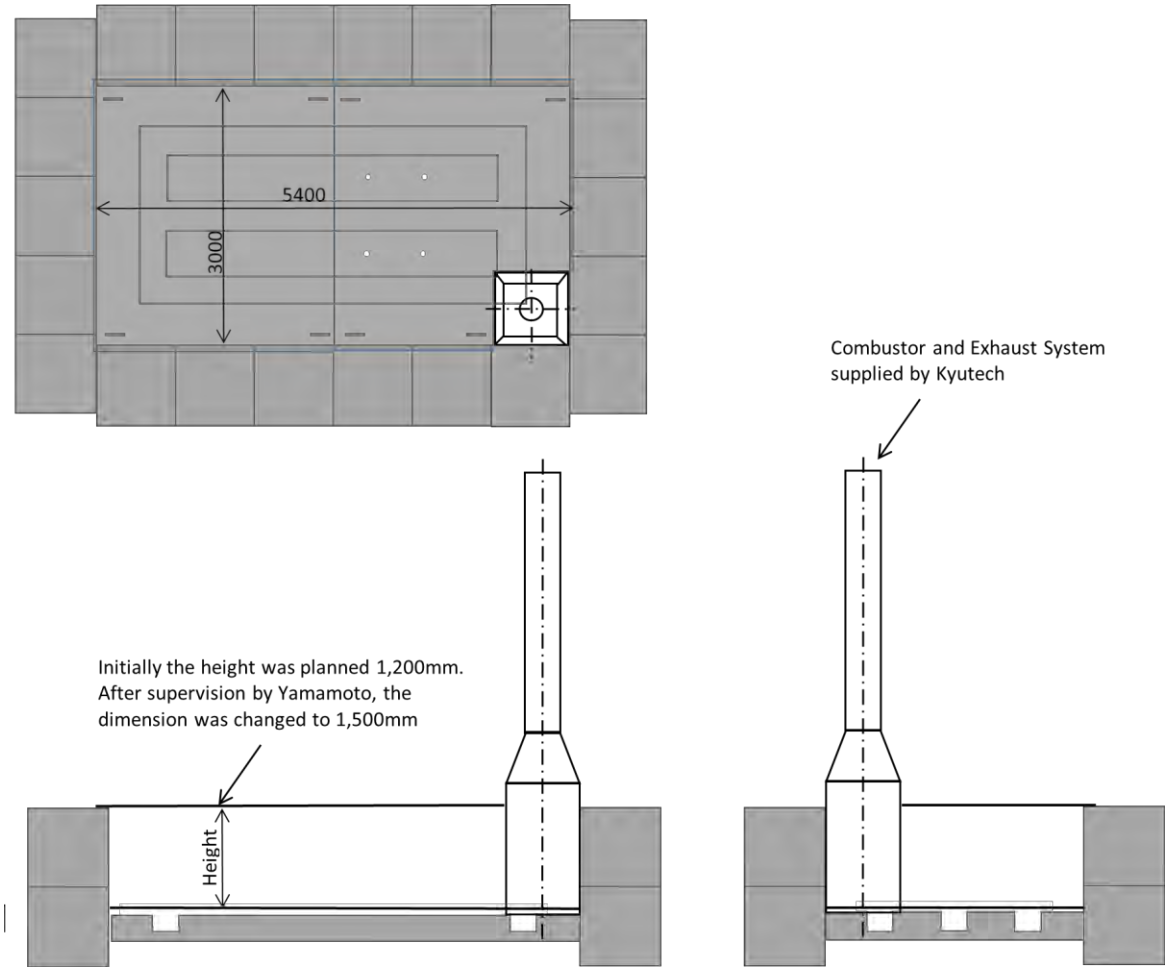
(Source: Yamasen web site http://xn--y7y688a.jp/yamasen/charcoal/trade_7.html)

Figure 5-11 Carbonization Process of Yamasen Flatbed Carbonization System

5-6-2 Construction of Carbonization system

The carbonization flatbed, the size is 5.4m x 3.0m x 1.2m (depth), was planned and constructed according to the information provided by Yamamoto Funtan Kogyo (refer to Figure 5-12). The flat oven is composed by two layers of non-reinforced concrete cubes (each side dimension is 900mm). The design criteria are the property of Yamamoto Funtan Kogyo and the system was faithfully constructed at the construction site based on the information supplied.

Yamamoto Funtan Kogyo requested structure changes of the system when they visited the site. Contents of requested design changes are described in **Chapter 8.**



(Source: JET, based on design information provided by Yamamoto Funtan Kogyo)

Figure 5-12 Outline of Yamasen Flatbed Carbonization System

Chapter 6 Procurement Lot

6-1 Basic Policy for Procurement Lot

Fabrication work for the facility, installation work and related construction work and procurement work for the heavy machines used for the plant operations are all required for the Project.

There is concomitant work through fabrication for the installations at the site so it is undesirable to divide this work from the point of view of the construction schedule management and quality management. On the other hand, there is no obstacle for dividing construction work and procurement work for heavy machines. Thus, the basic policy for the procurement lot was set so as to be divided into two lots, namely the plant fabrication and construction work lot (LOT 1) and the equipment procurement lot (LOT 2).

6-2 Plant Fabrication and Construction Work Lot (LOT 1)

6-2-1 Scope of Plant fabrication and Construction work Lot

Other than the equipment procured in Lot 2, Lot 1 covers all the remaining equipment procurement, and also includes plant fabrication and installation work for the Anaerobic and Aerobic Bioreactors, It also includes the Energy and water recovery system from waste steam (Heat Exchanger), Final effluent polishing system by an Engineered Wetland, Rainwater recovery system, Composting (Fertilizer) system and the Carbonization system.

The civil works at the site were considered to be another lot, but the scale of the civil work was small and the site was located in the backcountry. For these reasons, it might be considered that bidding has failed due to the lack of eligible bidders in case of dividing this into an individual lot. It is better that the contractor implements civil work at the site. If quality assurance issues rise at the site, then the contractor is the only person responsible for the issue. Thus, construction work and fabrication work were planned so as not to be divided.

There is no deterrent should the contractor wish to make a subcontract with a local civil contractor. In this case the contractor shall seek approval from the JICA Malaysia office.

6-2-2 Special Equipment

It is noted that following special facilities and equipment are included in this lot.

(1) Energy and Water Recovery System from Waste Steam (Drum Dryer)

With respect to the energy and water recovery system from waste steam (Drum Dryer) it takes a long time for this facility to be procured locally and transported to the site as compared with other facilities due to the requirements of inspections based on the Factory and Machinery Act 1967.

It was finally decided that this facility be procured in Japan, and transferred to Malaysia by Kyutech. This lot includes installation work and test operation of the facility but did not include procurement work of the facility, transportation to the site and acquisition of any approvals related the facility.

(2) Composting Turner

Two types of composting technologies were planned to be installed for this project. One is the method implemented in UPM which used heavy machinery called a compost turner for the mixing. This machine is

manufactured by Backhus, a German company. The counterparts requested that the same brand used in UPM be used in the project in order to enable comparisons and facilitate evaluation with the results of the composting tests conducted at UPM. In effect, the equipment must be of the same type, and made by the same company as that used at UPM. This means that the supplier is limited. Thus, the bidder is automatically limited if this lot is implemented as an individual lot. This lot would also have been planned to include the procurement work of equipment.

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(3) Combustor and Exhausting System for Flatbed Carbonization System

The combustor and exhaust systems were planned to be purchased from Yamamoto Funtan Kogyo by Kyutech, and then supplied to the site. The lot included the construction work for the flatbed carbonization system with installation work of combustor and exhaust systems but procurement and transportation of these items were not included.

6-3 Equipment Procurement Lot (LOT 2)

One (1) Mini excavator, one (1) Forklift and one (1) Skid steer loader were planned to be procured in Lot 2. Specifications for the equipment were defined so as to be the same as the equipment utilized in UPM (refer to Table 6-1). Leasing of the equipment was also examined rather than purchasing the equipment for this procurement lot, however no added merit through leasing could be found.

Table 6-1 Specification for procured equipment in Lot 2

Type of Heavy Machine	No of Unit	Specifications
Mini Excavator	1	- Model: Komatsu PC18MR-3 or equivalent - Flywheel Horsepower: 11.2kW - Operating weight: 1780kg - Bucket capacity: 44L
Forklift	1	- Model: Toyota 62-8FD15 or equivalent - Truck Weight: 2,700kg - Maximum Lifting Height: 4,000mm
Skid Steer	1	- Model Case SR220 or equivalent - Rated Operating Load: 1,000 kg - Engine Power: 57 kW

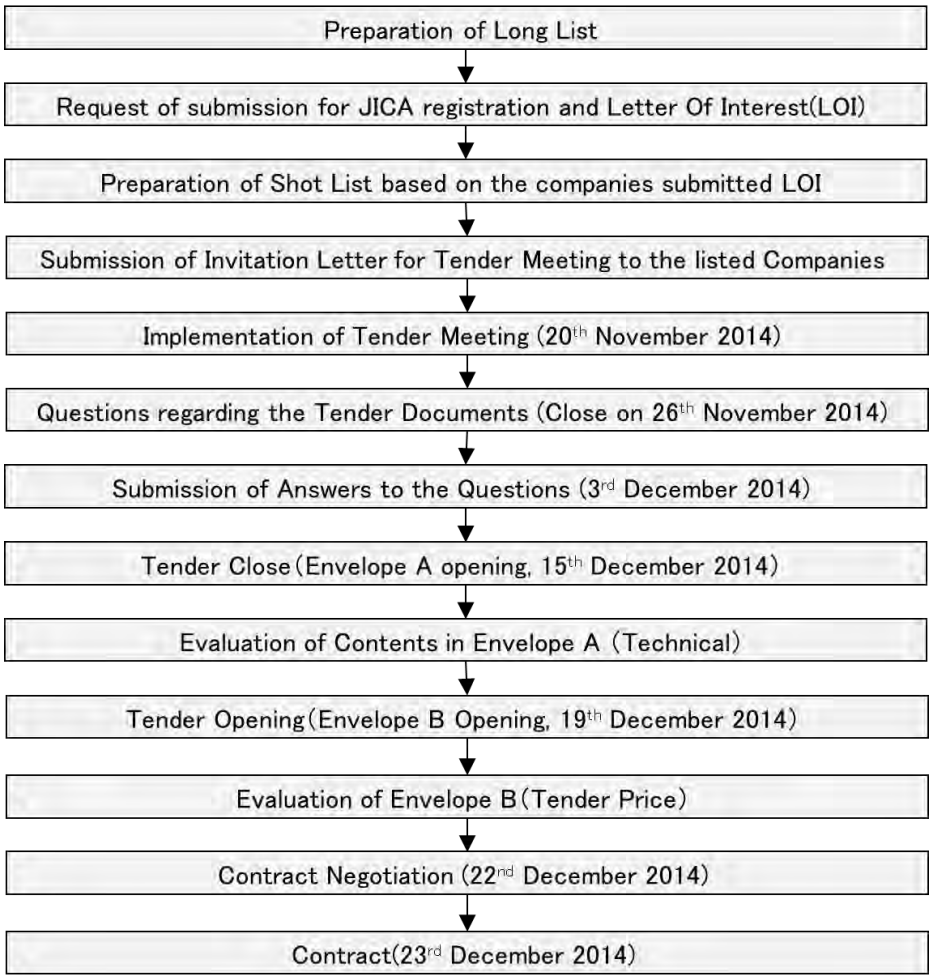
(Source: JET)

Chapter 7 Contractor and Supplier Selection

7-1 Plant Fabrication and Construction Work Lot (LOT1)

7-1-1 Process of the Contractor Selection

The contractor selection process was carried out following the procedures described in Figure 7-1. The contractor selection was by selective bidding. Initially a long-list was prepared, and companies included on this list were asked to express their intentions of interest. All companies desiring to participate in the bidding process were requested to register with the JICA Malaysia Office. At the same time, the companies were also asked to satisfy the prescribed criteria for bidding participants by stringent internal self-checking. Invitation letters for the bidding meeting sent to all companies who submitted letters of interest and also satisfied the prescribed criteria. The bidding meeting was held on 20th November 2014, and the bidding documents were distributed and bidding procedures and the outline of construction work explained at the meeting. After the bidding meeting, questions regarding the bidding documents were entertained and appropriate answers given.



(Source: JET)

Figure 7-1 Contractor Selection Procedures (LOT 1)

7-1-2 Support for the Contractor Selection

For the bidding participation, all bidders must satisfy the eight requirements described in Table 7-1 for plant fabrication and construction work:

Table 7-1 Qualification Criteria for LOT1

Qualification Criteria	Qualification Condition
Formation and Location of Company	Based on Malaysia Companies Act, 1965 (Act 125), the bidder must be an Engineering, Procurement, and Construction (EPC) company and must be registered to Companies Commission of Malaysia (CCM). The company must have an office in Selangor State regardless of whether it is the headquarters or a branch office.
Registration with the JICA Malaysia Office	The bidder must be registered with JICA Malaysia Office as a supplier.
Financial Condition	The bidder must be of sound financial condition during the last 2 fiscal years.
Registration with the CIDB	Based on the Construction Industry Development Board Act, 1994 (Act 520), the bidder must be registered with the Construction Industry Development Board Malaysia (CIDB) in the categories of both ME (Mechanical and Electrical) and CE (Civil Engineering Construction) at Grade 7 (G7). Any of the areas of specialization in each category are acceptable. Since foreign companies, including Japanese-affiliated companies cannot be registered with the CIDB as mentioned before prior to the local bidders, Provisional Registration of the construction company with the CIDB is required, and registration with the CIDB as a foreign contractor is mandatory in case the foreign company's bidding is successful.
Paid Up Capital Amount	Paid-Up Capital of the bidder must be more than 750,000 Ringgit.
Engineer	The bidder must have at least two engineers having a Bachelors Degree in Mechanical Engineering.
Construction Record – Amount of Contract Price	In the past 5 years, the bidder must have completed at least one example of construction work with a contract price of three million Ringgit or more.
Construction Record – Type of Construction Work	In the past 5 years, the bidder must have completed an example of construction work, including sub-contracted work, of water or wastewater treatment with a contract price of at least five hundred thousand Ringgit.

(Source: JET)

The most important part that required the contractor's experience in LOT 1 is the construction work for the anaerobic and aerobic bioreactors. The companies must also have their offices in Selangor, Malaysia, and have construction experience in water, industrial wastewater or domestic wastewater treatment plants. The opinions of the chief advisor of the SATREPS study team were taken into account for the company selection. Finally twenty (20) companies were short-listed.

The submission of letters of interest (LOI) and supplier registration with the JICA Malaysia office were requested from the short-listed twenty (20) companies. During the submission of LOI, the companies were asked to satisfy the bidder selection criteria by stringent internal self-checking.

As a result, seven (7) companies out of the original twenty (20) short-listed companies, had submitted their LOI and applications to the JICA Malaysia office.

One company was found to lack the CIDB registration which is one of the qualification criteria. Their registration grade was also G5 instead of the stipulated G7. After submission of the LOI, they requested as to whether there was a possibility of proposing their membrane anaerobic reactor. JET responded that the technology to be installed was based on the ideas of chief advisor. As a result, they were declined the right to participate.

Another company was not an EPC (Engineering, Procurement and Construction) contractor and did not have any construction experience of water or wastewater treatment plants exceeding Malaysian Ringgit 500,000. They too were not eligible to participate.

Thus, from the seven (7) initially shortlisted companies and given th ineligibility of the two (2) companies mentioned above a final number of five (5) companies were eligible for nomination as selective bidders.

7-1-3 Supporting for pre-bidding Meeting

The bidding meeting was held at 10:00am on 20th November 2014 at the JICA Malaysia office, the outline of the project, bidding procedures and the outline of construction work were explained at the meeting. The five (5) eligible companies mentioned above participated at the bidding meeting.

An on-site survey for those companies who desired to visit the site, was carried out on 25th November 2014.

7-1-4 Assistance for Bidding, Evaluation and Contract

The supervisor of the Japan International Cooperation System (JICS) assisted the JICA Malaysia Office in facilitating the proceedings of the bidding meeting held, and the Consultant assisted in the technical evaluation of the bid documents. The Bidding was opened at 10 am, 15th December, 2014, and three (3) companies submitted the relevant documents.

Bid Documents required by “Instruction to Bidders” are shown in Table 7-2. The Supervisor (JICS) checked availability of “Qualification Documents”, Envelope A (Copy and Original) and Envelope B (Copy and Original). The Consultant opened Envelope A, and the documents in Envelope A were evaluated to determine whether they were acceptable. The Consultant evaluated the equipment shown in Envelope A as to whether it satisfied the stipulated specifications.

At the first bidding, the bidding prices of all bidders in Envelope B were found to over the ceiling price limit. A second bidding was therefore conducted immediately, but these revised bidding prices were also over than the ceiling price limit. The bidder, Swing Water Sdn. Bhd. who offered the lowest price was therefore appointed as a first priority negotiator. Contract negotiations were held between JICA and Swing Water Sdn. Bhd., at which time they agreed to the making of the contract.

JICA and Swing Water Sdn. Bhd. had a meeting regarding the contract document at 1:00 p.m., 22th December, 2014. After confirmation of contract conditions such as contract price, period of execution of works, scope of works, advance payment and warranty against defects, the contract was finally made.

Table 7-2 Bid Documents required by "Instruction to Bidders"

Items	Required documents
Qualification Documents	1) Power of Attorney (duly signed by the legal representative of the bidders) 2) Certificate of Signature of the issuer of the said Power of Attorney (authenticated by a Public Notary in Malaysia)
[Envelope A]	3) Copy of the CIDB Provisional Registration (foreign company only) 4) List of construction record 5) Implementation Schedule 6) List of Engineers 7) List of Equipment
[Envelope B]	8) Form of Bidding 9) Bidding Price Schedule

(Source: JET)

7-2 Equipment Procurement Lot (LOT2)

7-2-1 Process of the Supplier Selection

The supplier selection was carried out following the procedures described in Figure 7-2. The supplier selection was planned by open bidding. A public announcement for the bidding was published in the newspapers on 21st November 2014, and the bid documents were distributed to the companies which demonstrated interest in the bidding process from the day of the public announcement until 26th November 2014. Before the submission of bids, the companies were requested to register with the JICA Malaysia office and the companies complying with the criteria were asked to submit their bids.

(Source: JET)

Figure 7-2 Supplier Selection Procedures (LOT 2)

7-2-2 **Support for the Supplier Selection**

For bidding participation for LOT 2, the bidders needed to satisfy the two requirements described in Table 7-3. The bidding notice was issued on 21st November 2014 in three local newspapers. As a result, seven (7) companies showed interest and received the bidding documents.

Table 7-3 Qualification Criteria of LOT2

Qualification Criteria	Qualification Condition
Formation and Location of Company	Based on Malaysia Companies Act, 1965 (Act 125), the bidder must be registered with the Companies Commission of Malaysia (CCM).
Registration with the JICA Malaysia Office	The bidder must be registered with the JICA Malaysia Office as a Supplier.

(Source: JET)

7-2-3 Assistance for Bidding, Evaluation and Contract

The Bidding was opened at 10 a.m, on 16th December, 2014, only two (2) companies participated. The Bid Documents required by "Instruction to Bidders" are shown in Table 7-4.

The evaluation results of the bidding document, showed that one bidder had submitted incomplete documents. The bidder also could not supply the forklift. Thus this bidder was disqualified. The bidding price from remaining bidder, Maju Engineering Services Sdn Bhd was within the ceiling price limit. The bidder was therefore successfully selected as the first party to make a contract.

After bidding, the bidding documents were carefully evaluated to make clear any questionable points. JICA and the bidder thereafter successfully concluded their contract negotiations.

Table 7-4 Required Documents in Bidding Meeting

Items	Required Documents
Qualification Documents	1) Power of Attorney (duly signed by the legal representative of the Bidder) 2) Certificate copy of Registration with JICA MALAYSIA OFFICE
Documents of BIDDING	1) BIDDING (FORM 1) 2) PRICE SCHEDULES (FORM 2) 3) DELIVERY SCHEDULE (FORM 3) 4) CATALOGUE OF NON-REFERENCE BRAND ITEM (per item) 6) Manufacturer's SUPPLY GUARANTEE CERTIFICATE addressed to the Bidder (FORM 5) 7) Financial Statements of past two (2) years

(Source: JET)

Chapter 8 Fabrication and Construction Supervision

8-1 Plant Fabrication and Construction Work Lot (LOT 1)

8-1-1 Developing Construction Supervision Plan

A construction supervision plan was prepared for fabrication and construction supervision. It described the construction supervision policy, the organizational structure relating to the project, an emergency contact list, and an attendance list of meetings and supervised items. The construction supervision plan was copied to the contractor, chief advisor and the SATREPS team in order to facilitate smooth operations.

Table 8-1 shows the contents of the construction supervision plan.

Table 8-1 Contents of Construction Supervision Plan

Item	Contents
1. Outline	Project name, Implementation schedule, Related organizations
2. Scope of Work	Location of the site, Major facilities to be built
3. Construction Supervision Work	Fundamental policy of Supervision, Scope of Work, Applied Laws and Standards, Priority of Documents
4. Contact List	Organization Structures of Consultants and Contractor, Emergency Contact List
5. Meeting	Period of Meetings and Attendees defined by the tender documents
6. Approval Procedure	Procedures of Document Approval
7. Construction Supervision	Supervision Items of Fabrication and Construction, Safety Management

(Source: JET)

The construction work schedule was planned and submitted by the contractor to ensure the completion of the procurement, manufacturing, construction and commissioning activities within the contract period. The work schedule was copied to the project team after obtaining the consultant's approval. Monthly progress reports were prepared and submitted to the Consultant.

8-1-2 Procurement Supervision

The items of equipment procured for the project were selected by the contractor based on the tender document. Requests for approval of the equipment were then submitted to the consultant. The consultant approved the request only when the stipulated specifications and quality were satisfied. The contractor procured the equipment only after obtaining the approval of the consultant.

8-1-3 Fabrication Supervision

Fabrication supervision was carried out by one (1) Japanese supervisor who was dispatched to the project site to check on the progress and inspect the major equipment. One (1) local engineer was also employed in order to visit the fabrication shop twice a week and report on work quality and progress to the consultant. The fabrication of equipment began only after obtaining the approval of the consultant. The necessary products were

fabricated by a sub-contractor who was selected by the contractor. The experience and capability of the sub-contractor was examined through relevant documents submitted to the consultant by the contractor, and the selected sub-contractor was then approved.

The following inspections were carried out during fabrication supervision;

(1) Dimension Inspection and its Result

Dimension inspections were performed by the contractor and the consultant to check on whether each part was fabricated as stipulated by the drawings both during fabricating and after completion of the fabrication. Provided the results of the inspection were successful, the consultant then instructed the contractor to proceed to the next work step i.e., painting or transporting.

(2) Welding Inspection and its Result

A nondestructive test is an evaluation method of welding quality. Several kinds of non-destructive tests have been developed, so that the most appropriate methods can be selected depending on the type of material or the shape of the object under consideration. Table 8-2 shows the major test categories Visual Test (VT) and Penetration Test (PT) were selected for the product in this instance because the plate thickness was thin, and any defects in the welded part would have shown up on the surface.

The results of VT and PT, showed that the welding work was successfully performed.

Table 8-2 Comparison of Major Nondestructive Tests

Name	Visual Test (VT)	Penetration Test (PT)	Magnetic Particle Test (MT)	Radiographic Test(RT)	Ultrasonic Test (UT)
Method	Visually inspecting the condition and flaws on a surface	Impregnating a special liquid (penetrant) to micro flaws opening on a test body. The penetrant is spread on the surface and the flaws are detected as a pattern of wave forms.	When there is flaw crossing of the magnetic flux, and magnetic poles occur because the flux has leaked out. A magnetic pattern is developed by administration of powdered magnetic particles.	Filming the internal condition of a test body as a 2D image by using the effect that X-rays and gamma-rays have to penetrate a test body and expose a photo film.	When an ultrasonic wave transmits within a test body, the wave goes straight to where the test body is flawless. But when there is flaw in a test body, the wave is reflected at the site and a probe detects the returning wave. The UT utilizes this phenomenon to detect the existence of flaws and their size
Object	Surface	Surface	Surface	Inside	Surface and inside
Advantage	No need for any special device or method	Requires penetrant and developer, no need any special device	Requires Electro-magnet and fluorescent particles	Requires radiation generator and films	Requires ultrasonic generator
Disadvantage	Only for big flaws on a surface	Only opening flaws are detectable.	Only for Ferromagnetic material	Expensive device. Requires X-rays	Diffused reflection may occur in complex structures

(Source: The Japan Association for Non-Destructive Testing Industry etc.)

(3) Water-filling Inspection and Its Result

After the nondestructive inspection, a water-filling inspection was carried out on the tanks. First of all, the tanks were assembled for testing and all drains were closed by using blind flanges. Then, the tanks were filled with fresh water, and inspected to determine whether leakage occurred or not. If the result of the inspection was good and showed no leakage, the consultant accepted the results.

(4) Painting Inspection and Its result

The painting work was to be carried out by the application of three (3) layers which are a primary coat (first layer), an under-coating (second layer) and a finishing coat (third layer). The specifications required that the thicknesses of each layer shall be measured and recorded with photography. However, the inspection by the contractor was carried out only once after the third layer had already been applied. Furthermore, the result of some parts showed areas which did not receive the required thickness of paint, Photography was used.and the consultant requested the contractor to confirm whether the painting was of the same or of a better standard than that of the stipulated specifications. The consultant made the contractor carry out the appropriate compensatory measures when problems occurred such as omission of procedures, and lack of application of countermeasures for the prevention of the omissions. The omissions occurred in places because the Contractor had not checked the progress of each painting process. The contractor promised to check the progress frequently in order to prevent recurrence of the problems.

(5) Motor Control Panel Inspection and Its Result

An inspection of the motor control panels was performed in presence of the consultant, appearance; dimensions, assembling, wiring and painting were confirmed. The Consultant evaluated the inspection result as being acceptable and instructed that the motor control panels be transferred to the site.

8-1-4 Construction Supervision

Construction works included civil work, structural work, piping work, electrical work and mechanical work. The Consultant visited the site according to requests made by the contractor and supervised the progress of management for the construction and inspections of the major construction works in the same manner as was done during the fabrication supervision phase. Meetings and discussions were held under the instructions of the consultant based on the tender documents and the construction work schedule. Table 8-3 shows the meetings and the discussion during the construction period.

Table 8-3 Meetings and Discussions Held

Name	Date	times
Pre-Construction Conference	15th,16th Jan.2015 (prior to construction)	2
Progress Meeting	Monthly (Feb.2015～Sep.2015)	8
Subcontractor's Site Meetings	When required	When required
Pre-Installation Conference	21st May.2015 (prior to installation)	1

(Source: JET)

Follow ups were done by communicating via telephone, e-mails and internet. These, were carried out to confirm the progress of the works at the site.

The following inspections were carried out during the construction supervision phase.

(1) Concrete Compressive Strength Test

Concrete had been used for the floor slab, column legs and blocks for the flatbed carbonization system at the plant. The compressive strength test measures the strength of the concrete. The test measures mechanical properties by gradually pressuring the test piece which is prepared at the same time as the concrete placing. The passing criteria for the test was that the compressive strength after 28 days from the concrete placing is more than that of the design value. The required strength for the concrete proposed by the contractor was 30 MPa/m^2 (Grade30). The result of testing shows that strength of the concrete satisfied the design values.

(2) Dimension Inspection and its Result

A dimension inspection was performed by the contractor and the consultant to check whether each part was fabricated to the same stipulated dimensions as the drawing during construction and after completion of the construction.

(3) Inspection by DOSH for Energy and Water Recovery System from Waste Water

After delivery of the system which was procured by Kyutech, at the site on 25th September 2015, the contractor checked packing conditions and parts quantities. No problems were found. Therefore, installation works of the system commenced under the manufacturer's instructions from 19th October. After completion of the work, an inspection by DOSH was carried out at the site on 22nd October. The inspection method had been confirmed by and between DOSH and the manufacturer in advance. The test which involved keeping the system for 30 minutes under 0.5 MPa of pressure by compressed air was carried out. Diminution of pressure had not occurred, therefore the inspection was considered successful.

(4) Final Inspections

Initially an inspection in advance the final inspections was carried out together with the chief advisor, SATREPS team members and the consultant on 17th December 1015 in order to carry out smooth inspection. Then the defects found through the inspection were informed and discussed with the Contractor.

The final inspections were carried out between 26th till 29th January 2016 based on a request from the contractor. At the site (KPOM), it was confirmed that completion conditions of the works have been satisfied by the Contractor, SATREPS team members and the Consultant. At the same time, it also was confirmed that the defects found through the inspection carried out the inspection in advance have been corrected.

A document inspection which is a part of the final inspections was carried held at the Contractor's office in Shah Alam, Selangor State on 29th January 2016. It was confirmed that all necessary documents have been prepared and satisfied.

The followings design changes and modifications were made during construction;

1) Energy and Water Recovery System from Waste Steam

An energy and water recovery system from waste water was to be procured by Kyutech. But due to other internal work of Kyutech, the bidding and bid opening were held only on 27th March 2015. The Nara Machinery Co., Ltd was awarded the right to supply the system and signed the contract. The delivery date of the system was set for 1st October 2015, and the installation work and commissioning were also set. Since the system to be procured from the company (drum dryer) was totally different from that originally designed for the system (evaporator) on method, structure and specifications; modifications to the apparatus and its arrangement had to be carried out and the construction period was thus delayed.

2) Flatbed Carbonization System

Yamamoto Funtan Kogyo visited the site on 1st, 2nd April and on 17th June 2015. Their requested modifications for the system are shown in Table 8-4.

Table 8-4 Modification of Flatbed Carbonization System

Changes	Original design	Instructions in April	Instructions in June
Bottom structure	All concrete structures	Flue area shall be a concrete structure, but others shall involve the spread of pressed gravel at a thickness of 300mm	To provide a few holes in the flue for passage of smoke
Depth of Furnace	1,200 mm	1,500 mm	
Concrete blocks	Lifting lugs are maintained Difference in level between the ground to top of the block is 200mm	Lifting lugs of upper blocks should be cut. Only two Lifting lugs at a neighboring point of the chimney should not be cut to give support for the chimney.	Gaps between blocks should be filled with slaked lime and sand. It is to be filled every time before the start of operations.
Additional processing	Unwelded steel plates are laid on the bottom	Steel plates should be welded to each other and the edges of the plates shall be in the pile.	
Ground floor around the system	Gravel is laid around the Carbonization system	Reinforced concrete shall be provided around the Carbonization system to prevent the falling of mixing gravel down into the system when heavy machinery moves around the project area.	
Chimney	Supports unnecessary	Supports necessary	Gaps between blocks and chimney should be filled by rock wool

(Source: JET)

8-2 Equipment Procurement Lot (LOT2)

8-2-1 Delivery and Inspection of Equipment

The inspection for procured equipment (skid steer loader, mini excavator, and forklift) at the delivery was carried out under the supervision of the consultant at the supplier's shop on 26th March 2015. After the inspection, the consultant received the equipment instead of JICA at the site on 28th March 2015. Thereafter, the ownership was transferred to JICA, and the equipment was stored in a place at the oil mill under the existing roof as permitted by KPOM. Furthermore, the consultant suggested that SATREPS team keep the supplied spare parts of the equipment at the supplier's storehouse since KPOM did not provide any safe storage for these spare parts.

The consultant instructed the supplier to store the spare parts by taking full responsibility and to directed that they be immediately prepared when requested by the SATREPS team. The consultant also suggested keeping a set of spare keys for the equipment at KPOM in case of an emergency, and the SATREPS team accepted the suggestion. The Consultant submitted the inspection report and letter of acceptance to JICA, after which the manuals, catalogues and keys for the equipment were passed onto to the SATREPS team on 30th March. Finally, the ownership was then transferred to the SATREPS team from JICA.

8-2-2 Operation Instruction and Safety Briefing

The operation instructions and safety briefings were held on 26th and 27th March 2015 by an instructor dispatched by the supplier. The number of trainees was six persons. They each obtained a completion certificate after the training sessions. Only these six persons are thus permitted to operate the equipment in order to ensure safety.

Chapter 9 Commissioning and Operation Instructions

9-1 Outline

9-1-1 Schedule

A meeting regarding the commissioning of the Project was held at UPM on 28th May 2015. In order to facilitate and confirm the commissioning a staff member was dispatched from UPM to inspect the necessary works. At the meeting, the Consultant suggested that the analytical work was indispensable for commissioning. At the meeting also necessary parameters to be measured and frequencies of measurement were proposed and a request made to UMS for the identification of measuring equipment and the establishment of an organizational structure to carry out the analytical work. The consultant has also prepared a commissioning plan and it was distributed to the concerned persons. Commissioning and operation instructions were carried out following the schedule described in Table 9-1.

Initially a third and fourth commissioning stage were not planned. This was made necessary due to the problems at the facility regarding the anaerobic and aerobic bio-reactors, and were carried out until the stipulated performance could be achieved.

Table 9-1 Implementation Schedule of Commissioning and Operation Instructions

Stage	Commissioning Period	Purpose
First	2nd -29th Aug., 2015	Safety Briefing, General Training Commissioning and Training for; - Wastewater Treatment system - Engineered Wetland system - Rainwater collection system - Composting system - Carbonization system
Second	23rd-26th Oct., 2015	Commissioning and Training for Drum Dryer System
Third	22nd-Nov-19th Dec, 2015	Commissioning for Wastewater Treatment system Implementation of the Pre Final Inspection
Fourth	26th Jan -29th Jan, 2016	Commissioning for Wastewater Treatment system, Issuing the Certificate of Completion to the Contractor Implementation of Final Inspection

(Source: JET)

9-1-2 Commissioning Plan

The commissioning plan made by the consultant included safety measures, organizational charts including emergency contact details, implementation schedules for commissioning, basic information on KPOM, fundamental policy on facility design, basic information on facility design, and related drawings. A draft form of the daily report and measurement parameters and frequencies were also included.

9-2 Commissioning and Operation Instructions

9-2-1 Safety Briefing

Prior to the start of operation, a safety briefing including explanation of proper wearing of work-clothes and prohibition of work alone, was carried out. Dangerous/hazardous aspects of any matters hidden in the various activities were anticipated and countermeasures were to be identified at the morning meeting to be held each day, in order to avoid them. This KY activity; (KY, Kiken Yochi which means danger precognition).

Defined dangerous/hazardous aspects of activities and the countermeasures identified were identified and confirmed as to whether they were appropriate or not at the closing meeting. These aspects were added to and revised as necessary, in order to be reflected in the work carried out the next day (PDCA cycle). These series of activities were decided to be continued autonomously by the SATREPS team.

KY Activity (1)

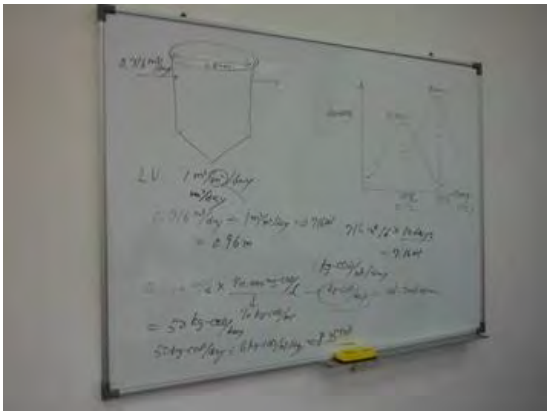
KY Activity (2)

9-2-2 Operation Instruction by Discourses

Initially a lecture on the overall process was given to the commissioning staff by the chief advisor, after that lectures on each process were given by the consultant in detail. Lectures covering topics such as the composting facility and the flatbed carbonization system were also given by the UPM staff who were familiar with these processes.

Descriptions of process flow diagrams which are expected as fundamental knowledge in chemical engineering together with logistics of automated operation methods (sequential circuits) were also carried out. In addition, to this in order to confirm the operator's understanding, a written examination was held. After the examination results were examined, correct answers were decided on through discussions under the instruction of the consultant.

Lecture by the Chief Advisor



Lectures of the Processes in Detail

Lecture in the Logistics of Automatic Operation

Written Examination

9-2-3 Commissioning and Operation Instructions for Each Process

(1) Anaerobic and Aerobic Bio-Reactors

Initially, each tank of the anaerobic and aerobic bio-reactors was filled with fresh water, and the proper operation of the facility was confirmed (unloading operation). After drainage, the anaerobic seed sludge was transferred to the anaerobic bio-reactor from an existing anaerobic pond. Two of sewage treatment plants (Sequential Batch Reactors) in Keningau were surveyed, aerobic seed sludge was transferred to the aerobic reactor from one of them. Subsequently, actual wastewaters were used to feed the system (loading operation).

During the loading operation, many aspects of the process were found to require modification or change, these aspects were then improved upon through discussions with the contractor. The most serious problem was that almost all of installed pumps were becoming clogged. After a period of trial and error, the pumps were finally replaced to match the same model which was being used for testing by the consultant at the design stage. The final commissioning was held in January 2016. Here it was confirmed that the system was possible to operate without big problems emerging in terms of operation and maintenance.

Unloading Operation Test using Fresh Water

Transfer of Anaerobic Seed Sludge

Survey on the Sewage Treatment in Keningau

Transfer of Aerobic Seed Sludge

(2) Final Effluent Polishing System by Engineered Wetland

Nursery plants of Napier grass were obtained from KPOM. After that, continued growth of the Napier grass was confirmed after treated water discharged from the anaerobic and aerobic bioreactors was fed into the system. The SATREPS team plans to confirm both the long term stability of Napier grass and its performance with respect to purification capacity. In addition harvested Napier grass will be applied as an additional material for composting.

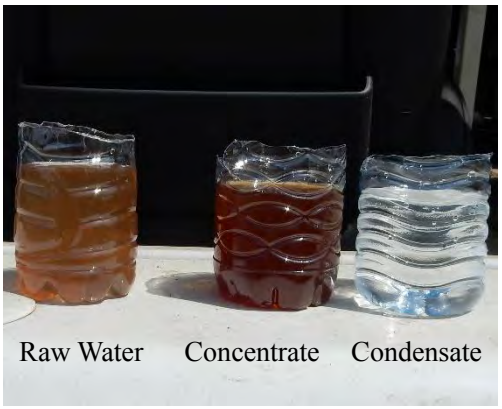
Planting of Napier Grass

Mature Napier Grass Plants

(3) Energy and Water Recovery System from Waste Steam

Commissioning of the system was carried out using fresh water as raw water, to confirm the validity of the process mechanism. After that, the determination of performance parameters like treatment capacity and concentration rate which are described in the specifications were confirmed through continuous operation of more than 5 hours.

Raw Water Feeding



Operation Result

(4) Rainwater Recovery System

Rain water collected from the roofs of the composting facility, the anaerobic and aerobic bioreactors as well as the flatbed carbonization system, were utilized in the unloading operations of the anaerobic and aerobic bio-reactors as well as the watering for the Napier grass and as cooling water for the energy and water recovery system from waste steam, during the commissioning phase.

(5) Composting (Fertilizer) System

20 tons of Shredded EFB as raw material for composting was conveyed from Desa Kim Loong Palm Oil Mill by arrangement of the SATREPS team.

Commissioning of the compost turner system (UPM method) was started after operating instruction from the supplier were confirmed to permit the system to operate optimally.

The scoop system started operation after completion of operating instruction implemented by the manufacturer. However shredded EFB was found to be clogged inside the drive chain, and the drive chain had separated from the sprockets. This led the chain and bearings to break. Therefore, necessary modifications were carried out. A part of the mixing bars were cut, in order to prevent the chain being clogged by the fibre of the EFB. Also the number of the mixing bars was reduced by up to 2/3. Broken bearings were replaced. After the modification, operating instruction were carried out once again by the manufacturer. The commissioning of this facility was then completed without any problem.

Conveyance of Material for Composting (Shredded EFB) **Compost Turner (UPM method)**

Scoop Type Composting System(After Modification) **Operation of Scoop Type Composing System**

(6) Flatbed Carbonization System

In the presence of both Yamamoto Funtan Kogyo (who is the technology owner), and the chief advisor, commissioning of the flatbed carbonization system was carried out. Oil palm leaf was prepared for ignition. The raw material for carbonization was shredded EFB. The product appearance of the bio-charcoal was satisfactory according to the chief advisor. Consequently, the confirmation of fundamental performance was completed.

This system was built based on technical information provided by Yamamoto Funtan Kogyo. This technology has been developed in Japan. One of challenges is that this technology has to be modified to a technology suitable for a tropical rainforest climate like Malaysia. The following problems (below) were recognized by the commissioning time period. The SATREPS team will improve and solve these problems through consideration of these problems, as part of their study theme.

1) Ground Water Leaching into the Flatbed Carbonization System

After heavy rains, infiltration of ground water into the flatbed carbonization system was found. The current structure cannot prevent infiltration of underground water from the walls and the ground. The SATREPS team plans to study whether or not the system can work under infiltration of groundwater, determine the infiltration limit of groundwater and devise countermeasures for necessary improvement.

Leaching Ground Water into the System

2) Smoke During the Starting-up and Shutdown Phases

The inside of the KPOM facility was filled with massive thick smoke exhausted from the carbonization system at the start-up and shutdown phases during commissioning. The SATREPS team plans to study on how to reduce this smoke either through changes to the operating method (material feeding or usage of top cover), or modification of the facility (change of chimney etc.).

Smoke discharged from the System

3) Effective Utilization of Wood Vinegar

A considerable amount of wood vinegar is being generated from the damper located chimney. Wood vinegar is a by-product which can potentially be utilized and thus the utilization of wood vinegar may also be a subject of research. The SATREPS team plans to institute a study regarding the recovery and use of wood vinegar.

Leakage of Wood Vinegar from the Damper

Chapter 10 Recommendations for Operation and Maintenance

The followings items were recommended to the SATREPS team in terms of operation and maintenance of the facility.

(1) Improvement and Modification of the Facility

The basic performance of the pilot plant has been confirmed by the project being commissioned. Achievable performance will be confirmed through continuing operation from now on, because the facility is set up for testing. As the pilot plant is not a commercial facility, improvement or modification of the final facility may be required. Already the flatbed carbonization system has been shown to require improvement if it is to be an appropriate facility in the region. To demonstrate the necessity of the proposed countermeasures is truly a development in itself. As the pilot plant has been adopted as a process with which the country has no past experience, the true evaluation of the process will be found by future operating results. Methodical collection of continuous operating data will be necessary for the study of improvements or modifications for the facility. The SATREPS team shall prepare the detailed operating plan and establish the implementation structure for execution, in order to efficiently collect such important data. The SATREPS team will implement the necessary improvements or modifications based on the test data obtained, then the pilot plant can become the optimal treatment facility at the time of completion of the project.

(2) Establishment of Organization for Operation and Analysis Works

The proposed organization structure for the operation and maintenance of the pilot plant (monitoring structure) is proposed in Chapter 4. The SATREPS team will operate the facility based on the organizational structure made by them. From now on, SATREPS team will establish the actual operation organization, and operate the facility. The team must well know the decision-making process in the organization and follow it. The chief advisor shall take the initiative, positively disseminate information how to operate. The team member at the site shall follow the instruction.

A minimum workforce of at least two persons at the site at all times is strongly advised in case of any emergency. Working alone at the site will be extremely dangerous. The chief advisor shall lead thoroughness of proper clothes, continuous implementation of KY activities.

Continuous operation of the facility is necessary for data collection because this pilot plant has biological treatment. When operation stops for a long period of time the pipeline may become easily clogged because the capacity of the facility is small, and both oil and solids are contained in the wastewater. A suitable operating schedule will be required to be established for daily operations.

In addition, analysis is indispensable for plant operation. This can be said of the wastewater treatment plant in general. The pilot plant is for continuing study. Thus changing any operational indicator without obtaining the relevant analytical results cannot be advised. Recommended analysis items and frequencies were already proposed to the SATREPS team. Based on this, the SATREPS team is requested to establish the necessary organizational parameters for analytical work as soon as possible.

(3) Preparation of Standard Operation Procedures

An instruction manual for each of the equipment and relevant operating manuals have been provided to the SATREPS team. However detailed operational procedures, such as,,for example, cleaning frequency of the strainers, the calibration frequency of the instrument, timer settings, withdrawing frequency of excess sludge etc., have not been shown. These parameters are empirically possible to be set by the operator based on long term operational results. The proper know-how for efficient operation can also be learnt through continuous operation. Standard Operating Procedures (SOP) describe such matters. Preparation of SOP by the SATREPS team is proposed in order that the work procedure be well known to the operators, who will then have the necessary knowhow which can then be continuously utilized.

(4) Cooperation with KPOM

This pilot plant can be operated with wastewater, waste steam and electricity provided by KPOM. The SATREPS team shall share information with KPOM closely know the operation schedule of the oil mill, and prepare the operating plan without having any adverse affects on the pilot plant. Materials for composting and carbonization need to be procured from outside the mill, and products of composting and carbonization need to be transferred to the outside. Obtaining prior approval from KPOM is necessary for such work. Operation of the pilot plant must not affect the mill operation, for if such a situation were to occur, the relationship with KPOM may be negatively affected.

The operator working at site, shall keep good relations with KPOM, and exchange information at all times. A responsible person (general site manager) shall always need to have a good grasp of the operating conditions at the site, and give appropriate instructions to the operator. A hot-line to the chief advisor should also be established for use in case of emergencies.