Chapter 3

Basic Design of the Model Integrated Facilities

3 BASIC DESIGN OF THE MODEL INTEGRATED FACILITIES

3.1 Preconditions for Design

3.1.1 Applicable Standard, Code and Regulation

The following Standards and Regulations are to be applied in designing the model facility as well as its operation.

- Philippine Society of Mechanical Engineering Code (PSME)
- Philippine Electrical Code
- National Structural Code of the Philippines
- National Plumbing Codes Handbook
- The Fire Code of the Philippines and Regulations
- Occupational Safety and Health Standard
- Japan Industrial Standard (JIS)
- American Standard of Mechanical Engineering (ASME)
- Equivalent International Standard and Code
- Building Code of the Lima Technology Center

3.1.2 Utilities

(1) Power Supply and Distribution System

Power supply for the model facility is available at 34.5 kV from the utility network within Lima Technology Center. For the connection to the network system, the facility is required to comply with the Philippine Electricity Act and the Local Regulations and/or those from National Power Corporation. Un-interruptible Power Supply (UPS) system is required for electricity distribution to instrumentation and control system. The lighting installation, the small power installation, the earthing system, and lightning protection system are also needed for the entire facility.

- 34.5/0.440 kV Transformer
- 34.5 kV Switchgear with all auxiliary devices
- 0.440 kV Switchgear with all auxiliary devices
- 0.440 kV Generator connection
- 34.5 kV Connection to public utility network
- UPS System
- Wiring works to each electric equipment
- Lighting and small power system
- Automatic power factor correction equipment

(2) Water Supply

Drinking water is provided by Lima Technology Center and distributed by natural gravity to the various consumers within the entire facility.

Though industrial water can also originally be provided by Lima Technology Center, the model facility will maximize the use of treated wastewater from PCT and thermal treatment facility as well as rainwater stored in reservoirs on site.

(3) Emergency Power Supply

An electrical generator will be installed in the case of emergency breakdown of power supply system. The generator will have an adequate capacity for the facility to avoid any mechanical as well as electrical failures.

3.1.3 Environmental Standards and Regulations

(1) Effluent standard

The facility must treat its wastewater in order to comply with the effluent standards set for the locators in the Lima Technology Center as shown in Table 3.1.1.

Table 3.1.1: Effluent Standards for Locators in Lima Technology Center

Parameters	Maximum Allowable Concentration
Color	100 PCU
Temperature °C (Maximum rise in °C receiving body of water)	3 °C
pH (range)	6.0~9.0
5 day 20°C Biochemical Oxygen Demand (BOD)	250mg/L
Chemical Oxygen Demand (COD)	500mg/L
Total Dissolved Solids (TDS)	1,000mg/L
Total Suspended Solids (SS)	250mg/L
Ammonia	48mg/L
Oil & Grease	5.0mg/L
Formaldehyde	1.0mg/L
PCB	0.003mg/L
Phenol	0.05mg/L
Surfactants (MBAS)	2.0mg/L
Aluminum	26mg/L
Arsenic	0.1mg/L
Borate (Boron)	100mg/L
Cadmium	0.02mg/L
Chromium (hexavalent)	0.05mg/L
Chromium (trivalent)	50mg/L
Copper	1.0mg/L
Cyanide	0.10mg/L
Lead	0.10mg/L
Manganese	10mg/L
Mercury	0.005mg/L
Nickel	1.0mg/L
Silver	5.0mg/L
Zinc	1.0mg/L

(2) Flue gas emission standard

The facility must treat its flue gas in order to comply with the flue gas emission standard shown in Table 3.1.2 and Table 3.1.3.

Table 3.1.2 Flue Gas Emission Standards

Item	Daily Average Values	Half Hourly Average Values
Particulates	10 mg/Nm^3	30 mg/N m^3
Gaseous and vaporous organic substances, expressed as total organic carbon	10 mg/N m^3	20 mg/N m^3
Hydrogen chloride (HCl)	10 mg/N m^3	60 mg/N m^3
Hydrogen fluoride (HF)	1 mg/N m^3	4 mg/N m^3
Sulfur dioxide (SO_2)	50 mg/ N m^3	200 mg/ N m^3
Nitrogen monoxide (NO) and Nitrogen dioxide (NO_2), exceed as nitrogen dioxide for incineration plants with a capacity exceeding 3 tones per hour	200 mg/N m^3	400 mg/N m^3
Nitrogen monoxide (NO) and nitrogen dioxide (NO_2), expressed as nitrogen dioxide for incineration plants with a capacity of 3 tones per hour or less	300 mg/N m^3	---
Ammonia	10 mg/N m^3	20 mg/N m^3

Table 3.1.3 Air Emission Standards for Metals, Dioxins and Furans

Item	Average Values
Cadmium and its compounds, expressed as cadmium (Cd)	Total 0.05mg/N m^3
Thallium and its compounds, expressed as thallium (Ti)	
Mercury and its compounds, expressed as mercury (Hg)	0.05mg/N m^3
Antimony and its compounds, expressed as antimony (Sb)	Total 0.5mg/N m^3
Arsenic and its compounds, expressed as arsenic (As)	
Lead and its compounds, expressed as lead (Pb)	
Chromium and its compounds, expressed as chromium (Cr)	
Cobalt and Its compounds, expressed as cobalt (Co)	
Copper and its compounds, expressed as copper (Cu)	
Manganese and its compounds, expressed as manganese (Mn)	
Nickel and its compounds, expressed as nickel (Ni)	
Vanadium and its compounds, expressed as vanadium (V)	
Tin and its compounds, expressed as tin (Sn)	
Dioxins and Furans	0.1 nano g/N m^3

(3) Control of Noise, Vibration and Offensive Odor

The level of noise has to be controlled in accordance with the Occupational Safety and Health Standard in the Philippines while vibration and offensive odor need to be maintained below the level that creates discomfort to the neighbors. The Study

established the noise levels within 100 meter from the point of generation area as shown in Table 3.1.4 below.

Table 3.1.4 Noise Control Standard

Category	Day Time (9:00-18:00)	Morning & Evening (5:00-9:00 and 18:00-22:00)	Night (22:00-5:00)
Light Industry	70 db	65 db	60 db
Heavy Industry	75 db	70 db	65 db

(4) Other Regulations

The model facility must comply with the Building Code specified by the LIMA Technology Center.

Although no regulation is provided regarding soil contamination in the Philippines, the model facility has to strictly control the leakage of hazardous substances of any forms into soil, groundwater, and other environmental media.

In addition, LIMA Technology Center regulated the setback, building coverage, building height, and so forth for all the locators as shown in below.

Table 3.1.5 Building Code in LIMA Technology Center

Building Coverage	70%
Building Story	Maximum 4 Stories
Building Height	Maximum 20m
Set Back	More than 15m away from the arterial road
	More than 12m away from the secondary road
	More than 10m away from the tertiary road
	More than 8m away from the adjacent land
	More than 10m away from the border of Industrial estate if applicable
Green Zone	More than 5m width from the arterial road
	More than 3m width from the secondary road
	More than 2m width from the tertiary road
Design of Fence	Specified by LIMA Technology Center
Fence Height	Maximum 2m

3.1.4 Emergency Measures

(1) Regulations and Codes Applied

As to emergency response measures, the model facility is required to comply with the Fire Code of The Philippines and Regulation, the Philippine Occupational Safety and Health Standard, OSHA code, and other relevant regulations and codes

(2) Fire Fighting System

1) Fire Alarm System

The fire alarm system is required to immediately communicate the occurrence of fire as well as its alert by relevant detection system to all over the facility by visual

as well as acoustic signals. Automatic fire/smoke detectors and manual fire alarms have to be installed throughout the entire facility. All the automatic fire/smoke detectors are designed to transmit the exact location of fire/smoke to the main control rooms of the facility and the likes. All the communication lines connecting these alarms and main control room have to be well protected from interruptions such as physical breakage, short circuit and being grounded.

2) Fire Extinguishing Methods

Different fire fighting devices have to be installed in the model facility so as to take proper measures responding to different fire sources and dangers depending on the location of fire as described below.

(A) Bulk Organic Solid Waste Storage

The concrete bunker storing bulks of solid waste needs to be properly protected from fire by extinguishers that can be remotely controlled via video-camera.

(B) Storage of Organic Waste Containers

The storage shall be a roofed building with louvered walls for natural ventilation. Remote-controlled water sprinklers have to be installed inside the storage.

(C) Drum Emptying/Feeding to Thermal Treatment Furnace

The empty drum storage area has to be equipped with the water sprinkler system that can be automatically as well as manually activated in the case of an emergency. Drum feeding operations at the thermal treatment facility has to be constantly monitored by TV cameras from the control room.

(D) Bulk Organic Liquid Waste Storage

The tank shall be divided by 1.0 m height of walls into sections of 3 storage tanks each, to prevent spreading and mixing of tank contents. Along each row of tanks in the tank area, stationary pipe systems will be installed for water cooling of the tanks by remote control from safe areas. In addition, water spraying nozzles have to be installed around the tanks as well as the feeding points of liquid wastes to the tanks.

(E) Electrical Installations

In the case of fire in areas with electrical switchboards and sensible electronic components water spraying cannot be used for fire extinction. Computer rooms, electrical control rooms and floors with cables installed below have to be equipped with the fire extinguishers making use of CO_2 or other equivalent media. All the above fire-extinguishing systems have to be designed to be automatically activated in response to the actuation of fire alarms while they can also be activated manually from the control rooms. Potable gas extinguishers may also be needed in the areas where the above extinguishing systems do not cover.

(F) Other Areas

The facility must have specially designated areas for keeping water for fire fighting. As for fire fighting in the building, fire hydrants, potable fire

extinguishers, booster lines, and other fire fighting equipment are properly installed so as to immediately respond to every possible fire incident.

3) Fire Fighting Equipment

All the fire fighting systems and relevant equipment installed in the model facility are constantly monitored from the control rooms. Considering that nobody may not be able to approach near the location of fire fighting systems or extinguishers due to smoke or toxic gases emitted by the fire, the following three types of fire fighting systems must be properly installed in the facility.

- Stationary, automatically activated extinguishers
- Stationary, manually activated extinguishers,
- Mobile fire extinguishers

4) Fire Hydrant

The firewater circuit pipeline has to be installed underground to connect firewater reservoir or tanks and fire hydrants installed at each building and treatment facility.

(3) Handling of Hazardous Waste

All toxic wastes have to be kept in the sealed drum containers prior to being weighed and fed into the kiln. The drum containers are directly fed through drum feeding facility.

In accordance with the Philippine Occupational Safety and Health Standard or other relevant regulations, eye-washing fountains are required for PCT and other Waste Handling facilities.

(4) Evacuation

When an emergency occurs, an evacuation order has to be immediately transmitted from the control room to the administration office as well as relevant facilities. Alarms must be immediately transmitted to the entire facility visually as well as acoustically so that everyone can easily recognize the situation. The instruction for evacuation has to immediately follow the alarms and properly inform the evacuation details through PA system. The alarms and the evacuation announcement should also be transmitted to the surrounding area.

3.1.5 HW Treatment Facilities in MIF and Their Design Treatment Capacities

MIF consists of the following 4 (four) types of HW treatment and disposal facilities:

- Physicochemical Treatment Facility (PCT)
- Solidification Treatment Facility
- Thermal Treatment Facility
- Controlled Landfill Facility

Design treatment capacity of each facility above is established as shown in below.

Table 3.1.6 Design Treatment Capacity of Each Treatment Facility in MIF

HW Treatment Facility	Design Capacity	Remark
PCT	10 tons/8hrs./day	250 days' operation per year
Solidification	20 tons/8hrs./day	300 days' operation per year PCT residues, fly ashes from thermal treatment and sludge are the main HWs to be treated.
Thermal Treatment	100 tons/24hrs./day	300 days' operation per year
Controlled Landfill	15,500 tons/year	Slag generated from thermal treatment process will be mainly disposed of.

The design thermal treatment capacity of 100 tons per day is determined in consideration of the projected treatment demand made in Chapter 2 as well as the scale economy of the facility. Treatment capacity of thermal treatment depends on the size of inlet as well as the capacity of kiln. The kiln applied in the thermal treatment facility is designed to treat HWs with the drum containers of 200-litter capacity. In fact, there is almost no difference in cost of this type of kiln if its treatment capacity ranges from 60 to 100 tons per day. Therefore, the Study selected the design treatment capacity of 100 tons per day. If it exceeds 100 tons per day, the cost will be totally different and its operation risk may increase. Through 300 days of operation, the thermal treatment facility can treat 30 thousand tons of HW annually, which can accept additional 3,000 tons of HW annually to the potential thermal treatment of 27,000 tons per year, which is estimated in Chapter 2.

The thermal treatment facility also accepts treated residual liquid of 4 tons per day from PCT facility for thermal decomposition by the secondary combustion chamber.

To meet the estimated potential PCT demand of 2,500 tons per year, its design treatment capacity is set at 10 tons per 8 hours operation daily. Although the annual operational day is set at 250 days, it can be increased if the demand is more than the amount estimated above. The daily operation hours can also be extended in response to possible increase of demand. By applying such flexible operation of PCT facility, MIF can minimize scale of PCT facility as well as its operation related risks.

As to Solidification facility, its design treatment capacity depends on the amount of ashes from thermal treatment facility, sludge from PCT, and direct acceptance of HW. Although the amount of ashes is determined by the ash content of each HW accepted, the Study made a rough estimation based on the actual records of similar facilities in Japan that 10% of HW input to thermal treatment would generate as ashes. Therefore, 10 tons of ashes are accepted daily by solidification facility. Concerning PCT sludge, the Study assumed that about 1 ton of sludge would be required for solidification to meet acceptance criteria for disposal by landfill in MIF. Finally, as mentioned in Section 2.3, about 2500 tons of HW per year (more or less 8 tons per day for 300 days operation per year) will be subject to solidification treatment before disposal by landfill in MIF.

Take all the above into account, the Study established the design treatment capacity of solidification facility at 20 tons per 8 hours daily operation.

Landfill capacity is determined in consideration of the amount of residues generated from MIF facilities (PCT, solidification, and thermal treatment) as well as the limitation of available areas for landfill in the project site. The Study estimated that composition of the amount of HW disposed by landfill in MIF would be as shown in below.

Table 3.1.7 Composition of the amount of HW disposed by landfill in MIF

Types of HW	Amount (tons/year)
Slag from thermal treatment	4,200
Sludge from PCT	600
Solidified inert waste	7,200
Inert Waste directly disposed by landfill	3,500
Total	15,500

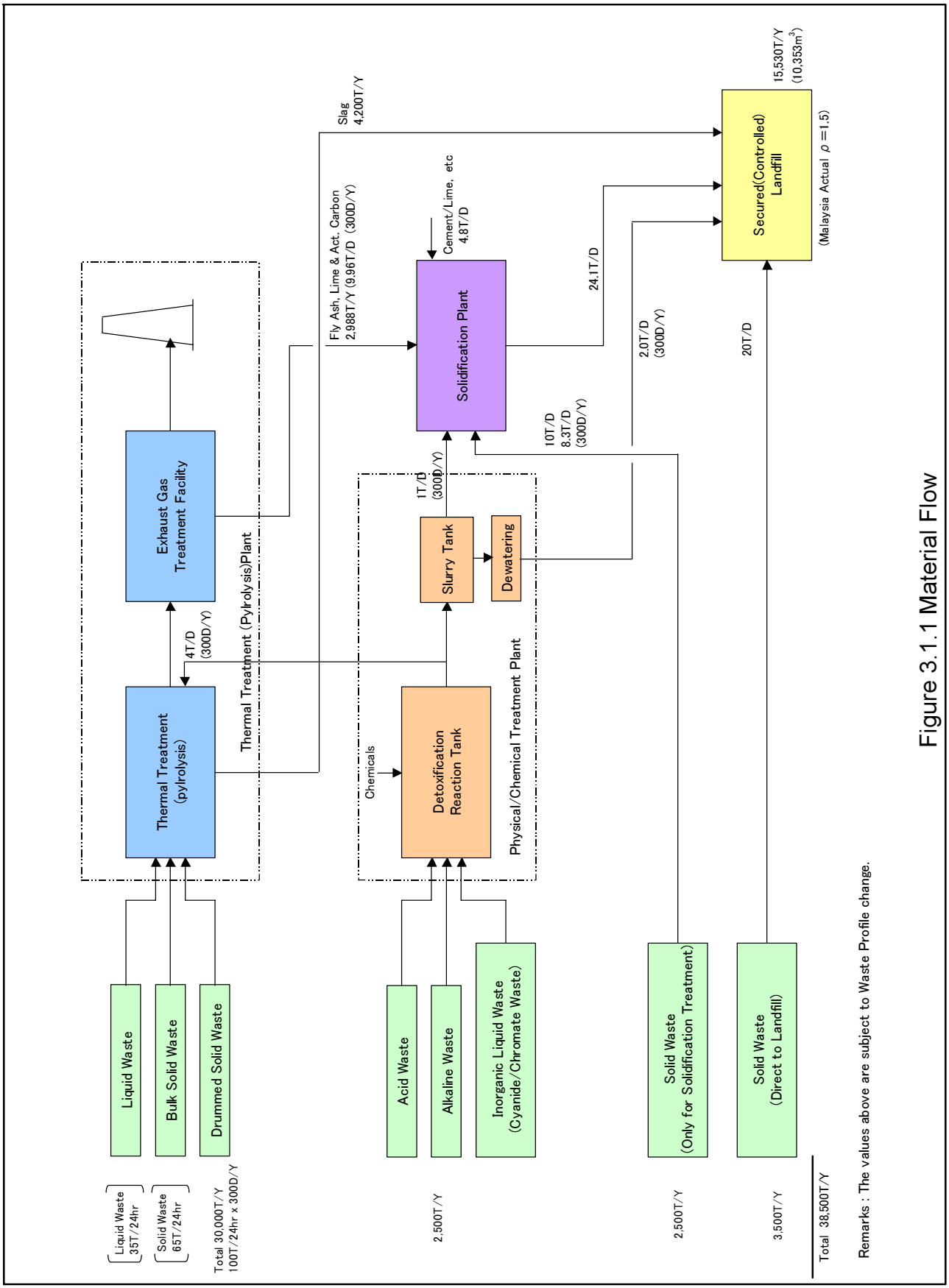


Figure 3.1.1 Material Flow

3.2 Physicochemical Treatment (PCT) Facility

3.2.1 Purpose of Physicochemical Treatment

To meet the requirement of the RA6969/DAO29, physicochemical treatment process is applied to detoxify some HW types that are acidic, alkaline, toxic, and/or reactive before its final disposal.

3.2.2 Design Treatment Capacity

Design capacity for the PCT facility is determined as follows:

Annual treatment amount: 2,500 tons/year

Daily treatment capacity: 10 ton per day (average daily operation of 8 hours)

If the demand will be more than the design capacity above, the facility will be able to cope with shortage of capacity by an extension of operating hours. There is also reserved area for installation of another PCT facility in the Project site.

The main types of HWs and their amount to be treated trough PCT facility are assumed as follows:

Table 3.2.1 Design Component of HWs to be Treated Through PCT Process

	Amount (t/year)	%
Plating wastes	250	10
Acid wastes	500	20
Alkali wastes	1625	65
Reactive chemical wastes	125	5
Total	2,500	100

Although alkali waste is suppose to be the largest amount treated by PCT, its main systems have to be designed to flexibly respond to the change in composition of the types of HWs accepted.

3.2.3 HWs to be treated

The HWs to be treated through PCT process include:

Alkali wastes containing low cyanide content,

Waste alkali (pH≥12.5), including caustic soda, caustic potash, and ammonium.

Waste acid (pH≤4), including sulfuric, hydrochloric, phosphoric, fluoric, and acids and acids containing chromium compounds.

Acid waste containing hexavalent chromium and other heavy metals,

Reactive chemical waste, including oxidizing agents, reducing agents, highly reactive chemicals.

The model facility can also accept waste acids of the pH4~7 and waste alkalis of the pH7~12.5. However, organic acid wastes, acetic acids, wastes, distillated liquid wastes, and organic alkali wastes containing amine compounds, should be thermally treated.

3.2.4 Treatment Process

(1) Necessary Treatment Process

The following treatment processes are required to remove or decompose toxic substances in HWs:

Cyanide waste shall be oxidized.

Hexavalent chromium shall be converted into the trivalent state and thereafter be precipitated.

Fluorides shall be precipitated.

Wastes containing heavy metals shall be reacted with lime or sulfide in the multipurpose reactor and precipitated. The precipitates shall then be dewatered by making use of filter press.

Wastes containing ammonium or other complexes shall be treated in such a way that the complexes are decomposed and the toxic elements detoxified.

Alkaline shall be neutralized (except cyanide).

Acid waste shall be neutralized after detoxification (except hexavalent chromium).

(2) Details of PCT Processes

The PCT in the model facility will consist of the following treatment processes.

The alkaline liquid wastes containing cyanide compounds shall be oxidized by hypochlorous acid and then neutralized by diluted sulfuric acid solution.

The liquid wastes containing hexavalent chromium shall be first treated by acid to adjust their pH, followed by reduction of hexavalent chromium by ferrous sulfide and finally neutralized by calcium hydroxide (slaked lime).

Other alkaline liquid wastes shall be neutralized by sulfuric acid or waste acid.

Acid wastes containing chrome shall be neutralized by caustic soda, calcium hydroxide (slaked lime), or alkaline liquid wastes.

Liquid wastes containing mercury or copper shall be precipitated as sulfide by adding sodium sulfide while the remaining liquid shall be neutralized.

Salts generated from PCT process shall be dewatered by filter press. The remaining solids (sludge) shall be disposed of at the landfill while the wastewater from dehydration shall be discharged to sewer after pH adjustment or reused for process water in thermal treatment.

Solids content in liquid wastes shall be coagulated and precipitated by making use of iron chloride or other coagulants, followed by solid-liquid separation through filter press or directly solidified.

Wastewater from PCT process shall be transferred to wastewater tank after pH adjustment and reused for cooling kilns.

Sludges containing heavy metals, e.g. chromium, mercury, etc. are subject to solidification treatment.

The wastes that are treated through the PCT are divided into the following 5 categories in accordance with the appropriate processes applied (see Figure 3.2.1). Then, separated sludge through the above processes are discharged directly at the landfill, or solidified before its final disposal. On the other hand, the wastewater from the PCT process goes to effluent treatment system after pH adjustment or thermal treatment process as the cooling water.

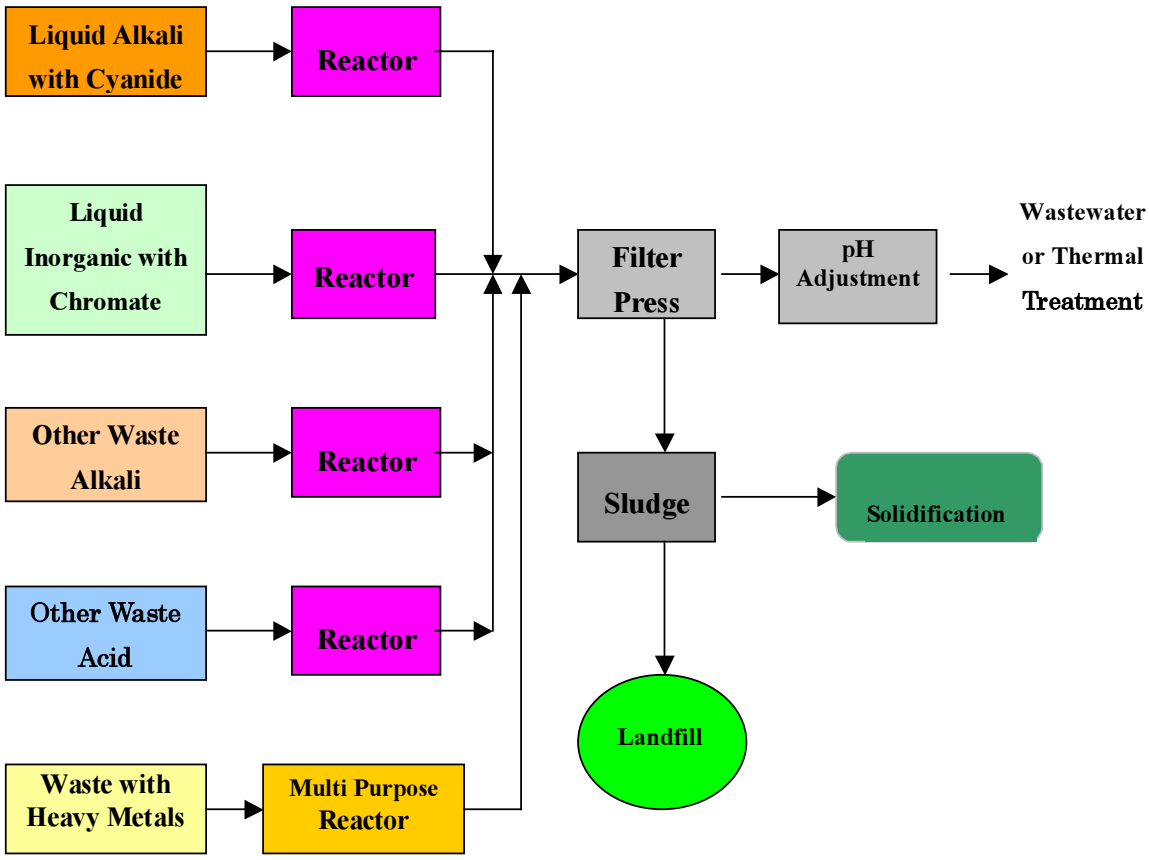


Figure 3.2.1 Physicochemical Treatment Process

PCT mainly consists of neutralization, reduction, oxidization, and precipitation processes. PCT technology also includes recovery of sulfuric acid by thermal decomposition, electrodialysis, ion exchange, recovery of acid by solvent extraction, collection of caustic soda or ammonia from alkaline waste, contact wet-type oxidation method, and so forth although most of these technologies are applied for treatment of particular types of acid or alkaline liquids.

In the case of the current model facility, the most widely applicable chemical treatment processes are selected in terms of technical applicability and economic efficiency. Neutralization is the most widely applicable process to treat acid and alkaline wastes. The reaction tanks for neutralization can be used for reduction, oxidation, and precipitation processes.

One batch operation of PCT in the reaction tank normally takes 3 to 5 hours depending on the concentration of chemical compounds in the wastes. When all reaction is completed, reacted solution and accumulated slurry (solids) are discharged out from the bottom of the tank. These solution and slurry materials (salts) are transferred to the filter press for liquid-solid separation, or directly solidified without such separation.

3.2.5 Chemical Reaction Processes

(1) Cyanide oxidation

Cyanide waste is decomposed through two stage oxidation processes. The first stage is adjusted into an alkaline environment (pH >11), and then it is converted to cyanate using sodium hypochlorite or chlorine gas. The oxidation process must be operated carefully to prevent generation of poisonous cyanide chlorine gas. In the second stage, the cyanide waste shall be controlled within pH 7~8 through dosing of sodium hypochlorite, then ionized hydrocyanic acid is separated into nitrogen and carbon dioxide gas. The following are chemical reaction processes.

First Stage: $CN^- + ClO^- + H_2O \longrightarrow CNCl + 2OH^-$

$CNCl + 2OH^- \longrightarrow CNO^- + Cl^- + H_2O$

Second Stage: $2CNO^- + 4\ OH^- - 6e \longrightarrow N_2 + 2HC_3 + H_2O$

The cyanide containing waste often contains relatively large amounts of organic substances such as those from degreasing process. The organic substances shall also be oxidized to the environmentally acceptable level by the process. Since chlorine gas is easily generated by an overdosing of oxidizing agents in the process, the generated chlorine gases must be removed by dosing of ferrous sulfate ($FeSO_4$) in order to perform a complete reaction. Process control is monitored by ORP Meter and pH Meter in the reactor. The reaction time is normally 10 to 15 minutes in the first stage, and 20 to 30 minutes in the second stage. Heavy metals are normally contained in wastewater through the process reaction. Therefore, the metals must be precipitated as hydroxide compounds and ~~be~~ removed as sludge.

(2) Reduction of Hexavalent Chromium

Hexavalent chromium is reduced to trivalent chromium by dosing of bisulfate ($NaHSO_3$) or ferrous sulfate ($FeSO_4$) and its pH is adjusted to 2 -3 within 10 ~ 15 minutes. The following shows the chemical reactions involved.

$2H_2Cr_2O_7 + 6\ NaHSO_3 + 3H_2SO_4 \longrightarrow 2Cr_2(SO4)_3 + Na_2SO_4 + 8H_2O$

$H_2Cr_2O_7 + 6FeSO_4 + 6H_2SO_4 \longrightarrow Cr_2(SO4)_3 + Fe_2(SO4)_3 + 7H_2O$

Controlling of the process is monitored by ORP Meter and pH Meter. It is critical to carefully control the correct dosing of chemicals, because overdosing will generate

sulfurous acid gases and inhibit the precipitation of chromium hydroxide ($Cr(OH)_3$). The pH must be increased by adding caustic soda or lime, which will precipitate hexavalent chromium as chromium hydroxide ($Cr(OH)_3$).

$$Cr_2(SO4)_3 + 3\ Ca(OH)_2 \rightarrow 2Cr(OH)_3 + 3CaSO_4$$

(3) Neutralization for Acid Waste (except hexavalent chromium contamination) and Waste Alkali (except cyanide contamination)

Delivered acid and alkaline wastes are usually difficult to treat by a wastewater treatment process at generators' plant. The acid waste will be waste nitric acids (HNO_3), phosphoric acids (H_3PO_4), hydrogen fluoride (HF) and other similar acids that are generated through chemical etching and/or polishing processes. These acids are neutralized by addition of slaked lime and the metallic ions are precipitated as metallic hydroxide compounds.

(4) Precipitation of Fluorine

Fluorine wastes are discharged through processes of surface finishing or solder plating. While fluorine is not a prescribed hazardous waste, it is recommended to remove it because of its toxic nature. Fluorine-containing wastes should be neutralized by addition of slaked lime or coagulant, which leads to the precipitation and easy separation of fluorine.

(5) Precipitation of Special Metals

Precipitation of metals mainly as metal hydroxides is a final process within the PCT. The pH level must be adjusted based on the combination of different types of ionized metals, of which hydroxides precipitate at different pH. However in an operation, the pH value should be generally controlled between 9.5 ~ 10.

Mercury, Lead, Arsenic and Selenium should be reacted with sodium sulfide (Na_2S) to precipitate these metals as sulfide compounds. It is required to carefully dose just enough quantity of sodium sulfide (Na_2S), because excess dosing will generate hydrogen sulfide gases. If overdosing occurs, it is possible to treat the excess sodium sulfide (Na_2S) with ferrous sulfate ($FeSO_4$). In addition, this process shall be operated under negative pressure to avoid a fugitive hydrogen sulfide gases (H_2S) while controlling optimum pH level.

(6) Residue Treatment after PCT

All sludges that are generated from neutralization of acid and alkali wastes through PCT process are normally dewatered and then usually directly discharged at a landfill site. However, if these sludges cannot satisfy the landfill acceptance criteria, these should first be solidified prior to discharge at a landfill site. The sludge is usually dehydrated to at least 40 % dry matter. Certain sludge types may be solidified without dehydration.

(7) Effluent Treatment

The pH of the effluent from the PCT facility is adjusted by neutralization in a collection tank, from which heavy metals and mercury are removed through the Chelation Process. The final effluent is transferred to a Contaminated Water Storage Tank or, if effluent standards are satisfied, discharged into the sewer system.

(8) Fume Gas Treatment System

The reactor tank is operated under slightly negative pressure by running a suction fan. Sucked fume gas is transferred into the alkali and acid scrubber for eliminating harmful substances and offensive odor.

3.2.6 Basic Design of PCT Facility

PCT facility consists of five major components, such as a reactor tank, a waste storage tank, a chemical storage tank, equipment, and a building.

(1) Reactor Tank

A. Cyanide Waste Reactor Tank

- Number of Unit: 1 units
- Capacity: 2 ton
- Size: 1200 ϕ x 1800 h mm
- Material: Steel + Hard Epoxy Coating
- Type of tank: Cone bottom with legs
- Pressure: none
- Agitator: top mounted mixer shall be installed
- Accessory: Manhole, Sight Glass, Temperature Gauge, Platform & Ladder

B. Chromium Compound Waste Reactor Tank

- Number of Unit: 1 units
- Capacity: 2 ton
- Size: 1200 ϕ x 1800 h mm
- Material: Stainless Steel or Steel + Rubber Lining
- Type of tank: Cone bottom with legs
- Pressure: none
- Agitator: top mounted mixer shall be installed
- Accessory: Manhole, Sight Glass, Temperature Gauge, Platform & Ladder

C. Alkali Waste Reactor Tank

- Number of Unit: 2 units
- Capacity: 5 ton
- Size: 1800 ϕ x 2400 h mm
- Material: Steel + Hard Epoxy Coating
- Type of tank: Cone bottom with legs
- Pressure: none
- Agitator: top mounted mixer shall be installed
- Accessory: Manhole, Sight Glass, Temperature Gauge, Platform & Ladder

D. Acid Waste Reactor Tank

- Number of Unit: 2 units
- Capacity: 5 ton
- Size: 1800 ϕ x 2400 h mm
- Material: Steel + Hard Epoxy Coating
- Type of tank: Cone bottom with legs
- Pressure: none
- Agitator: top mounted mixer shall be installed
- Accessory: Manhole, Sight Glass, Temperature Gauge, Platform & Ladder

E. Multi Purpose Reactor Tank

- Number of Unit: 1 unit
- Capacity: 5 ton
- Size: 1800 ϕ x 2400 h mm
- Material: Steel + Hard Epoxy Coating
- Type of tank: Cone bottom with legs
- Pressure: none
- Agitator: top mounted mixer shall be installed
- Accessory: Manhole, Sight Glass, Temperature Gauge, Platform & Ladder

(2) Waste Storage Tanks

Storage tanks for acid and alkali wastes should be capable of storing an inventory needed for average 5 ~ 6 days' operation of PCT. The other waste storage tanks should be capable of storing the other wastes with average 2 ~ 3 days' operation.

A. Alkali Waste Storage Tank

- Number of Unit: 1 units
- Capacity: 25 ton
- Size: 3000 ϕ x 3600 h mm
- Material: Steel + Hard Epoxy Coating
- Type of tank: Plane bottom
- Pressure: none
- Accessory: Manhole, Ladder

B. Acid Waste Storage Tank

- Number of Unit: 1 units
- Capacity: 25 ton
- Size: 3000 ϕ x 3600 h mm
- Material: Steel + Hard Epoxy Coating
- Type of tank: Plane bottom
- Pressure: none
- Accessory: Manhole, Ladder

C. Chromium Compound Waste Storage Tank

- Number of Unit: 1 units
- Capacity: 5 ton
- Size: 1800 ϕ x 2400 h mm
- Material: Stainless Steel
- Type of tank: Plane bottom
- Pressure: none
- Accessory: Manhole, Ladder

D. Cyanide Waste Storage Tank

- Number of Unit: 1 units
- Capacity: 5 ton
- Size: 1800 ϕ x 2400 h mm
- Material: Steel + Hard Epoxy Coating
- Type of tank: Plane bottom
- Pressure: none
- Accessory: Manhole, Ladder

E. Heavy Metal Waste Storage Tank

- Number of Unit: 1 units
- Capacity: 5 ton
- Size: 1800 ϕ x 2400 h mm
- Material: Steel + Hard Epoxy Coating
- Type of tank: Plane bottom
- Pressure: none
- Accessory: Manhole, Ladder

(3) Chemical Storage Tank

A. Type of Chemicals

The following chemicals will be stored in tanks.

- Quick Lime (CaO) storage tank (Silo)
- Sodium hypochlorite (NaOCl)
- Sulfuric Acid (H_2SO_4)
- Sodium sulfide (Na_2S~~$O4$~~)
- Ferric chloride ($FeCl_3$)
- Ferrous sulfate ($FeSO_4$)
- Sodium hydroxide (NaOH)
- Polymer coagulant

B. Number of Tanks: 8 Units

C. Capacity: 1 ton

D. Size of Tank: ϕ 800mm × H1000 mm

E. Material: FRP

(4) Equipment and Other System

The following equipment and systems are required with operating the PCT.

A. Waste analysis instrument:

- pH Meter with Recorder
- Clock ORP Meter
- Temperature Meter with Recorder
- Weight Scale
- Redox Meter
- Wall

B. Filterpress with Tray (Pan)

- Size: 20 m^2

C. Sludge Container (Steel Box)

- Size: 80 x 80 x 80 cm

D. Filtrate (Wastewater) Adjustment Pond

E. Waste Handling Equipment

- Hoist Crane: 3~5 ton
- Hand Pump

F. Eye washing Fountain and First Aid Box

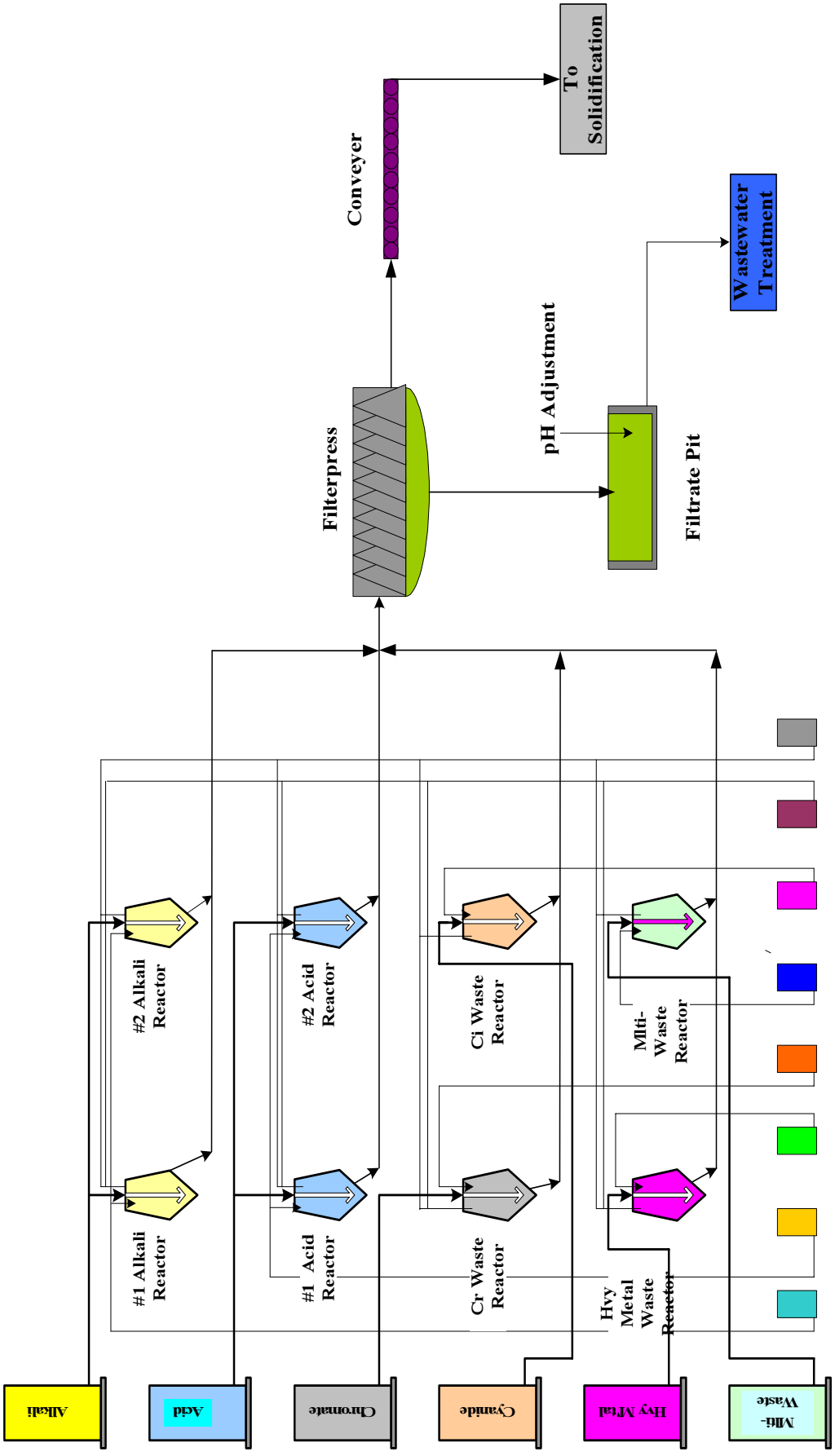


Figure 3.2.2 Flow of Physicochemical Treatment

3.3 Solidification Facility

3.3.1 Purpose of Solidification

Solidification treatment is carried out to prevent the contamination of soil with toxic substances leached from solid HWs, so as to makes the waste comply with the landfill acceptance criteria. The other objective of solidification treatment is to control the elution from the HWs.

3.3.2 Type of Waste to be treated

Typical categories of waste to be solidified are:

- Sludge contaminated with heavy metals
- Noncombustible and high viscosity sludge contaminated with heavy metals
- Metal hydroxide sludge from wastewater treatment system
- Oxide or sulfate from wastewater treatment facilities
- Residues from PCT (if contaminated with heavy metal)
- Fly ashes contaminated with heavy metals

3.3.3 Design Capacity of Solidification Facility

Design capacity of the Solidification should be 6,250 tons per year as estimated on the following Table 3.3.1.

Table 3.3.1 Design Capacity of Solidification Facility

Type of HW	Design Treatment Capacity	
Direct from Generator		
Alkali Waste, Metal containing Sludge	2,500 t/year	40.0 %
Residues of PCT	750 t/year	12.0 %
Fly ashes of Thermal Treatment	3,000 t/year	48.0 %
TOTAL	6,250 t/year	100.0%

3.3.4 Process of Solidification

TOC (Total Organic Carbon) is measured upon receiving the inorganic solid waste, and the waste whose TOC is less than 5 % can be treated by the solidification process. Waste containing heavy metals, such as Pb, Hg, Cr, and Zn, needs solidification in order to meet the landfill acceptance criteria.

These wastes are discharged to waste bunkers, where these are mixed with other similar wastes, then loaded into waste hopper before being transferred to a concrete mixer by screw conveyors. The wastes are carefully mixed with cements, limes and water in the concrete mixer. The most important factor in the concrete solidification is to determine the blending ratio of cement and wastes. Molding is not required in this process. The treated wastes are dumped into bucket containers, then discharged at landfill site.

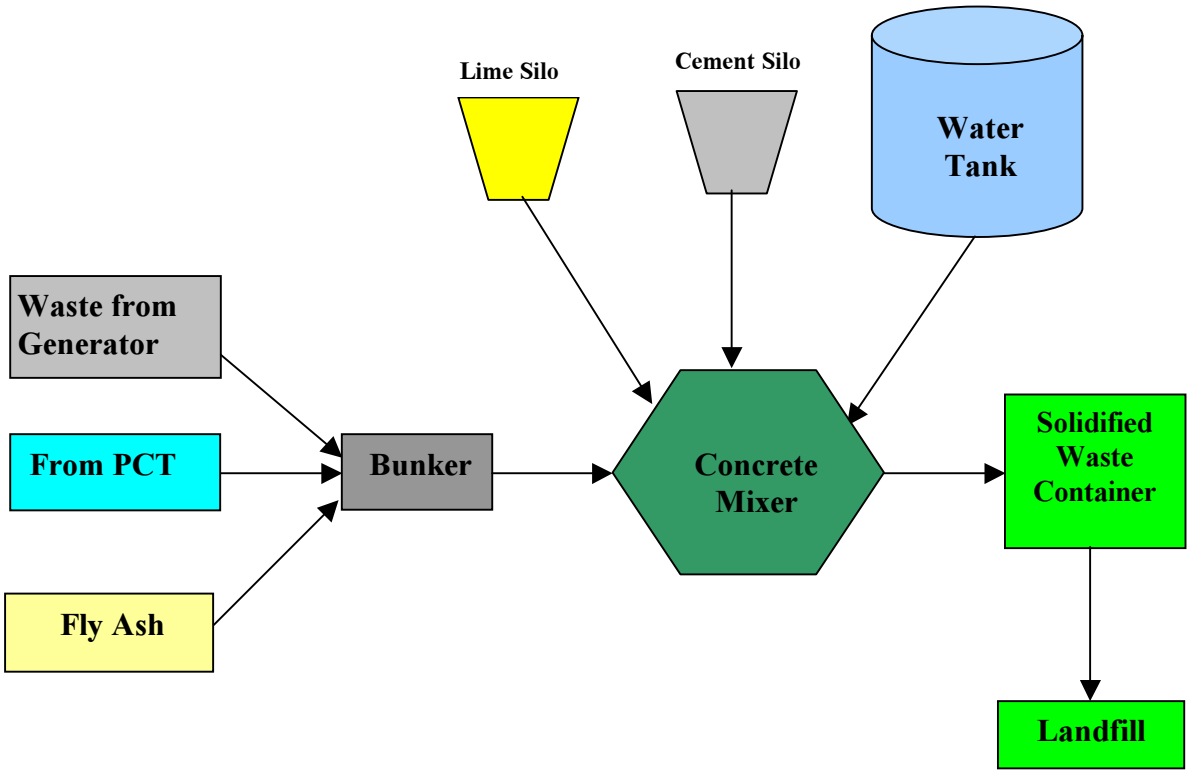


Figure 3.3.1 Solidification Process

3.3.5 Basic Design for Equipment and System

Stand-alone Roofed Structure

Measuring Instruments; pH Meter, Thermo Meter and Redox Meter

Cement Silo (36 ton) x 1

Lime Silo (12 ton) x 1

Water Tank (50 ton) x 1

Hoist Crane (5 ton) x 2

Screw Conveyer (5 meter) x 2

Solidification Pits (4 x 4 meter) x 1

Cement Mixing Equipment (5 ton Concrete Mixer) x 1

Treated Waste Container ($3m^3$ Steel Bucket) x 2

Waste Bunker (5 x 10 x 3 meter Concrete Bunker)

3.4 Thermal Treatment Facility

3.4.1 Purpose of Thermal Treatment

The purpose of thermal treatment is to reduce the pollution potential of targeted hazardous wastes by their conversion to the mineralized and stabilized form. According to RA6969/DAO92-29, the hazardous wastes shall be principally converted into an inert state, before it can be discharged at a landfill. Non-inert or unstable hazardous wastes cannot be discharged at a landfill site without proper treatment. Consequently, it is essential to convert such wastes into their mineral state through the thermal treatment.

The methods of mineralization for organic hazardous waste are: biological decomposition, carbonization, incineration, calcination (in cement kilns).

Biological decomposition, carbonization, and incineration are not suitable for inactivating non-recyclable organic hazardous wastes. Biological decomposition can be used for degrading organic wastes, but this method is only applicable to recycled waste oil whose organic contents are very low. Carbonization cannot decompose volatile toxic substances and incombustible substances in organic hazardous wastes due to its low process temperature; moreover, carbonized residues are not inert. Incineration of organic hazardous wastes in typical wastes incinerator results usually in the generation of ashes (waste residues) that are not inert.

Slagging by the thermal treatment or calcination by cement kilns are the only methods that can mineralize the nonrecyclable organic hazardous wastes.

3.4.2 Category of Hazardous Wastes and Design Capacity

Thermal treatment capacity is designed as 30,000 tons per year per estimate by this F/S Study. Type of hazardous wastes to be treated by thermal process will be determined the landfill acceptance criteria for organic wastes, which is less than 5% total organic carbon (TOC).

Following are the target hazardous wastes to be treated by the thermal process;

1. Liquid organic wastes (Spent Solvent, Organic Acids)
2. Solid organic wastes containing toxic materials (Organic Sludge, IC Waste)
3. Poisonous wastes (PCB, Insecticide)
4. Hi-Viscosity wastes (Oil sludge)
5. Infectious wastes
6. Special wastes (High Concentrated Cyanide Wastes, Cyanide Compounds, Laboratory Wastes, Highly Odorous Materials)
7. Waste oils

3.4.3 Selection of Thermal Treatment Process

(1) Types of Thermal Treatment

The primary considerations in selecting the type of thermal treatment process for organic wastes are: 1) the process can treat a variety of target wastes (whether in liquid or solid form, of high or low calorie), 2) the process can treat persistent organic materials, especially PCB, dioxins, and chlorinated solvents, and 3) the generated ashes and other residues shall be in an inert condition.

1) Applicable Types of Thermal Destruction Furnace

The following 4 types of thermal destruction furnace have been selected, all of which commonly satisfy the desirable treatment performance of transforming the target hazardous wastes into the inert state. These 4 types also comply with the flue gas emission standard provided by the Clean Air Act.

a. Rotary kiln incinerator

This furnace has the same construction as that of a cement rotary kiln. Incineration of the hazardous wastes occurs through combustion at 950℃. However, this furnace is not adequate to treat persistent PCB wastes.

b. Slagging rotary kiln

This type of furnace has almost the same construction as that of a cement rotary kiln, but the furnace temperature is higher at over 1200℃. The ashes are slagged and converted into inert state. Incompletely combusted gases generated in the rotary kiln are further combusted in the vortex-flow-type secondary combustion chamber (SCC) and then completely decomposed.

c. Shaft type melting furnace

This furnace is similar to a blast furnace that employs coke combusting oven at the bottom (coke bed). There is little or no experience in the use of this furnace for incinerating organic hazardous wastes. Moreover, it is difficult to control the furnace temperature according to the demands of fluctuating caloric values caused by various types of organic waste feed.

d. Rotary kiln type gasification and melting furnace (indirect heating)

This type of rotary kiln is fitted with an indirect heating mechanism and, as such, may be classified as "Non-burn Technology" under the Philippines' Clean Air Act. However, carbonized materials and incompletely combusted gases are later combusted or "burned" in a subsequent vortex-type-furnace thereby putting in doubt its designation as a "Non-burn technology". Same as with other furnace types, this furnace requires a final flue gas treatment system to comply with the emission standard. Also, it is difficult to control the furnace temperature according to the demands of fluctuating caloric values caused by various types of organic waste feed.

2) Evaluation Criteria

The preferred thermal treatment furnace should be selected using the following essential criteria.

a. Environmental compliance

The facility shall fully comply with the flue gas emission standard provided by the Clean Air Act (RA8749) and ambient quality standard provided by RA6969 and DAO 92-29.

b. Economic feasibility

The construction as well as operating costs of the facility shall be minimized. All technologies shall be economically feasible and do not require special expertise.

c. Technical acceptability

The process must be typically familiar, well engineered, capable to treat various types of organic waste, allow easy control of the furnace temperature as well as deliver stable thermal decomposition.

3) Evaluation results

Based on the above criteria, the slagging rotary kiln has been selected as the best suitable thermal treatment technology (see Table 3.4.1).

Table 3.4.1 Evaluation of Thermal HW Treatment Technologies

		Incineration Rotary Kiln (Burn Technology)	Slagging Rotary Kiln (Burn Technology)	Melting by Shaft Furnace (Cokes bed) (Burn Technology)	Rotary Kiln Type Gasification and Melting (Non-Burn Technology)
Environmental Criteria (Priority I)	Compliance with the emission standards	Possible by the installation of a flue gas treatment system	Possible by the installation of a flue gas treatment system	Possible by the installation of a flue gas treatment system	Possible by the installation of a flue gas treatment system
	Characteristics of syngas (generated during the treatment) and flue gas	A large emission of flue gas would entail a heavy burden of flue gas treatment costs.	Low concentration of toxics in the flue gas before its treatment; most of toxics are decomposed by high temperature in the kiln.	Unburned carbon may exist in the syngas, which is combusted in the secondary combustion chamber.	Unburned carbon may exist in the syngas, which is combusted in the secondary combustion chamber.
	Environmental soundness	A	A	A	A
Technical Criteria (Priority I)	Range of treatable HWs	・ Relatively wide range of treatable HWs ・ Difficult to decompose persistent organics due to low treatment temperature	・ Wide range of treatable HW ・ Drums and PCB contaminated soil can be treated.	・ Treatable HWs are limited. ・ Unsuitable for the treatment of organic solvents ・ Drums and PCB contaminated soil can be treated.	・ Treatable HWs are limited. ・ Unsuitable for the treatment of organic solvents and HWs in drums
	Response to load fluctuation	Flexible	Flexible	Inflexible	Inflexible
	Generation of unburned carbon that could form dioxins in the chamber / Capability to decompose persistent organics	Possible generation of unburned carbon	No generation of unburned carbon / Capable to decompose persistent organics (by high temperature in the rotary kiln and the secondary combustion chamber)	The emission of unburned carbon is prevented by combusting the generated gas in the circulation chamber.	The emission of unburned carbon is prevented by combusting the generated gas in the circulation chamber.
	Technical suitability	B	A	C	C
Economic Criteria (Priority II)	Construction costs	Furnace is inexpensive, but flue gas treatment facility is expensive due to a large amount of flue gas generation.	Total construction costs would be the same as those of the incineration rotary kiln.	Furnace is extremely expensive.	Furnace is extremely expensive.
	Actual construction costs in Japan	P. 6 to 13 million /t	P. 10 to 15 million /t	P. 16 to 20 million /t	P. 20 million /t
	Operation costs (estimates)	P. 3,000 to 4,000 /t excluding labor costs	P. 4,000 to 5,000 /t excluding labor costs	P. 6,000 /t excluding labor costs	No estimates due to a lack of necessary data
	Maintenance costs	Low	Medium	High	High
	Economic feasibility	**A**	**B**	**C**	**C**
Overall Evaluation		**B**	**A**	**D**	**D**

(2) Detailed Process of the Slagging Rotary Kiln

Wastes are discharged onto waste bunkers, where these are mixed with other wastes in order to obtain a uniform and constant caloric value compatible with the design specification of the furnace. Then, the mixed wastes are loaded into a waste hopper and transferred to a crusher before being led to the furnace inlet by screw conveyors, if required. The mixed wastes are shreded into appropriate size to promote complete decomposition. Alternatively, the system can also handle wastes contained in drum containers so long as the wastes combination results in the right level of calorific value.

Mixed wastes are intermittently loaded into the furnace and then decomposed. The generated gases and char are incinerated by the high temperature. The wastes are converted into slag in approximately 2 hours at the kiln chamber. The incompletely combusted gases flow into the secondary chamber (SCC) and combusted by the extremely high temperature. The flue gases are released from a stack after passing through the flue gas cleaning system in order to comply with the Emission Standard of the Clean Air Act.

3.4.4 Basic Design of Slagging Rotary Kiln Facility

(1) Process

The selected Slagging Rotary Kiln is the most applicable treatment furnace that is flexible enough to accept many types of wastes in various proportions as well as types of container. In addition, the treatment process is a quite common and well-known engineering technology especially in the cement industry. The design and engineering is quite practical and there is great confidence gained in its operation due to long term experiences in Europe, Japan and also in Malaysia.

1) Main construction

The slagging rotary kiln consists of a kiln reactor and a secondary combustion chamber. The kiln reactor is typically 10 or more meters long, inclined slightly from the horizontal (3~4% gradient) and is rotated at about 0.08 to 0.5 revolutions per minute. The kiln reactor is lined throughout with refractory bricks providing varying degrees of insulation to the steel shell. The refractory brick composition vary from around 25 to 35% alumina at the cooler back end, 45% alumina in the calcining zone and rising to 80%, or more alumina at the high heat zone. Heat transfer within the kiln reactor system results from a complex interchange between the gas, inner kiln reactor walls (refractory) and feed surface.

2) Thermal treatment process

The wastes are gasified in a low temperature zone of the kiln furnace, then the combustion gases and the fixed carbons are combusted at higher temperature emanating from the radiation of refractory materials in the calcination zone. Generated ashes are melted and converted into slag at high temperature (approximately 1200℃) in the high temperature zone. In order to control the temperature properly, the outlet gas temperature shall be maintained above 1200℃ by combusting of auxiliary fuels.

The non-combusted or incompletely combusted gases from the kiln furnace are transferred into the secondary combustion chamber (SCC), retained there for 2 or more minutes for complete combustion. The outlet temperature of SCC shall be controlled at approximately 950℃.

The slag is cooled down by spraying water at cooling chamber, then discharged ~~out~~ from the SCC.

3) Treatment of residues

Produced residues are slag that can be environmentally safely discharged at landfill without additional treatment.

4) Wastewater treatment system

Flue gas absorption using the wet type scrubber has great advantages. However, heavy metals in vapor state are condensed out of the flue gas stream by the temperature reduction induced in the wet scrubber and transferred to the scrubber water. The heavy metals other than those forming the flue gas are melted and then encapsulated in the slag in the slagging rotary kiln, and discharged out of the furnace in a stable condition that allows safe disposal at the landfill site.

The acid gases are neutralized by sodium hydroxide solution. Suspended solids and waste absorption solutions containing salts are transferred into a recovering pond for recycling, or, if effluent standards are met, directly discharged into sewerage.

If mercury or other toxic metals are present, it is necessary to remove these through a filtration process.

The sulfur dioxide can be removed by absorption through alkaline solution with a removal efficiency of up to 80%.

The wastewater treatment system is operated together with the scrubber; the treated wastewater may be reused as process water.

5) Flue gas treatment system

The dioxins, metallic oxides and generated acid gases (mostly HCl) shall be treated in compliance with the Clean Air Act. A flue gas cooling system is required to bring down the temperature of flue gases to below 200℃ to avoid forming dioxins. The following systems are typical cleaning set-up for cooled flue gases

a) Dry Type Absorber + Electric Dust Precipitator + Fabric Filter

b) Electric Dust Precipitator + Scrubber + (Scrubber)

c) Dry Type Absorber + Fabric Filter + (Scrubber)

In order to comply with the Emission Standard as described in Table 3.1.2 and Table 3.1.3, especially important items are HCl (10mg/Nm^3), HF (1mg/Nm^3), Dioxins and Furans (0.1ng/N m^3), and Heavy Metals. The method that can effectively and economically removes these chemicals is described above (3). An Electric Dust Precipitator is not being used at present to treat quick quenched low temperature flue gases due to low efficiency.

The set-up a) is possibly not capable of meeting with the emission standard of Hydrogen Chloride (HCl).

The set-up b) entails high operation costs due to a full operation of the scrubber.

The set-up c) can principally treat all items described on Table 3.1.2 and Table 3.1.3 because the toxic materials in the flue gas are absorbed by spraying of limes and activated carbons before a fabric filter system (Dry Absorber). However emissions of Hydrogen Chloride (HCl) will exceed the standard, if wastes including HCl shall be treated. Consequently a scrubber, that can optionally be operated when needed, shall be appropriate system for this purpose.

The following are the main equipment for the system selected by the study:

1. Induced Draught Fan (IDF)
2. Flue Gas Quick Cooling System
3. Lime and Activated Carbon Absorbing System
4. Fabric (Bag) Filter
5. Wet Scrubber
6. Funnel stack

6) Energy recovery system

Flue gases emitted from a hot furnace possess typically a high temperature of around 1000°C. If this energy is recovered and reused in steam form and/or converted into electricity, the operating cost of the facility will be offset and costs of the hazardous waste treatment can be reduced. Advantages of the energy recovery are:

1. To reduce the flue gas volume
2. To reduce the steam plume from the stack
3. To reduce the water-vapor concentration
4. To reduce the gas temperature
5. Better conditioning for particulate aids in their accumulation and removal
6. To feed downstream use of the boiler
7. Smaller pollution control system
8. Less operational cost
9. Revenue from sales of the energy, or savings from internal consumption

The most common energy recovery method is to generate the steam by a waste heat boiler, and then converted it into the electricity by a steam turbine generator. However the capacity of generated electricity will be not very large: approximately 400 Kwh at a treatment capacity of 100 ton per day. Thus, the steam energy will be normally used as the energy for driving an ID Fan. In the process, the temperature of the flue gas can be quickly cooled down to prevent generation of dioxins. A waste heat recovery boiler for this purpose shall be consequently

essential equipment in this plant. As a result, the steam is generated, and an installation of a steam turbine generator will be affordable process. With this facility, it will be possible to obtain a stable amount of the steam because of the high temperature operation of the furnace. In this regard, a steam turbine generator should be installed and the generated electricity may be utilized for the internal power consumptions.

In addition, an air heating system can also be installed wherein the generated steam can be used to heat-up the combustion air of the furnace.

The following are necessary equipment.

1. Waste heat boiler
2. Steam turbine power generator
3. Air heating system

(2) Main Composition of Process

The thermal treatment facility shall consist of the following system.

1. Waste bunkers and hopper
2. Waste shredder and feeding system
3. Waste handling and pumping system
4. Auxiliary fuel storage tank system
5. Slagging Rotary Kiln and Secondary Combustion Chamber
6. Slag discharge system
7. Air heater (heat recovery system)
8. Waste heat recovery boiler (steam)
9. Flue gas cooling system (quenching tower)
10. Dust collector (fiber filter)
11. Electric power generator system (with steam turbine)
12. Exhaust gas treatment system
13. Emission monitoring system
14. Induced draft fan system
15. Lime and activated carbon supply system with silo
16. Wet scrubber system
17. Wastewater treatment system, if required
18. Fly ash solidification system or transferring system
19. Funnel stack

(3) Design Concept for Main System

1) Waste Reception Facility, Bunker and Feeding System

(a) Easy unloading facility

- Solid and liquid waste as well as hi-viscosity shall be handled.
- Fire protection shall be installed.

(b) Segregation of wastes in waste bunkers

- Wastes shall be segregated depending on caloric value.
- Mixing space shall be required.

(c) Compliance with various type of waste containers

- Wet wastes shall be handled.
- Pumping and conveyer system can handle both dry and wet waste.
- Drum lifter, lid opener shall be installed.

(d) Safety Installations

- The electrical devices shall not ignite flammable and/or combustible wastes.

2) Rotary Kiln Type Furnace

(a) No or minimal pre-treatment

- Wet wastes shall be handled.
- Whole pieces of steel or plastic drums can be fed.
- Packed medical wastes can be treated as an option.

(b) Stable Continuous Operation

- Operation shall be stable in accommodating load fluctuation.
- Continuous operation is achieved.
- No clogging of slag shall ~~be~~ occur~~red~~ upon discharging.

(c) Easy Operation

- Easy operation/maintenance shall be provided.
- Easy start-up/shut-down and stable continuous operation shall be provided.

(d) Alternative Fuel

- Ignition and heat-up is operated by 20cSt oil under normal operations, however, waste oil or solvent, and/or high calorific plastics waste shall be utilized as alternative fuels.

(e) High Quality Molten Slag

- The slag shall be retained for sufficient time in the furnace, so that these are melted at the high temperature environment (1,250~1,350 ^{o}C) and becomes glassy molten slag, which prevents heavy metals from leaching.

(f) Safety Installations

- The electrical devices shall not ignite flammable and/or combustible wastes.

3) Secondary Combustion Chamber (SCC)

- Gas retention time shall be 2 seconds or more.
- Outlet temperature of the flue gas shall be kept at 950 ^{o}C or higher.
- Vortex flow shall be generated and sufficient turbulence shall be given to gas and air in order to achieve the best combustion with the Oxygen (O_2).
- As the result, a concentration of Carbon Monoxide Gas (CO) shall be kept approximately 100 mg/Nm^3.
- Oxygen concentration will be maintained at 6% or more to achieve sufficient combustion.
- The electrical devices shall not ignite flammable and/or combustible wastes.

4) Flue gas Cleaning Facility

- The emission of flue gas shall be fully comply with Standards of the Clean Air Act of Philippines.
- Particulate shall be removed by Fabric Filter or equivalent
- HCl shall be removed by Dry Type Absorber or equivalent
- SOx shall be removed by Dry Type Absorber or equivalent
- A Quick Quenching System for flue gases shall be installed to prevent generation of dioxins; the emission gases shall be appropriately controlled by Fabric Filter System.

5) Process Water & Wastewater Treatment

The facility shall employ a "Close Water System" wherein basically no wastewater will be discharged under a normal operation. The wastewater from PCT through the dehydration process, cooling tower and wet scrubber shall be recycled and utilized as the process water. However excess rainwater and/or recycled process water can be discharged into sewer lines within the facility, if these comply with the Effluent Standard of the Lima Technology Center.

(4) Technical Requirement for Main System

1) Waste Reception Facility, Bunker and Feeding System

The waste reception facility shall be required with easy unloading devices and safety construction, as well as low maintenance. The waste reception facility consists of waste unloading device, storage bunker, feeding system, drum lifter and lid opener and pumping system. All electrical devices shall be fitted with safety features. The waste reception area shall be provided with spill protection ditch and catch pit, and an appropriate fire fighting system.

Waste bunker: Concrete construction

Over head crane: crab type: 2 m^3 x 2.5 ton bucket (loading capacity)

Shredder: 650 dia. x 2-shaft type

Waste hopper: 8 m^3 (steel construction)

Waste feeding conveyer: Epron type x 500~5,000 t/h

Dram lifter: 250 kg (lifting capacity)

Liquid waste pumping system:

Hi-viscosity waste pumping system

2) Rotary Kiln

The rotary kiln shall be be designed with a diameter and length that promotes complete combustion of all the solid combustion residues. It shall be ensured that the process of combustion can be regulated within wide limits by

1. Modulating the combustion air flow rate
2. Varying the energy supplied through the proper waste mix (e.g. reduction of low-heating value solid material and instead increase of high-heating value liquid fuels)
3. Modulating the speed of rotation of the rotary kiln

Technical specification

* Design Capacity	: 100 ton per day
* Normal Operating Capacity	: 100 ton per day
* Operating Temperature	: Max. 1,350 °C
* Control Temperature	: 1,250 °C
* Residence Time for Solid Waste	: 20 ~ 120 min.
* Rotating	: 0.08 ~ 0.5 time per minute
* Dimension	: Dia. Apprx.3.7 m (inside refractory)
* Length	: Approx.12 m

Main Components

* Steel jacket with refractory brick work
* Support structure with support roller
* Drive with variable speed and emergency drive
* Sealing at secondary combustion chamber
* Sealing system at front wall

3) Secondary Combustion Chamber (SCC)

The SCC shall be designed vertically with gases flowing from bottom to top. The refractory lining of the SCC and the emergency relief vent shall be of such quality and thickness that can withstand, without suffering damage, continuous temperature of up to 1,300°C.

Technical Specification

* Max. Design Temp. of Exhaust Gas	: 1,100 °C
* Control Tem. of Exhaust Gas	: 900 ~ 1,100 °C
* Minimum Residence Time	: 2 or more sec.
* Max. Mean Effective Flow Velocity	: 6 m/sec.
* Min. Mean Effective Flow Velocity	: 2 m/sec.

Main Components

* Support structure, gas-tight steel jacket, refractory lining
* Insulation including cladding
* Port for rotary kiln, slag extraction, inspections, burners, lances, air supplies and camera
* Expansion joints at transfer point
* Refractory lined flue gas ducts to waste heat boiler
* Burner for auxiliary fuel oil
* Injection lance for energetic liquid waste
* Injection lance for aqueous liquid waste
* Refractory lined emergency relief vent with damper
* Injection nozzle for incineration of organic vapors

4) Waste Heat Recover Steam Boiler and Turbine Generator

A steam boiler shall recover the heat energy from the high temperature flue gases, then the waste heat shall be converted into the steam energy. The recovered steam is utilized for the steam turbine generator.

Main Component

* Steam Boiler: Max. 11,000 kg/h
* Water Purification System
* Feeding tank
* Feed pump
* Instrument & control
* Stem Turbine Generator: 400 KW
* Steam Condenser

Technical Specification

* Max. Inlet Temp.: 1,100°C
* Min. Outlet Temp.: 300°C, or under

5) Slag Removing System

The kiln residue handling system shall consist of a horizontal, water filled quenching trough and a steel belt conveyer which shall operate on a sloped section to elevated the drained residue to the discharge level. All highly stressed components shall be equipped with wear plates, which can be readily replaced. The drop-off level of the slag conveyer should be at approximately 2.5 meters depending upon the type and size of the slug containers. The steel drums can be easily discharged after the treatment. The following items are necessary components.

1. Steel belt conveyor slag extractor
2. Rail for removing the slag extractor
3. Removable metal casing around the slag extractor
4. Rupture panel below water level
5. Device for water supply and water level regulation in the quench system
6. Ducts for water vapor extraction

6) Quick Cooling System (Quenching Tower)

The high temperature flue gases shall be quickly cooled down through the Cooling Tower as possible to prevent generation of the Dioxin. The water for quenching process shall utilize recycled water such as the wastewater from PCT, Leachate Pond and other facilities as well as the rainwater. Excess used quenching water shall be recycled, and then utilized as quenching water.

The following items are necessary components.

1. Cooling Tower (Quenching Tower): Steel Vertical Cylindrical Tower
2. Cooling water supply pump
3. Atomizing air supply system
4. Flue gas supply system
5. Temperature monitoring system

Technical Specification: 300 to 170℃ of approximately 30,000 Nm^3 (normal flue gas flow)

7) Control and Instrumentation System

The control and instrumentation system shall be equipped with a state-of-the-art monitoring and control system that shall be centralized in the control room and divided into two systems: the analogue/digital loop controllers and operator work stations. The control system shall be utilized to implement the desired control functions for safe and efficient facility operation. The control and instrumentation are required with the following functions:

1. Waste pump status
2. Waste tank level
3. Rotary kiln outlet temp.
4. SCC outlet temp.
5. Pumpable waste feed rate/pressure
6. Solid waste feed rate
7. Auxiliary fuel feed rate/pressure
8. Rotary kiln pressure
9. Rotary kiln burner on/fail
10. SCC burner on/fail
11. Atomizing media pressure
12. Combustion air funs on/off status, low air pressure, air flow
13. Instrument air pressure
14. Rotary kiln speed
15. Ash conveyer on/off status
16. Process water pressure

17. SCC pressure
18. Inlet/Outlet Temp of waste heat recovery boiler
19. Inlet/Outlet Temp of quenching tower
20. Fabric filter press
21. Feeding rate of Lime and Activated Carbon
22. ID fan on/off status, failure, vibration, amp.
23. Stack CO high concentration, analyzer fail
24. Stack HCl high concentration
25. Stack SO_2 high concentration
26. Stack TOC high concentration
27. Stack gas flow rate
28. Stack gas opacity

8) Induced Draft Fun (IDF)

The flue gases shall be cooled down by two sets of I.D.Fans. The shaft of the impeller shall be mechanically stabilized by a set of double side bearing construction. The impeller shall be counterbalanced both statically and dynamically. Induced Draught Fan is consists of following items.

1. No.1 I.D.F.: 1,250 m^3/400 Aq at 170℃
2. No.2 I.D.F.: 1,100 m^3/250 Aq at 70℃
3. Radial fan
4. Expansion
5. Silencer
6. Electrical device
7. Safety devices

9) Lime Silo and Activated Carbon Silo Tanks

The silos, tanks and hoppers with heating devices (if necessary), level control, level switches and alarm levels (if necessary)

Silos and tanks with pressure/vacuum valves (if necessary) and exhaust air filters or exhaust air ducts

10) Fabric Filter System

A Fabric filter shall be capable to treat a normal flow with 30,000 Nm^3/h of the flue gases. The fabric materials shall be of durable construction and withstand the acid environment. The system shall allow easy operation as well as maintenance. The fabric filter consists of following items.

1. Type of Fabric Filter: Pulse reverse type (compartment)
2. Filter Area: 910 m^2
3. Filter housing with inlet/outlet duct sections including shut-off valves
4. Internal gas distribution system
5. Filter bags
6. Discharge devices
7. Automatic flushing system
8. Dust conveying system
9. Supporting structures
10. Safety devices and monitoring equipment
11. Dust level control system
12. Differential pressure monitor
13. Heating system for normal operation, during outage/start up
14. By-pass
15. Local panel
16. Lifting & special tools

11) Wet Scrubber System

The wet scrubber shall be installed for removing excessive HCl in compliance with the standard of CAA. The scrubber must be constructed of FRP to prevent corrosion caused by HCl solution. There shall be a self-supporting structure of FRP fitted with a base structure to serve as a static connection between the scrubber and the supporting foundation of reinforced concrete. Caustic soda solution shall be utilized to neutralize acid-water, then discharged. Dust and small particles within the flue gases also shall be removed by washing-down process in the scrubber.

The wet scrubber consists of following items.

1. Scrubbing tower with internal tray system
2. Caustic soda supply system
3. Circulation pumps
4. Effluent discharging system
5. Control and monitoring system

12) Wastewater Treatment System

Wastewater treatment system is required as an option to neutralize and treat the wastewater from the wet scrubber as well as other treatment systems, such as PCT and solidification, and leachate water. However the wastewater shall be transferred and stored in the Wastewater Tank, so that it can be fed into the SCC.

The effluent quality should fully comply with the Standards of Wastewater Treatment Facility of Lima Technology Center, if these will be discharged into the sewer system.

Construction of the wastewater treatment facility consistes reinforced concrete structure pond and scrape and particle collection devices. Sludge dewatering system shall be installed and the recovered sludge ~~is~~ treated through the solidification process.

13) Funnel Stack

The flue gas stack shall consist of 50-meter high steel stack with one insulated internal flue. The design and construction shall be in accordance with Philippine Standard or equivalent. The supporting structure of the stack shall be a self-supporting cylindrical structure of steel and also comprise a base structure, as a static connection between the stack and the supporting foundation of reinforced concrete.

3.5 Process Flow Diagram

The flow diagram for Slagging Rotary Kiln Type Thermal Treatment System is described in Fig.3.5.2.

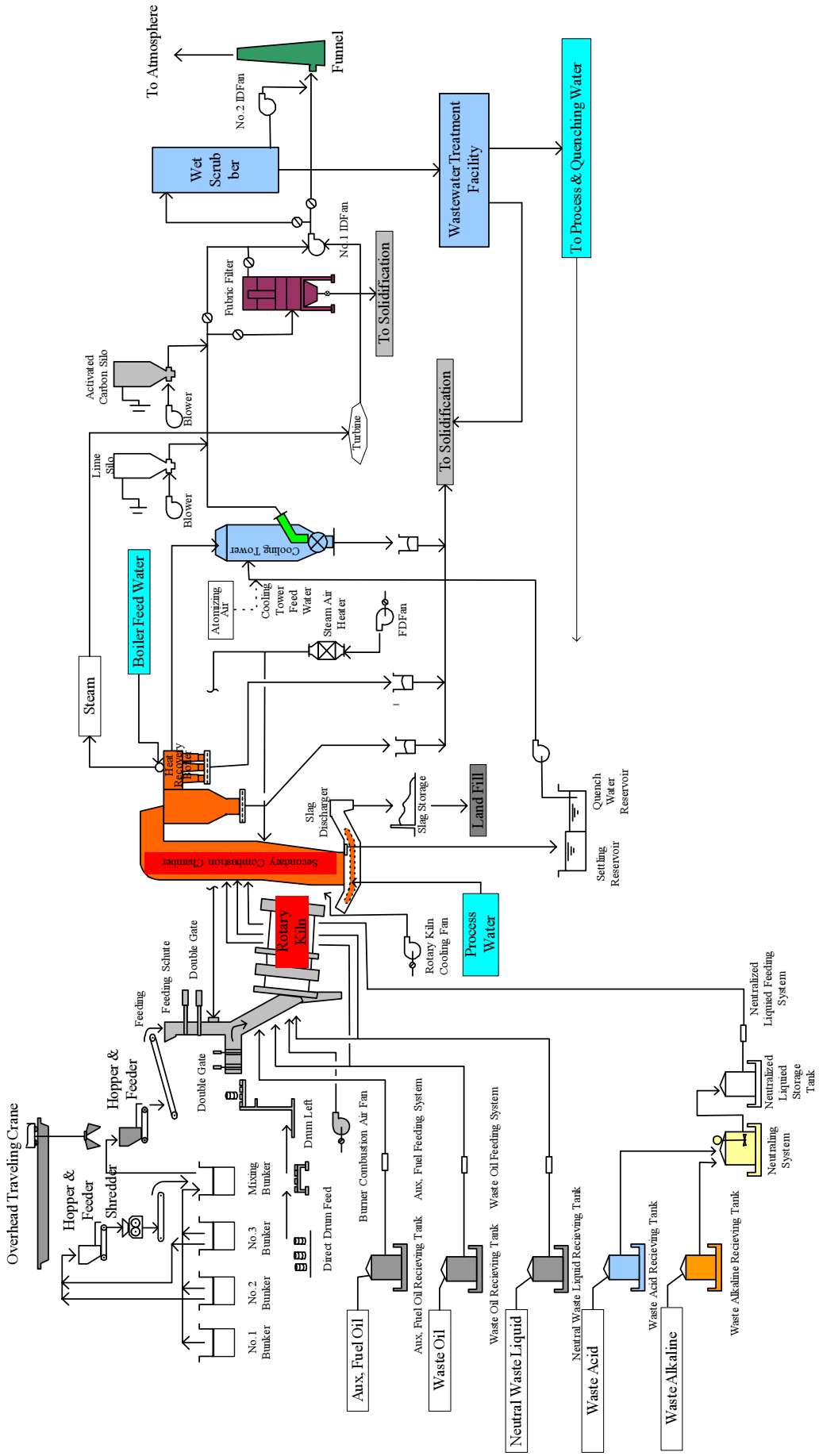


Figure 3.5.1 Process Flow of Thermal Treatment System (Slagging Rotary Kiln)

3.6 Utility Plan

3.6.1 Electrical Power Supply

(1) Design Standard and Code

Applicable design standard and code shall be the Philippine Electrical Code, or equivalent Japan Industrial Standard (JIS), and/or International Standard.

(2) Design Philosophy

The power supply for the facility shall be connected to the 34.5kV public utility network, which is provided by Lima Technology Center at the boundary of the facility. The general principal and philosophy are as follows.

Voltage	Level	
High Voltage	34.5 kV	60 Hz
Low Voltage	440/220 V	60 Hz

The design of high tension, 34.5 kV/440 V, transformers shall be carried out as a distributed system. The design criteria shall be to group the facility into units, each unit having its own transformer. Units with low power consumption can be connected to a transformer belonging to another unit.

Connection to the public utility network shall comply with the requirement of the most recent revision of the Philippine Electricity Act, or equivalent as well as the regulation of Local Power Supply Company.

Uninterrupted Power Supply (UPS) System shall be installed, as well as Instrumentation & Control Components such as operator work station, programmable logic controllers/programmable process controllers (PLC, PPC), valves, control actuators, etc.

Lighting installation, small power installation, earth system as well as lightning protection are essential equipment/devices for the entire facility.

(3) Cabling

For the dimensioning of the cable-cross-section, the current-carrying capacity for 40°C ambient air temperature on continuous operation shall be taken into consideration. For area close to the furnace or in the mechanical hall, cables are subjected to higher temperature and consideration shall be paid accordingly. Also the area exposed to direct sunlight requires adequate cablings.

(4) Supply and distribution system

- 34.5/0.440 kV Transformer
- 34.5 kV Switchgear with all auxiliary devices
- 0.440 kV Switchgear with all auxiliary devices
- 0.440 kV Generator connection
- 34.5 kV Connection to public utility network
- UPS System
- Cabling of electrical consumers and installations

- Lighting and small power system
- Automatic power factor correction equipment

(5) Technical Requirement

1) Transformer

Two winding, 3-phase oil immersed transformer for continuous running duty shall be installed in accordance with IEC 76, or equivalent standard.

2) Switchgear

The 34.5 kV switchgear shall be metal-enclosed design with fixed-mounted equipment and shall be designed in accordance with the following standard or equivalent JIS.

* IEC 298 Metal-enclosed switchgear

* IEC 265 General-purpose switches

* IEC 129 Disconnecters and earthing switches, and

* IEC 56 Circuit breakers

3) Cabling

For the dimensioning of the cable-cross-section, the current-carrying capacity for 40°C ambient air temperature on continuous operation shall be taken into consideration. For area close to the furnace or in the mechanical hall, cables are subjected to higher temperature and consideration shall be paid accordingly. Also for the area exposed to direct sunlight requires adequate cablings.

4) Lighting and Small Power System

Metal-clad sub-distributional units with fixed mounted equipment such as circuit breakers, contactors and relays for push button energizing, disenergizing of lighting circuits shall be installed. The lighting shall be generally controlled by push buttons.

5) Outdoor Lighting

For the outdoor lighting hot-dip galvanized steel columns with luminaries of 10 m height shall be installed. The lightings shall have automatic switches for daylight and nighttime controlling.

6) Emergency Lighting

One emergency lighting system shall be installed for the entire facility. This emergency lighting shall principally be installed for orientation and escape-way, and UPS shall be its power source.

7) Earthing and Lightning Protection

A complete earthing system for all installations, including electric machines, transformers, switchgears, pipes and cable trenches, steel structures, and all other installations shall be installed. The earthing installations shall be designed and constructed in accordance with the relevant IEC, or equivalent standard.

8) Emergency use Generator

One set of electric generator shall be installed that operate automatically in case of power failures. The generator shall have a necessary capacity to permit the facility to automatically shutdown.

3.7 Structural Plan

3.7.1 General Requirement

Construction of structures shall comply with the National Structural Code of the Philippines, or equivalent JIS.

3.7.2 Main Office Building

The Main Office Building shall be consolidated with Administration Office, Laboratory, Training and Function Room, Canteen and Workshop. However Administration and Laboratory, Training and Function Room area shall be segregated from Canteen and Workshop area and having independent entrances/exist in a compound building.

Table 3.7.1 Composition of Main Office Buiding

Space	Area (m^2)
Ground Floor	
Entrance & Lobby (6 x 6m)	36
Guest & Customers Room (6 x 12m)	72
Laboratory Office & Lab Facility (6 x 16m)	96
Canteen: (18 x 12m)	216
Workshop & Tool & Store Room (12 x 18m)	216
Technician Room (3 x 3m)	9
Men's Room with shower room & toilet (6 x 10m)	60
Men's Locker Room (6 x 6m)	36
Women's Room with locker room & toilet (4 x 10m)	40
Emergency & Doctors & Clinic Room (4 x 6M)	24
Ground Floor Total	805
2nd Floor	
Administration Office (12 x 12m)	144
Management Officers Room (6 x 12 m)	72
Meeting & Conference Room (4 x 12 m)	48
Training Room (6 x 12 m)	72
Men's Toilet Facility for Administration (4 x 4m)	16
Women's Toilet for Administration (4 x 6m)	24
Function Room	252
Extra Space for Future Use	144
2nd Floor Total	772
Others (Stairs, Corridors, Common & Utility Space, Etc.)	151
TOTAL AREA	**1,728**

1) Number of office personnel

* Administration: 6 persons

* Laboratory: 4 persons

* Professional: 3 persons

2) Building Structure

* 2 stories concrete construction

3) Total Area

* Main Office and Laboratory, Training and Function Room	:	792 m^2
* Canteen and Workshop	:	532m^2
* Utility & Other	:	404 m^2
* Total	:	1,728 m^2

3.7.3 Control Room

A control Room shall be constructed within the thermal treatment area and equipped with Data Processing and Communication, Computed Monitoring, Automatic Operation within a compound.

Number of operators	:Operator for Thermal Treatment: 3 operators
Building Structure	:Concrete construction built on the bunker pit
Total Area	:75m^2

3.7.4 Roofed Structure for PCT

(1) Building Structure

Single story open-air building with steel column and beam structure. Total floor area shall be non-penetration, or equivalent construction.

(2) Total Area

1,120m^2 (28 x 40 m)

3.7.5 Roofed Structure for Solidification

Building Structure	:	Single story open-air building with steel column and beam structure. Total floor area shall be non-penetration, or equivalent construction.
Total Area	:	608m^2 (16 x 38 m)

3.7.6 Waste Storage Facility

(1) Roofed Storage Facility

Building Structure	:	Single story open-air building with steel column and beam structure. Total floor area shall be non-penetration, or equivalent construction. Catch pit and trench for spilled waste shall be installed
Total Area	:	900m^2 (30 x 30 m)
Height	:	Max. 10 m

(2) Open Storage Facility

Construction	:	Open storage area shall be non-penetration, or equivalent construction. Catch pit and trench for spilled waste shall be installed
Total Area	:	2,700m^2 (30 x 90 m)

3.7.7 Ground Surface Finishing

Either reinforced concrete or asphalt finishing shall pave the following area. However the areas where are utilized for the waste storage, waste reception, waste feeding, PCT and fuel storage area shall be paved by non-penetration concrete, or equivalent construction.

1. Internal Access road
2. Waste Reception Area
3. Waste Feeding Area
4. Fuel Storage Area
5. Thermal Treatment Furnace Area
6. PCT Facility
7. Solidification Facility
8. Outdoor Waste Storage Area
9. Roofed Waste Storage Area
10. Tank Yard Area
11. Parking Area

However other open ground surface area shall be graveled or planted, or lawn covered.

3.8 Disposal Facility

3.8.1 Planned Disposal Volume

38,500 tons of hazardous waste are annually reduced to 15,530 tons of inert waste to be disposed through the solidification and thermal treatment process. The design disposal volume estimated is shown in Table 3.8.1. The apparent specific gravity of the disposed waste is assumed as 1.5 tons/m^3.

Table 3.8.1 Design Disposal Volume

Items	Unit	First 5 Years	Second 5 Years	Total
Daily amount	t/day (m^3/day)	52.1 (34.5)	52.1 (34.7)	52.1 (34.7)
Annual disposal volume	m^3/year	10,420	10,420	10,420
Top covering soil	m^3	4,050	4,050	8,100
Accumulated waste volume	m^3	52,100	52,100	104,200
Accumulated covering soil	m^3	4,050	4,050	8,100
Total disposal volume	m^3	56,150	56,150	112,300

3.8.2 Disposal Facilities

(1) Landfill area development

The gross area of the site is approximately 10 hectares. The disposal area is planned to be located at the southern part of the site, in an area that is almost 1/3 of the total usage area. The total area of the design disposal capacity is 112,300m^3, which will suffice for ten years of landfill operation. However, two landfill pits will be separately constructed in 2 phases so that the initial construction cost can be reduced by half.

The enclosure dike around the landfill pit is proposed to prevent the inflow of rainwater. In addition to this dike, a small embankment, called a “divider”, will divide the landfill pits into four zones to reduce the landfill working area in facing rainfall. By dividing the landfill pit into the four zones, leachate will be generated from only the active landfill area and rainwater will be collected from the other areas effectively. Accordingly, the storm-water drainage systems can be easily established so that the capacity of the leachate reservoir can be minimized because of reduction of leachate generation.

On the other hand, it is known that the liner is not durable, and may be easily damaged during construction and/or landfill operation. In addition to the above circumstances, the minimized active landfill area allows easier identification a leachate leaking area.

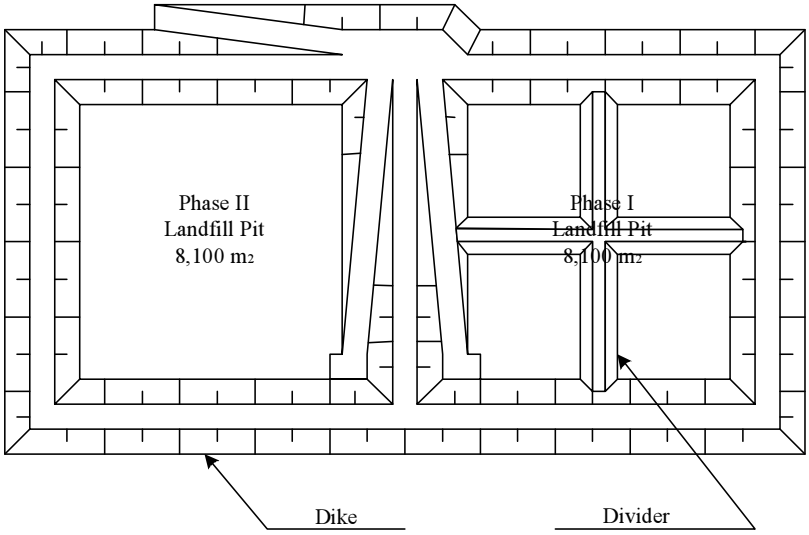


Figure 3.8.1 Plan of Disposal Facility

(2) Drainage system

Basically, a water circulation system, that utilizes the collected rainwater for cooling the thermal plant, etc., will be established on the MIF premises. However, the rainwater that falls on the bare ground will be directly discharged to the creek because it includes impurities damaging to the plant.

The inflow of storm-water to the active landfill area will be minimized as much as possible by the enclosure dike and the dividers. The storm-water from the surrounding areas will be collected by an open drain system to be placed along the outside of the enclosure dike. A drainage system in the landfill area is also designed to collect the storm-water and divert it to the creek.

(3) Leachate

Basically, the leachate generated in this landfill site will not be hazardous because only the inert landfill waste should be accepted. Furthermore, the waste will be covered with a plastic sheet daily in order to prevent rainwater from infiltrating into the waste and better control the generation of leachate.

However, the proposed disposal facility has been planned considering serious possible case scenarios such as an elution of toxic substances caused by acid rain

1) Leachate collection

A perforated reinforced concrete pipe placed on the liner made of HDPE plastic sheet will collect leachate. Leachate is filtered through the crushed stone enclosing the perforated RC pipe into the pipe. The geo textile and 50cm thick layer of sand covering the HDPE plastic sheet protect the liner from damage that may be caused by the landfill equipment.

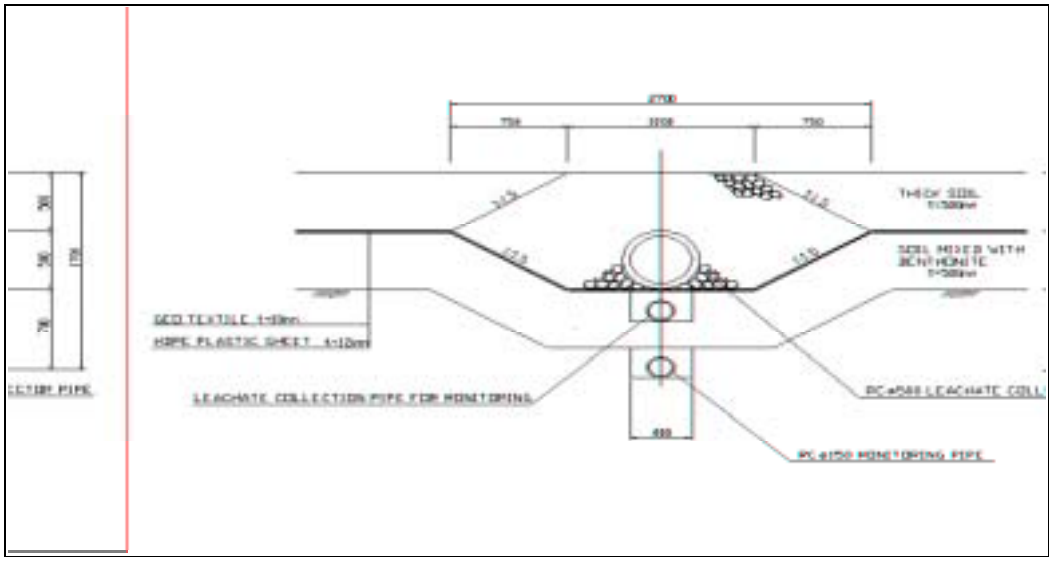


Figure 3.8.2 Cross Section of Leachate Collection Pipe

2) Liner

Double liners, consisting of an upper liner made of HDPE plastic sheet and a lower one made of clay mixed with bentonite as shown in the above figure, cover the bottom of the whole landfill area and leachate reservoir. This structure is one of the most reliable structures for preventing leachate leakage.

3) Leachate reservoir

The leachate will be collected at the reservoir planned at the northeastern part of the disposal facility and 100 m^3/day will be sent to the MIF plant. During maintenance of the plant, the wastewater collected will be sent to the wastewater treatment facility of the LIMA Technology Center.

If the monitoring shows that leachate contains heavy metal, it will be sent to the physical/chemical treatment process as a HW.

4) Measures to counter leakage of Leachate

To collect the leachate leaked, two kinds of collection systems are proposed under the HDPE liner and clay liner respectively as shown in the Figure 3.8.3. In case of damage to the liner during landfill operation, the geo textile to be placed between the HDPE and clay liner will collect the leachate leaked and it will be discharged to the monitoring manhole. If both liners are damaged, leachate leaked will be collected by the perforated pipe to be placed under the clay liner and discharged to another manhole. Leachate in these manholes will be monitored everyday by the landfill operator.

If a leakage of leachate is detected in the manhole, the liner in the active landfill area mentioned in close A will be repaired immediately.

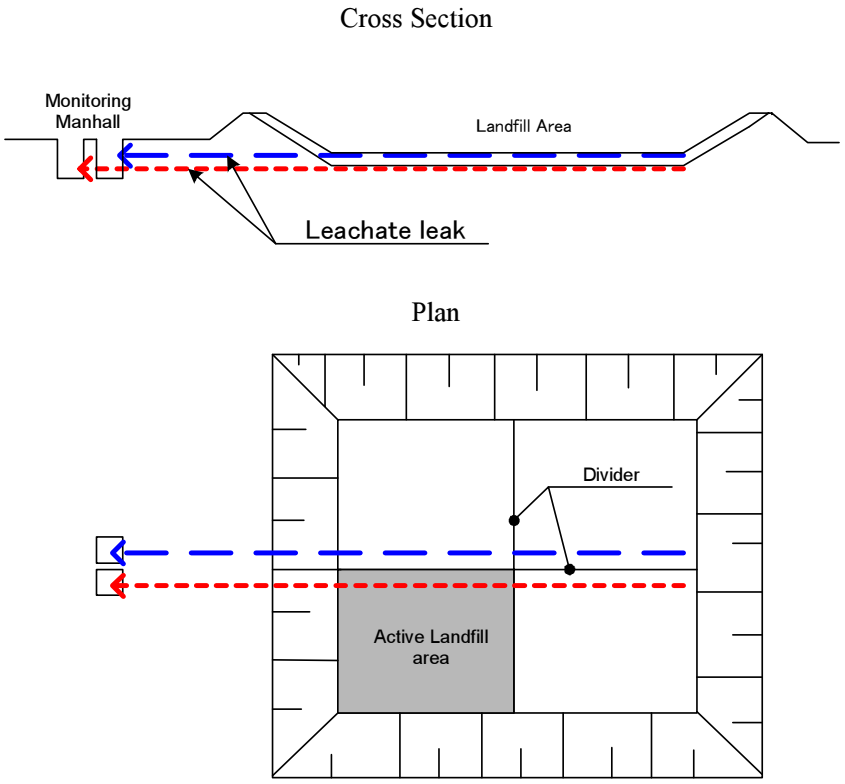


Figure 3.8.3 Monitoring System for Leakage of Leachate

3.9 Access road

An access road connecting the site to the expressway and/or national highway will be constructed by LIMA Land. Therefore, only the burden of the maintenance cost should be considered in the project.

The total distance from the site to the national highway is about 3.74km, in which the 1.39km section from the National Highway paved with concrete is already in-service. LIMA Land will construct the remaining 2.35km section with 25m of width in near future. The route of the access road and geometric design standards adopted are shown in Figure 3.9.1 and Table 3.9.1.

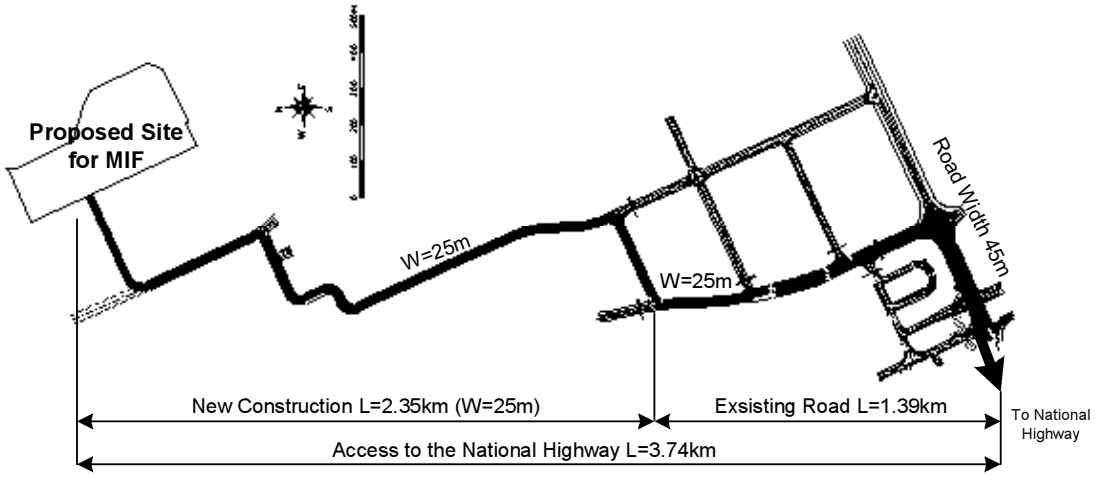


Figure 3.9.1 Horizontal Alignment of Access Road

Table 3.9.1 Typical Geometric Design Standard for Internal Road in LIMA Technology Center

Road Type	Expanded Secondary Road (w=45m)	Secondary Road (w=25m)	Tertiary Road (w=18m)
Design Speed	60km/hr	40km/hr	40km/hr
Desirable Minimum Horizontal Radius (no super elevation)	100m	45m	45m
Absolute Minimum Horizontal Radius (on C.L)	NA	NA	14m with curve widening
Min. Longitudinal Gradient	0.4%	0.4%	0.4%
Max. Longitudinal Gradient	6.0%	7.0%	8.0%
Desirable Min. Sag. VC Radius	600mR	260mR	260mR
Abs. Min. Crest VC Radius	550mR	150mR	150mR
Abs. Min. Sag VC Radius	300mR	150mR	150mR

3.10 Equipment

3.10.1 Waste Handling Vehicle and Equipment

(1) Waste Reception Facility

- Fork Lift: 1 ton x 1 unit
- Fork Lift with Drum Lifting Device: 1 ton x 1 unit

(2) Waste Storage Facility

- Fork Lift x 2 tons x 1 unit

(3) Thermal Treatment Facility

- Back Hopper Loader: 1 ton x 1 unit

- Slug Transport Truck: 4 ton dump truck x 1 unit

(4) PCT Facility

- Hoist Crane: 2 tons x 2 units
- Treated Solid Traveling Truck: 4 ton pick up truck

(5) Solidification Facility

- Hoist Crane: 2 tons x 2 units
- Solidified Waste Traveling Truck: utilize the PCT truck

(6) Others

- Emergency Vehicle

3.10.2 Waste Reception and Measurement

A pit type truck scale (weighing capacity: 60 tons, 3.0m×15m) is installed for measuring the amount of waste brought into the landfill. The automatically recorded weight data of waste will be sent to the data management system to be established in the main office.

3.10.3 Landfill Equipment

The required equipment for landfill work is presented in Table 3.10.1. The wheel loader is for loading waste onto the dump truck. The bulldozer will be used for the compaction and leveling of the disposed waste.

As the Back-hoe will not be used so frequently, the project will secure this equipment on lease.

Table 3.10.1 Landfill Equipment

Items	Specification	Quantity	Remark
Wheel Loader	1.2m^3	1	Procured
Back-hoe	0.7 m^3	1	Lease
Bulldozer	3.5ton	1	Procured
Dump truck	4ton	1	procured

3.11 Analytical Equipment

3.11.1 Monitoring Items

The items to be looked at both intermediate treatments facilities and disposal sites for industrial wastes are as follows;

(1) Storage site

Offensive odor, leachate, possibility of igniting fire, etc. Special attention should be paid to presence of offensive odor which is common in waste storage site.

(2) Intermediate treatment facilities

- Incineration: atmospheric pollution, deterioration of bricks.
- Waste water treatment: content of effluent-heavy metal, coloration, oxidizing-reducing agents.

(3) Landfill disposal site

- Elution of toxic substances
- Offensive odor
- Leachate control

(4) Management items

1) Storage

(a) Organic (solid)
- Composition of waste after grinding, calorie, etc

(b) Organic (containing sludge, oil)
- Composition, moisture, calorie, and types of oil, etc

(c) Organic (waste fluid)
- Composition, concentration, Na, K

(d) Landfilled wastes (inorganic)
- Analysis of landfilled materials, elution test

(e) Inorganic (waste fluid)
- pH value, concentration of heavy metal, etc.

2) Intermediate treatment

(a) Thermal treatment
- Exhaust fumes: atmospheric diffusion gas,
- Offensive odor
- Elution test: heavy metal ash

(b) Waste water treatment
- Analysis of treated wastewater, the monitoring by pH, ORP, color, smell, etc

3) Landfill site

(a) Perform elution test (periodically)

(b) Measurement of malodorous gas

(c) Leachate
- Quantity and component of leachate if present

(d) Final effluent
- Analysis for the volume, toxic substances, and chlorine content

(e) Analysis of ground water from an observation well for toxicity.

(f) Prepare equipment for measuring pH value and electric conductivity.

(g) Wastes are classified into two groups as

- Routine (waste usually carried in)
- Spot wastes

The routine waste can be monitored easily since the composition of the waste stays fairly alike. For reducing the analytical cost, appropriate management of manifest systems is essential.

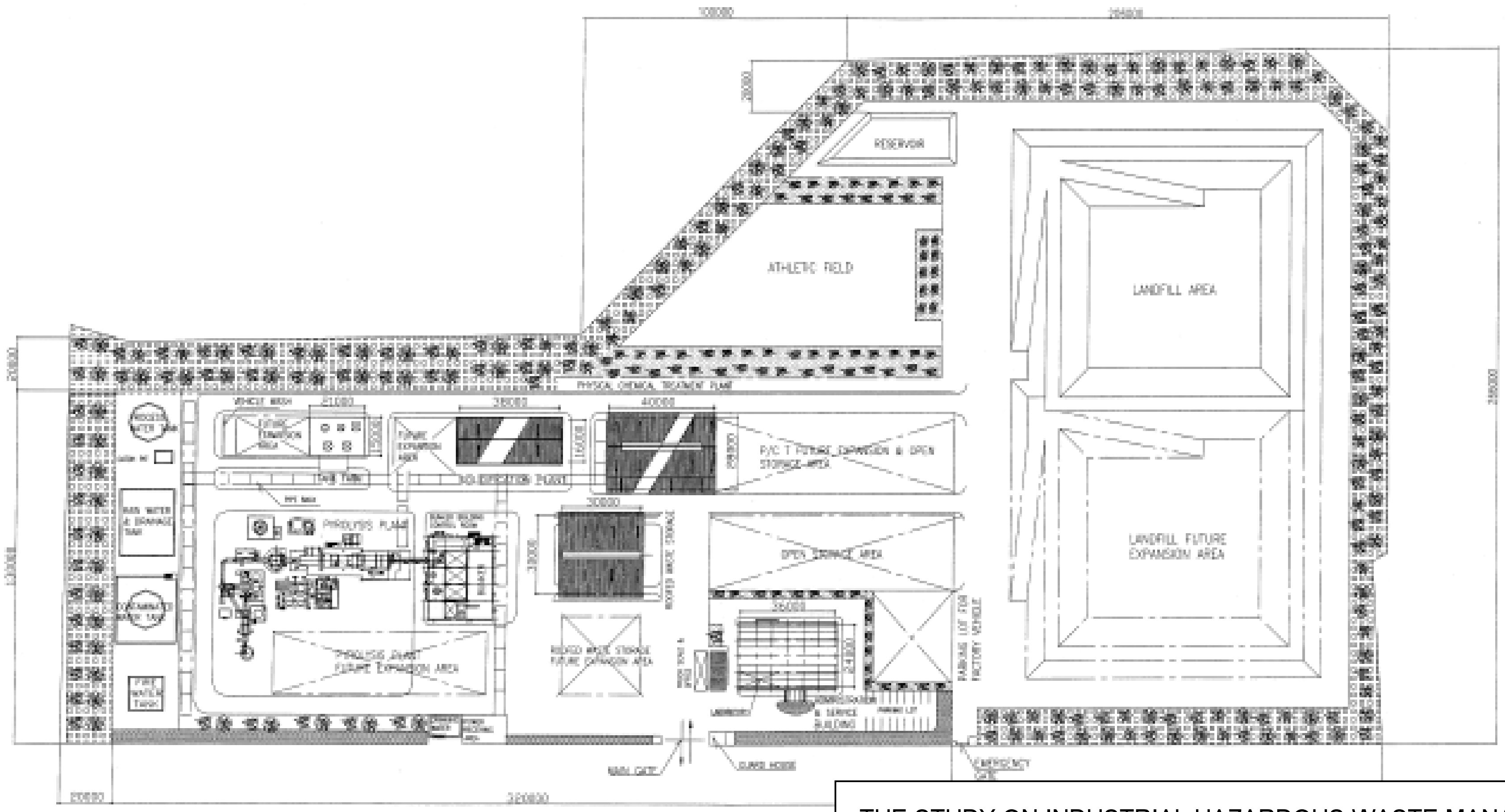
3.11.2 Required Laboratory Equipment

The following Table 3.11.1 shows required laboratory equipment for the facility.

Table 3.11.1 Required Laboratory Equipment

No	Item	Quantity	Remarks
*	For analysis of inorganics		
1	Atomic Absorbtion Spectrometer	1	
2	Automatic mercury analysis	1	
3	Ion chromatograph	1	
4	pH meter （for ion selective electrode）	3	
5	ORP meter	1	
6	Precision scale	1	
7	Deionizer （distillation＋Resin）	1	
8	Ion electrode （CN、F、Nh_3、etc）	10	
*	For analysis of organics		
1	Gas chromatograph (GC)	1	
2	GC- MS	1	
3	Total organic carbon analyzer	1	
4	Gas detector tube	10	
5	Flashing point tester	1	
6	Calorimeter	1	
7	Oil content meter	1	
*	For analysis of solid matter		
1	Refrigeration crushing instrument	1	plastic, etc
2	Muffle kiln （Max：1,100°C）	1	
3	Jar tester （quintuple）	1	for elution test
*	Miscellaneous facilities and appliances		
1	Screen	1	
2	Standard for analysis	20	
3	Water bath	1	
4	Hot plate （with mixture）	1	
5	Vacuum pump	2	
6	Stirrer	3	
7	Distillation equipment （glasses）	2	for CN、F、As
8	Laboratory-table	5	one at the center, four on the side
9	Draft	3	
10	Shelf for medicines	2	
11	Sink	3	
12	Set of chemical analysis equipment (glass beaker, cylinder, etc)		

3.12 Layout Plan



THE STUDY ON INDUSTRIAL HAZARDOUS WASTE MANAGEMENT
IN THE REPUBLIC OF THE PHILIPPINES (PHASE 2)

EX CORPORATION, KOKUSAI KOGYO CO., LTD

Figure 3.12.1 Layout Plan of the Industrial Hazardous Waste Treatment Facility

3.13 Cost Estimates

3.13.1 Technical Specification

(1) Treatment Capacity

Facility	Capacity per day	Annual Capacity
Thermal Treatment	100 ton / (24 hours)	30,000 ton / (300 days)
PCT	10 ton / (8 hours)	2,500 ton / (250 days)
Solidification: Waste	10 ton / (8 hours)	2,500 ton / (250 days)
* From PCT	3 ton / (8 hours)	750 ton / (250 day)
* Fly Ash	10 ton / (24 hours)	3,000 ton/ (300 day)

(2) Rotary Kiln

Technical Description	Specification
Design Capacity	100 ton per day
Normal Operating Capacity	100 ton per day
Operating Temperature (Outlet)	Max. 1,350 °C
Control Temperature (Outlet)	1,250 °C
Residence Time for Solid Waste	20 ~ 120 min.
Rotating Speed	0.08 ~ 0.5 time per min.
Dimension	Dia.: Apprx.3.7 m (inside refractory) Length: Approx.12 m

(3) Secondary Combustion Chamber (SCC)

Technical Description	Specification
Design Temp.(Flue gas)	Max.1,100 °C
Average Control Temperature (Flue gas)	900 ~ 1,000 °C
Minimum Residence Time	2 or more sec.
Max. Mean Effective Flow Velocity	6 m/sec.
Min. Mean Effective Flow Velocity	2 m/sec.
Flue Gas Capacity: Kiln Outlet	22,000 Nm^3/h (Normal)
Generated Gas + Secondary Air Capacity	8,000 Nm^3/h (Normal)
Normal Flue Gas Capacity	30,000 Nm^3/h

(4) Waste Heat Recover Boiler

Technical Description	Specification
Inlet Temperature	Max. 1,100 °C
Outlet Temperature	300 °C, or under
Normal Flue Gas Capacity	30,000 Nm^3/h

(5) Steam Turbine Generator

Technical Description	Specification
Turbine Type	Back pressure turbine
Normal Output	400 KW
Normal Steam Capacity	7,290 Kg/h

(6) Flue Gas Cooling Tower

Technical Description	Specification
Normal Inlet Temp	300 °C
Normal Outlet Temp	170 °C, or under
Flue Gas Flow (Normal)	30,000 Nm^3/h

(7) Fabric Filter

Technical Description	Specification
Type	Pulse reverse type bag filter
Treatment Capacity (Normal)	30,000 Nm^3/h
Filter Area	910 m^2
Dioxin Inlet	2~3 ng/Nm^3
Dioxin Outlet	0.1 ng/Nm^3

(8) Wet Scrubber

Technical Description	Specification
Construction	Standalone, Steel + FRP
Naturalization Process	Washing by Caustic Soda Solution
HCl: Inlet (Normal)	50 ppm
HCl: Outlet	Less 10 than ppm

(9) Funnel Stack

Technical Description	Specification
Structure	Steel Reinforced Concrete Foundation and Steel Support Structure
Height	50m
Flue Gas temp	70~80°C (after wet scrubber)

(10) PCT Reactor Tank

Technical Description	Specification
Material (other than Chromium)	Steel + Epoxy Coating
Material (for Chromium Waste)	Stainless Steel
Capacity	5 ton

(11) Liquid Waste Storage Tank

Technical Description	Specification
Material	Steel
Capacity	10 ton

(12) Chemical Tank

Technical Description	Specification
Material	FRP
Capacity	1 ton

(13) Concrete Mixer for Solidification

Technical Description	Specification
Material	Steel Fabrication
Capacity	5 ton

(14) Roofed Structure

Technical Description	Specification
Waste Storage Area	900 m^2 (3o x 30 m)
PCT Area	1,120 m^2 (28 x 40 m)
Solidification Area	608 m^2 (16 x 38 m)
Construction	Single Story Steel beam and Column

(15) Main Building

Technical Description	Specification
Building Structure	2 Stories Concrete Construction
Office & Lab Area	792 m^2
Canteen and Workshop Area	532m^2
* Utility & Other	404 m^2
Total Area	1,728 m^2

(16) Control Room

Technical Description	Specification
Building Structure	Single Concrete Construction on the Bunker Pit
Total Area	75m^2

(17) Disposal Facility (Landfill)

Work Items		Specification	Unit	Phase1	Phase2	Total
1 EARTH WORK						
1.1	Clearing & Grubbing		sq.m	100,000	13,000	113,000
1.2	Cutting (A)	Soil (handling L<300m)	cu.m	160,000	30,000	190,000
1.3	Filling (A)	Soil (handling L<300m)	cu.m	130,000	25,000	155,000
1.4	Disposal of excess	Soil (handling L=500m)	cu.m	30,000	5,000	35,000
2 SLOPE PROTECTION						
2.1	Filling slope	Turfing	sq.m	7,000	5,000	12,000
3 PAVEMENT WORK						
3.1	Concrete pavement	reinforced concrete t=15cm	sq.m	850	850	1,700
3.2	Binder course	Crashed stone 0-40, t=20	sq.m	850	850	1,700
3.3	Sub-base course	Design CBR>8	sq.m	3,000	3,000	6,000
3.4	Asphalt concrete	t=5cm	sq.m	3,000	3,000	6,000
3.5	Gravel surface course	t=15cm	sq.m	3,000	3,000	6,000
4 DRAINAGE WORK						
4.1	Concrete pipe – 150	diameter=150mm	m	1,000	1,000	2,000
4.2	Concrete open drain - 0.8	800x800	m	600		600
5 LEACHATE COLLECTION WORK						
5.1	LC pipe 150	perforated concrete pipe	m	520	520	1,040
5.2	LC pipe 500	perforated concrete pipe	m	350	350	700
5.3	LC pipe (D) 500	ductile pipe	m	150		150
5.4	Monitoring pipe	perforated concrete pipe d=300	m	15	15	30
6 MISCELLANEOUS WORK						
6.1	Guard fence	barbed wire fence h=1.8m	m	1,500	1,500	3,000
6.2	Guardrail (A)	for earth structure	m	680	680	1,360
6.3	Ventilator for leachate monitoring		m	900	900	1,800
6.4	Planting tree	h=1.5m	no.	7,100		7,100
7 LINING WORK						
Disposal pit						
7.1	High density polyethelene sheet	t=1.5mm	sq.m	11,500	11,500	23,000
7.2	Geotextile (short fibre type)	t=10mm	sq.m	11,000	11,000	22,000
7.3	Geotextile (long fibre type)	t=10mm	sq.m	12,000	12,000	24,000
7.4	Protection soil		cu.m	2,000	2,000	4,000
7.5	Soil mixed with bentonite	Dry weigh rate 10%	cu.m	6,000	6,000	12,000
7.6	Liner Fixer		m	1,500	1,500	3,000
Reservoir						
7.7	High density polyethelene sheet	t=1.5mm	sq.m	660		660
7.8	Geotextile (short fibre type)	t=10mm	sq.m	190		190
7.9	Geotextile (long fibre type)	t=10mm	sq.m	470		470
7.10	Soil mixed with bentonite	Dry weigh rate 10%	cu.m	400		400
7.11	Liner Fixer		m	160		160

3.13.2 Cost Estimates

(1) Thermal Treatment Facility: P1,200,000,000-

- Rotary Kiln and Secondary Combustion Chamber
- Control and Instrumentation
- Bunker and Feeding System
- Heat Energy Recovery Boiler
- Flue Gas Treatment System
- Wastewater Treatment System
- Control Room, Building Structure and Civil Work

(2) PCT facility: P100,000,000-

- Storage Tanks
- Reactor Tanks
- De-Hydrator (Filterpress)
- Pumping System
- Building Structure and Civil Work
- Instrumentation
- Roofed Structure and Civil Work
- Effluent Catch Pit

(3) Solidification Facility: P60,000,000-

- Waste pit and loading Equipment
- Concrete Mixer and Screw Conveyer
- Control Equipment
- Roofed Structure and Civil Work

(4) Laboratory Equipment: P40,000,000-

(5) Waste Storage Facility and Others: P52,000,000-

- Track Scale
- Roofed Structure

(6) Utility and Other Equipment: P80,000,000-

- Water Supply System

(7) Administration Building: P80,000,000-

- Main Office
- Laboratory Facility
- Training/Function Room
- Workshop
- Canteen

(8) Landfill (Phase I only): P148,340,450 -

- Rain Run-Off/Leachate Pond
- Local Monitoring System

Table 3.13.1 Cost Estimates for the Facility except Landfill

Unit: Pesos

Item	Foreign Cost	Local Cost	Total
Thermal Treatment Facility			
Plant	800,000,000-	0-	800,000,000-
Structure & Civil Work	80,000,000-	200,000,000-	280,000,000-
Electrical & Control	80,000,000-	40,000,000-	120,000,000-
Sub Total	960,000,000-	240,000,000-	1,200,000,000-
PCT Facility			
Plant	24,000,000-	28,000,000-	52,000,000-
Structure & Civil Work	0-	40,000,000-	40,000,000-
Electrical & Control	0-	8,000,000-	8,000,000-
Sub Total	24,000,000-	76,000,000-	100,000,000-
Solidification Facility			
Plant	20,000,000-	8,000,000-	28,000,000-
Structure & Civil Work	0-	28,000,000-	28,000,000-
Electrical & Control	0-	4,000,000-	4,000,000-
Sub Total	20,000,000-	40,000,000-	60,000,000-
Laboratory Equipment			
Major Equipment	32,000,000-	0-	32,000,000-
Other Special Instrument	8,000,000-	0-	8,000,000-
Sub Total	40,000,000-	0-	40,000,000-
Storage Facilities & Others			
Storage Facilities: * Wastewater Tank * Contaminated Water Tank * Fire Fighting Water Tank	20,000,000-	32,000,000-	52,000,000-
Other Facilities: * Road Construction * Plantation & Landscaping * Fencing * PA & Lighting * Related Civil Works	0-	40,000,000-	40,000,000-
Sub Total	20,000,000-	72,000,000-	92,000,000-
Utility &Other Equipment			
Drinking Water Tank & Supply System	0-	80,000,000-	80,000,000-
Sub Total	0-	80,000,000-	80,000,000-
Administration Building			
Building Construction	0-	60,000,000-	60,000,000-
Related Equipment & Others	0-	20,000,000-	20,000,000-
Sub Total	0-	80,000,000-	80,000,000-
Grand Total	**1,064,000,000-**	**588,000,000-**	**1,652,000,000-**

Table 3.13.2 Cost Estimates for Landfill

Unit Pesos

Item	Phase 1	Phase 2	Total
1 EARTH WORK	102,300,000	19,055,000	121,355,000
2 SLOPE PROTECTION	1,750,000	1,250,000	3,000,000
3 PAVEMENT WORK	4,027,250	4,027,250	8,054,500
4 DRAINAGE WORK	2,700,000	300,000	3,000,000
5 LEACHATE COLLECTION WORK	2,363,000	1,463,000	3,826,000
6 MISCELLANEOUS WORK	4,055,000	2,990,000	7,045,000
7 LINING WORK	31,145,200	29,535,000	60,680,200
TOTAL	**148,340,450**	**58,620,250**	**206,960,700**

(9) Total Facility Cost

Unit: Pesos

Facility	Foreign Cost	Local Cost	Total
PCT (plant only)	24,000,000-	28,000,000-	52,000,000-
Solidification (plant only)	20,000,000-	8,000,000-	28,000,000-
Thermal Treatment (plant only)	800,000,000-	0-	800,000,000-
Civil Works (exc. landfill)	100,000,000-	340,000,000-	440,000,000-
Electrical & Control (Plant related)	80,000,000-	52,000,000-	132,000,000-
Landfill (Phase I only)	26,000,000-	122,000,000-	148,000,000-
Laboratory Equipment	40,000,000-	0-	40,000,000-
Administration Office (exc. civil works)	0-	60,000,000-	60,000,000-
Others (Storage, Utilities, etc.)	0-	100,000,000-	100,000,000-
Physical Contingency*	25,200,000-	92,400,000-	117,600,000-
Total	**1,115,200,000-**	**802,400,000-**	**1,917,600,000-**

* Physical Contingency cost is 20% of civil works and landfill.

(10) Cost of the Transferring and Commission Test

1) Facility Transferring Cost

- Transfer of the Facility shall be done upon completion of the mechanical and hot-run testing.
- The Manufacturer shall be responsible to carry out these tests and bear the costs, such as supervisors, consumable materials. However operational manpower and the utilities will be provided by the Facility, under a training program on request basis.
- 5 % of he contract amount shall be held for one year from the date of transfer as Retention Bond and shall be released at the end of mechanical guarantee period.

2) Cost of Commissioning Test

- Upon the completion of the mechanical and hot-run testing, the Facility will be responsible to operate and carry out the commissioning test under supervision of the Manufacturer's Program.

- The Manufacturer shall provide necessary number of supervisors/engineers and shall be responsible to provide a necessary training program for the Facility's Operators.
- Total cost of the commissioning test will be borne by the Facility; however, costs for sampling and analysis of wastewater and exhaust emission flue gases shall be the responsibility of the Manufacturer.

3.14 Replacement Cost

3.14.1 Replacement Schedule

Some components that are utilized in the treatment facility shall be recommended to be periodically replaced. Major critical mechanical device and equipment as well as corroded tanks shall be completely or partially replaced within 10~20 years or shorter period depending upon the operational conditions. Consequently, the following facilities should be renewed according to the prescribed schedule.

(1) Thermal Treatment Facility

Equipment	Replacement Period
Storage Tanks	Every 20 years
Heat Energy Recovery Boiler	Heating tube shall be replaced every 10~15 years
Waste Feeding Device	Every 20 years
Wet Scrubber	Every 20 years
Pumping System	Every 10~15 years
Major Control Instrumentation	Every 15~20 years

(2) PCT Facility

Equipment	Replacement Period
Storage Tanks	Every 20 years
Reactor Tanks	Every 10 years
Pumping System	Every 10~15 years
Filter press	Every 15~20 years

(3) Solidification Facility

Equipment	Replacement Period
Loading Equipment and Screw Conveyer	Every 15~20 years
Concrete Mixer	Every 15~20years

(4) Laboratory Facility

Equipment	Replacement Period
Major Analyzer, Computer and Recording Unit	Every 10~15 years

(5) Other Facility

Equipment	Replacement Period
Waste Handling Equipment and Vehicles	Every 10~15 years
UPS and Power Generator	Every 10~20 years

3.14.2 Replacement Cost

Unit: Pesos

Facility	Foreign Cost	Local Cost	Total
Thermal Treatment	80,000,000-	55,000,000-	135,000,000-
PCT	3,000,000-	20,000,000-	23,000,000-
Solidification	10,000,000-	4,000,000-	14,000,000-
Laboratory Equipment	8,000,000-	3,000,000-	11,000,000-
Others	0-	20,000,000-	20,000,000-
Total	**101,000,000-**	**102,000,000-**	**203,000,000-**

Chapter 4

Operation Plan

4 OPERATION PLAN

4.1 Waste Acceptance and Management of Waste Flow in MIF

4.1.1 Waste Acceptance procedure

In receiving HW, MIF will obtain information on the HWs from each generator for examining their acceptability at MIF. Prior waste analysis may be carried out as the need arises.

If the HWs are acceptable, MIF will make a treatment agreement with the HW generator. The agreement will specify the name of generator, types and quality of HWs accepted.

Although normal confirmation of the types of HWs is conducted by visual inspection and manifest checking, direct analysis of HWs will also be carried out periodically.

If MIF finds that the HWs accepted is not in accordance with those specified in the agreement, the issuance of manifest will be ceased until they are confirmed acceptable. Figure 4.1.1 shows the overall HW acceptance procedure.

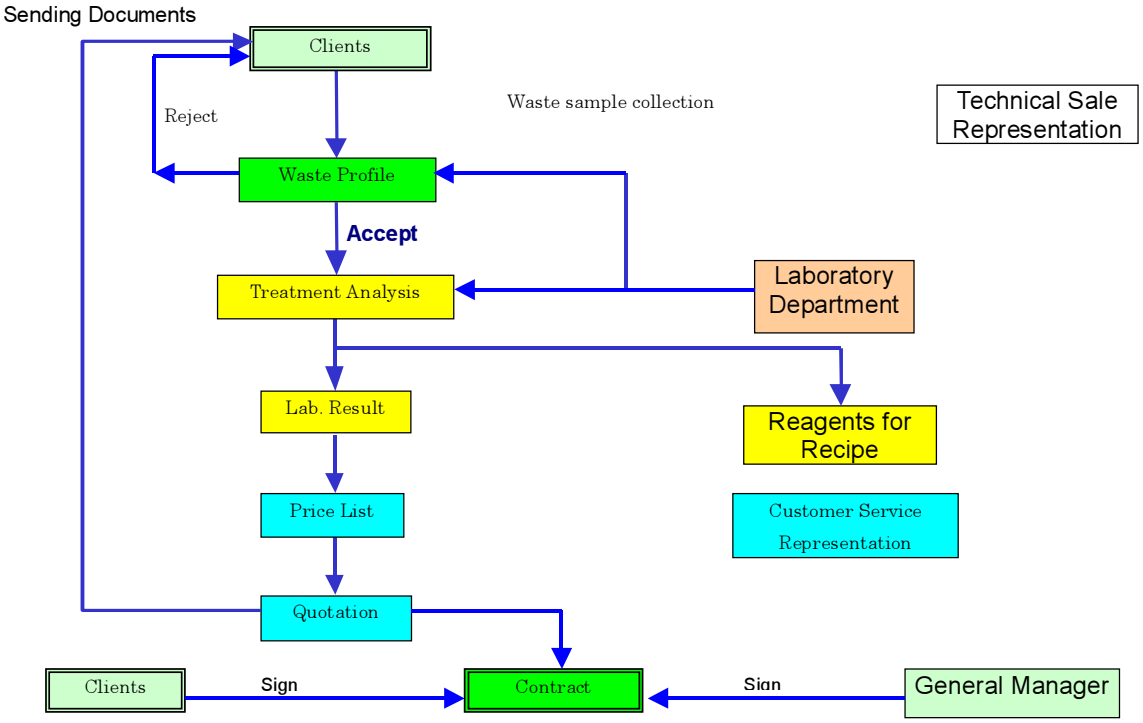


Figure 4.1.1 HW Acceptance Procedure

4.1.2 Prior Consultation between the Generator and the Treater

When the facility receives an inquiry about the waste treatment from a client, it collects information from the client about the hazardous wastes to be treated at the facility. The following items should be clarified in order for the acceptability of the waste to be preliminarily determined and the treatment fee to be initially estimated.

(1) Physical Characteristics of the HW

- Liquid, solid, or sludge
- Consistency
- Viscosity, if liquid
- Chemical composition
- Volume

(2) Heat Content or Calorific Value

- Heat to be generated by burning the HW
- Achievability of a high temperature over 900°C by burning the HW alone
- Need for auxiliary fuel for burning the HW

(3) Residue and Ash Volume

- Amount of ashes to be generated by burning the HW
- Estimated volume of the slag
- Consideration on frequent de-slagging

(4) Any Special Considerations

- Need for special care in handling
- Highly toxic or odorous characteristics
- Incompatibility with other HW

4.1.3 Waste Analysis

(1) Analysis of HW before the Agreement (Pre-analysis)

If the waste is likely to be acceptable to the facility, it requests the client to submit a waste analysis report before making an agreement with the client. If the report is not available, the facility should request the client to provide a waste sample for the analysis so that the physical characteristics of the wastes can be identified. Volumes of the sample should be:

- Liquid waste: 500cc x 2 bottles
- Solid waste: 500g x 2 packs

When the facility receives a sample of wastes, the laboratory staff at the facility carries out analysis of waste characteristics. The following items should be properly analyzed so that the treatment cost can be estimated while the treatment process can be determined. Based on the results of the analysis, the facility makes a decision on acceptance of the HW treatment.

Items to be analyzed include:

- Viscosity
- pH value
- TOC value
- calorific value
- Heavy metal concentration
- Cyanide or chromium
- Contents of halogen, sulfur, nitrogen, and phosphorus

(2) Analysis upon Delivery of Wastes to the Facility

When wastes are delivered to the facility, the laboratory staff takes a sample of the waste. Then the waste shall be analyzed for chemical/physical properties to determine whether the results of the analysis are equivalent to the pre-analysis data. If there are any discrepancies between the two data, the facility can discuss with the client whether the treatment fee should be adjusted. If the client disagrees with the fee adjustment, the facility may decline to accept the waste.

4.1.4 Agreement on HW Acceptance

If the HWs are acceptable to MIF, an agreement will be made with the HW generator. The conditions of HW acceptance will be specified in the agreement.

4.1.5 Acceptance of Wastes

When the delivered waste matches the pre-analysis data, or the client agrees with the treatment fee adjustment depending upon excess concentration and/or containing of different type of composition, the facility accepts the wastes. MIF, in principle, will not accept the HWs not specified in the agreement.

4.1.6 HW Flow Management

The HWs accepted at MIF will be managed in accordance with the mechanism shown in Figure 4.1.2 below.

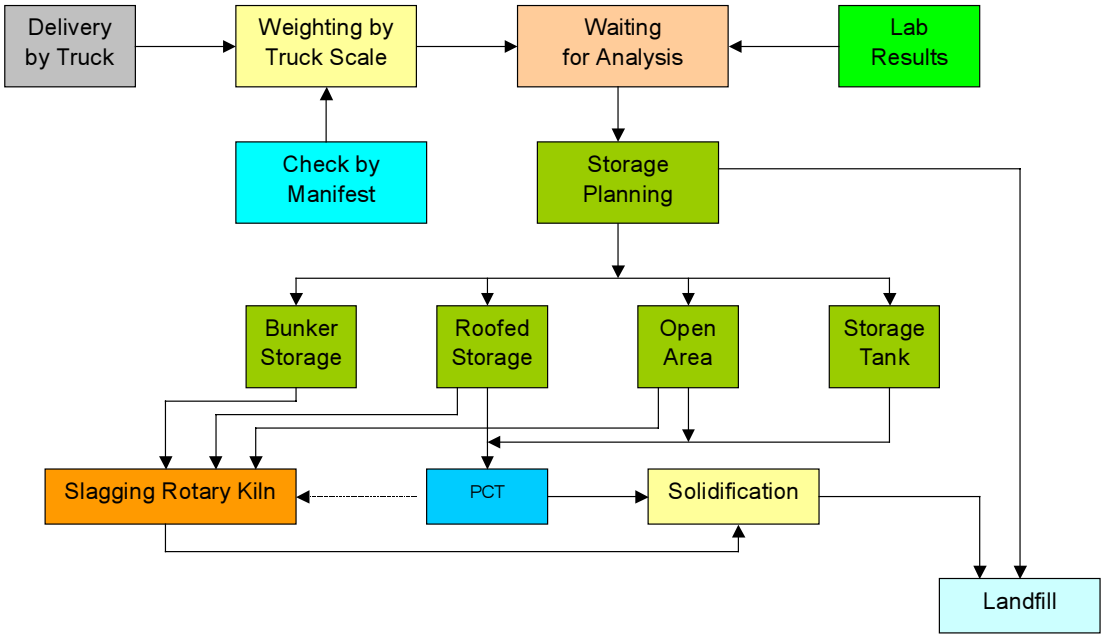


Figure 4.1.2 Management Flow of HW in MIF

4.2 Waste Collection and Transportation

4.2.1 Principle of Waste Collection and Transportation Services

The facility provides waste collection and transportation services for the client as follows:

- The basic treatment fee includes the cost of containers and waste pick-ups
- Waste pick-up service is provided
- Standardized containers are supplied to the clients, but clients can use their own containers and/or transportation, if the facility approves

4.2.2 Amount of HW to be collected

According to the design treatment capacity of the facility, the expected amount of wastes to be collected is estimated as in Table 4.2.1.

Table 4.2.1 Expected Amount of HW Collected by the Facility

ste by Category		Annual Amount (t/y)	Daily Amount (t/d)
Liquid Waste	Organic	10,500-	35-
	Inorganic	2,500-	10-
Sub-Total		13,000-	45-
Combustible Solid Waste		19,500-	65-
Solidified Waste		2500-	10-
Direct Landfill Waste		3,500-	12-
Total		38,500-	132-

4.2.3 Collection of Non-Bulky Waste

Collection of non-bulky waste (liquid and solid) waste is planned as follows:

(1) Containers

The facility provides the client with containers to pack HW to be treated at the facility. The containers are repeatedly used. The facility sells containers to clients, if they wish. A client may pack and store the waste in its own containers, of which the facility examines and approves the form and material prior to the transport of the waste. These containers include:

- Drums and lid seal-able metal cans
- Polyethylene containers

(2) Types of Transport Vehicle

Commercial truck type vehicles are employed to collect the waste, but the vehicles should be equipped with devices to load and unload drums, steel cans, and polyethylene containers.

(3) Loading Plan

All the containers should be placed on a pallet and then loaded on the transport vehicle. Loading capacity required for the transport vehicle is 4 drums per a pallet, which is 1.2 squire meters in size. The loading height is approximately 1.25 meter. A van type light truck (with enclosure) is desirable especially for collecting small containers, which would reduce risks associated with spilling of HW during the transportation.

(4) Number of Vehicles

1) Design Capacity for Waste Collection

- Liquid waste : 45 ton per day
- Solid waste : 43.5 ton per day (remaining waste is collected as bulky waste)
- Total capacity: 88.5 ton per day

2) Loading Plan

- Long bed light truck: 30 drums (4.5 ton)
- Long bed truck : 60 drums (9.0 ton)

3) Daily Trips Plan

- Long bed light truck: 3 trips per day
- Long bed truck : 2 trips per day

4) Daily loading amount per vehicle

- Short bed light truck: 4.5 ton/car x 3 trips /day = 13.5 ton per day
- Long bed truck : 9.0 ton/car x 2 trips/day = 18.0 ton per day

5) Number of Vehicles

Number of vehicles required is calculated from following formula:

Number of vehicles
= Amount of daily collection by vehicle type ÷ Daily loading amount
Short bed light trucks collect 50% of the daily collection; so do long bed trucks.

- Short bed light truck: 3 trucks
- 88.5 t/d x 50% ÷ 13. 5 t/d = 3.27 ≒ 4 trucks
- Long bed truck: 2 trucks
- 88.5 t/d x 50% ÷ 18.0 t/d = 2.45 ≒ 2 trucks
- Spare vehicle: Short bed light truck: 1

4.2.4 Collection of Bulky Solid Wastes

Collection of bulky waste is planned as follows:

(1) Containers

The facility provides the client with containers to convey Bulky Solid Wastes to treat at the facility. These containers are re-usable.

(2) Type of Transportation Vehicle

Commercial truck type vehicles are employed to collect bulky solid wastes, but the vehicles should be equipped with devices to load and unload bulky waste containers, each of which holds about 2 tons of wastes.

(3) Number of Vehicles

Number of vehicles necessary for collecting bulky solid wastes is calculated as the following:

- Daily collection amount: 43. 5 tons per day
- Planned loading capacity: 6 m^3 container x 4 (approximate 8 ton)
- Number of trips per truck: 2 trips per day
- Daily loading capacity per truck: 2 trips/day x 8t/trip = 16t/day
- Number of vehicles is calculated as
- Daily collection amount ÷ Daily loading capacity
- 43.5 t/day ÷ 16t/day = 2.72 ≒ 3 trucks
- Spare vehicle: short bed light truck: 1 unit

4.3 HW Data Management in MIF

HWs data in MIF is managed through the manifest system. Identification number of HW generator and HW code are given to each type of HW accepted at MIF. By making use of bar code format, flow of HW in MIF is managed by centralized computer in the main office. All the HW haulage vehicles will be equipped with bar-code entering and reading device.

In receiving HW at MIF, types and amount of HW are confirmed by reading the barcode on the manifest sheet. The reading data will be directly sent to the data center in the main office so as to confirm whether the HWs accepted are in compliance with the agreement with the HW generators. The process of HWs in MIF will also be electronically managed by the same data system.

4.4 Safety and Environmental Management and Education

4.4.1 Safety Measures

MIF will establish its own safety management committee and appoint a plant safety manager. A safety regulation will also be established in MIF, in which the emergency response measures are specified. Training of emergency measures and safe plant operations will be carried out for MIF workers.

4.4.2 Environmental Management

MIF will make an environmental agreement with the neighboring community, in which a self-environmental management standard will be established. MIF will also

establish environmental management committee and appoint an environmental management officer in charge of overall environmental management of the facilities.

As to flue gas, HCl, TOC, and SO_2 will be constantly monitored while NO_x, FH, dust and ammonia will be analyzed every month. Other toxic pollutants (including dioxins and furans) provided in the regulations in the Philippines will be analyzed twice a year.

Elution tests of the slag from thermal treatment and solidified waste are conducted for every type of waste once per month.

Wastewater from MIF will be analyzed for each item of the effluent standard in the Philippines before discharging outside the facility.

Leachate leakage detection system in the landfill is inspected every day.

The analyzed data above will be compiled into a report for information disclosure to the neighboring communities in response to their request.

4.4.3 Education

The following seminars and training program will be held in the main office of MIF.

Table 4.4.1 Proposed Seminars and Training Programs in MIF

Topics	Schedule
Education and training of the MIF workers	Once a year
Training on HWM for the facility operators	Twice a year
Training on HWM for the HW haulers	Once a year
Training on HWM for the HW haulage vehicle drivers	Twice a year
Seminars on HWM for HW generators (for managing executives)	Once a year
Seminars on HWM for HW generators (for PCOs)	Twice a year
Seminars and trainings for government officers	As needed

4.5 Maintenance of Treatment Facilities

4.5.1 Maintenance of PCT Facility

The facility shall be continuously operated throughout the year with periodic checking of the mechanical components. Regular care and maintenance shall be performed. If any damages are found, worn and rusted parts should be replaced as these usually result in increased mechanical noise, friction, abnormal leakage and/or malfunctions even before the normal lifespan of the parts is reached.

The main equipment and system installed in the physiochemical treatment facility are reaction tanks with agitator, filter with pump, waste gas scrubber with circulation pump and analyzing equipment. All equipment should be kept in good conditions for continuous dependable operation. General guidelines for the maintenance of the equipment are described below.

(1) Filter Cloth

The filter cloth is regenerated by back washing and can be reused repeatedly. However, it is necessary to replace when the filtration pressure increases or the filtration efficiency drops due to clogging.

(2) Shaft Seal of Pump

The pump shaft seals are important parts that prevent leakage from the pump. Through repeated operations, including start-up and shut down as well as long hours of continuous operation, the shaft seal becomes worn out, losing its capacity to seal. It is then time to replace the shaft seal in accordance with the instruction manual to prevent the pump from leaking.

(3) Tank

Corrosion of tanks normally occurs after a long-term operation even though the facility is constructed with corrosion resistant materials. Measuring the thickness of materials through a spot test should be carried out periodically. If the measured thickness is less than the allowable thickness, replacing the weakened component should be considered.

(4) Waste Gas Scrubber

The efficiency of the scrubber depends mainly on the chemical composition of fluids used for scrubbing. Their chemical composition should be periodically analyzed, and scrubber fluid and/or absorbent should be renewed.

4.5.2 Maintenance of Solidification Facility

Basic equipment, such as a concrete mixer, feeding conveyer, pump, hoist crane and etc. should be mechanically checked periodically. Worn parts shall be replaced before any malfunction is observed.

4.5.3 Maintenance of Thermal Treatment Facility

The thermal treatment facility need to be properly maintained to keep desirable conditions for a variety of combinations of the HW it receives. Most of the troubles are due to malfunctions of equipment and instruments. Major causes of the malfunction include built-up scale in pumps and pipelines, changing a combination of fuels, and sudden breakage of nozzles, controllers, and similar units. Good maintenance is always the best technique to avoid those malfunctions.

Among the equipment, pumps and motors, including rotating machines and parts as well as electrical devices require daily maintenance. The electrical insulation should meet the specified levels.

Table 4.5.1 shows information on types of malfunctions, their indications, and necessary responses to each malfunction. This table is extremely important as it provides troubleshooting measures to keep the facility in the best operating condition.

Table 4.5.1 Malfunction of Thermal Treatment Facility and Recommended Action

#	Type of Malfunction	Indication	Recommended Action
1	Partial or complete halt of delivery of liquid waste feed to ALL liquid burners	a) Flow meter reading out of the specified range b) Pressure build-up in feed lines c) Replacement of the refractory d) Feed pump failure, zero amps	➢ Stop feeding wastes, start troubleshooting and maintenance of affected systems. ➢ Re-initiate or increase auxiliary fuel feed to maintain combustion zone temperature. ➢ Continue operation of the air pollution control devices (APCDs)
2	Partial or complete halt of delivery of liquid waste to only ONE burner	Same as a), b), c) above	Stop waste feed to affected burner only
3	Partially or complete halt of solid wastes feed to the rotary kiln	a) Drop in combustion temperature b) Power loss in the waste feed conveyer or other feed system	Same as in the No.1 above
4	Puffing or sudden occurrence of fugitive emission from the rotary kiln due to unstable temperature	a) Pressure surge in the kiln (rapid change in manometer level) b) Visible emission from air seals at either end of kiln	➢ Stop feeding any solid waste to kiln for 10-30 min. but continue combustion ➢ Evacuate unnecessary personnel from immediate vicinity of the kiln ➢ Re-evaluate waste prior to further combustion
5	Failure of forced air supply to the liquid waste feed or fuel burners	a) Flow meter reading for air supply off-scale b) Automatic flame detector alarm activated c) Zero amps or excessive current draw on blower motors	➢ Stop waste and fuel feed immediately ➢ Start troubleshooting immediately and re start as soon as possible ➢ Continue operation of APCDs but reduce air flow at induced draft fan by "damping" accessory
6	Combustion temperature too high	a) Temp. indicator at control panel b) Alert or other alarm system	➢ Check fuel or waste feed flow rates; reduce if necessary ➢ Check temp sensors ➢ Check other indicators of combustion if multiple sensors are used ➢ Automatic or manual activation of the combustion chamber vent

#	Type of Malfunction	Indication	Recommended Action
7	Combustion temperature too low	a) Same as above b) Same as above	➢ Check other indicators of combustion if multiple sensors are used ➢ Check fuel or waste feed flow rates; increase if necessary ➢ Check the sensor's accuracy
8	Sudden loss of integrity of refractory lining	a) Sudden loud noise b) Partial stoppage of air drawn into combustion resulting in decreasing combustion temp, increased particulate emission and development of hop spots on external wall of combustion chamber	Shut down facility as quickly as possible
9	Excess opacity of stack plume	Visual or instrument opacity readings which are above maximum allowable operating point	➢ Check combustion condition, especially temp O_2 (excess air) and CO monitor ➢ Check APCD operation ➢ Check nature and feed rates of wastes being combusted ➢ Check ESP interval, cycle duration and intensity
10	CO in exhaust gas in excess of 100 ppm or in excess of normal CO values	CO indicator	Check and adjust combustion conditions, especially temp and excess air (O_2 in stack gas), and adjust accordingly
11	Indicative or actual failure in the induced draft fan	a) Motor overheating b) Excessive or zero current (amps) c) Stoppage of the fan d) Pressure drop across blower inlet and outlet	➢ Switch to the standby fan if available ➢ If two induced draft fans are used in series, reduce operational levels immediately, stop the failing unit and operate at reduced rate on single fan only, until maintenance works are completed ➢ If there is only one fan, and the fan failure appears serious, shift into an emergency shutdown mode for entire facility

#	Type of Malfunction	Indication	Recommended Action
12	Increase in gas temperature after quench zone affecting scrubber operation	a) Partial or total loss of water supply to quench zone b) Increase of combustion temp	➢ Check water flow to quench zone. ➢ Prepare for limited operation rate until water supply is restored ➢ Check combustion conditions especially temperature
13	Partial or complete halt of supply of water or caustic solution to the scrubber	a) Decreasing trend of pressure in the scrubber as indicated by manometers or other instruments b) Zero or increased amps on water or solution pumps c) Flow meter readings out of specified range d) Large increase in acid components in stack gas as detected by NDIR or other type instruments	➢ Stop feeding waste, start troubleshooting and maintenance of the affected system ➢ Start up secondary pumps, if available ➢ Check recycle water or solution tank levels ➢ Switch alkaline solution to water, if available ➢ Check for solid deposition from recycled liquor in pump lines ➢ Use the emergency (stand-by) system supplying waster by gravity until the whole system can be shutdown
14	・Deposition of solids in the scrubber from recycled waste or caustic solution, or from excess flue gas ・Solid elements in emissions from the combustor	a) Increasing trend of the pressure in the scrubber as indicated by manometers or other instruments b) Increase hold-up of liquor in packed or tray towers due to clogging of the tray. This can also be detected by liquid level indicator	Shut down the scrubber to clean out the tower and internal scale
15	pH of recycled scrubber liquor not in spec	a) pH to be out of the desired operating range b) Drop in scrubber efficiency with excess acid gas in stack gas	➢ Check for adequate supply and metering of alkaline agent ➢ Check for accuracy of the pH meter and the alkaline solution metering pump associated with recycling of scrubber liquor
16	Failure in demister operation	Decreasing trend of the pressure, as measured by manometer, due to solids accumulation on demister elements	Backwash the demister elements

4.6 Operation of Facility

4.6.1 Operational Concept in Designing

The facility shall be designed with the maximum safety condition to continuously operate with all necessary system and/or equipment.

(1) PCT Facility

A basic operational concept for the PCT facility is designed to employ a "batch operation" from feeding of wastes to a completion of PCT process that is consisted with all individual equipment. For this purpose, the PCT can be completely manually operated. Besides, crystallized slurries or solids with the waste liquid is sucked from the bottom of the Reactor tank, and then transferred into a filterpress through a pump system to dehydrate. The dehydrated cake (sludge) is normally loaded on a dump truck and discharged at the landfill site. However the cake (sludge), which contains toxic substances, such as heavy metals and etc., shall be transferred to the solidification facility by loading in a container.

(2) Solidification Facility

A basic operational concept for the solidification facility is designed to employ a "batch operation" by a cement mixing equipment. Wastes, which are necessary to be treated by the solidification, shall be dumped into a mixing pit to check the characteristics and measured the moisture level. Then a volume of additional water, sands as well as cements shall be determined by this analysis. The analyzed wastes are fed into the cement mixer through a belt-conveyer. However ashes, which are discharged from the flue gas treatment of the thermal treatment facility, shall be once stored in an air-tight measuring hopper and then discharged into the cement mixing equipment when appropriate volume is reached for one batch operation. The wastes are completely solidified without curing process and transferred by dump truck, then discharged at the landfill site.

(3) Thermal Treatment Facility

A basic operational concept for the thermal treatment facility is designed to employ with a complete automated control system. Consequently these integral total system and equipment that are consisted with a slagging rotary kiln, secondary combustion chamber (SCC), flue gas quenching system, flue gas treatment system, bag filter system, ID Fan system and scrubber system, are fully automated. And then the facility can be continuously controlled in the operation by an automatic control device that is located at a main control room.

However the system of feeding wastes and discharging slag are designed to manually operate so that an operator can determine the best possible timing of both processes while he always monitors conditions in a destruction process time to time.

The facility shall employ the maximum safety operational devices and all system/equipment shall be integrated and controlled. When emergency events, such as explosion, abnormal combustion, or fires in an operation are detected, the facility shall be automatically shut down and then the inert gases shall be purged into the kiln and secondary combustion chamber to prevent extending of the fire. And also the facility is designed to manually operate an emergency generator to provide a

necessary power to safely shut down all system and equipment in the facility when the power is cut, such as lightening, or abnormal power fails.

4.6.2 Operation of Facility

(1) Reception of Wastes

The facility can manage to receive wastes from generators 12 hours in weekdays but except on the Saturday and Sunday. All vehicles shall stop at the reception office and the delivered wastes by trucks and other vehicles shall be measures by a truck scale. A manifest shall be submitted to a receptionist and a control manager at the main office shall inspect the waste contents. All information described on the manifest and shall be controlled with data from the truck scale through a main computer. The control manager shall instruct a driver to carry the wastes to the classified storage facility when all data registration work is completed.

However the control manager shall take a sample from the wastes and bring to the laboratory for analyzing of the contents and/or concentration depending upon the waste conditions. Transportation to the classified storage facility shall be done upon a completion of analysis result at the laboratory.

(2) Acceptance Test and Analysis

A control manager shall take a sample from the waste for a brief analysis if it will be required to analyze depending upon waste conditions. A laboratory manager shall inform the waste control manager that the wastes are unqualified for acceptance, if there is any discrepancy between the manifest.

(3) Storage Facility

All accepted wastes shall be temporally stored at the classified storage facility. Drum-packed solid wastes are segregated and stored by characteristics of the wastes-profile in the roofed storage facility. However balky-solid wastes in containers shall be stored at the outdoor storage area and then transferred to banker pits at the thermal treatment facility by a treatment planning.

Drum-packed organic liquid wastes can be stored at the outdoor storage area, however these can be pumped into the classified storage tank, if these are prior identified inorganic liquid wastes. However inorganic liquid wastes for PCT, which are normally delivered by drum-pack, shall be temporary stored in the roofed storage facility. Balky organic liquid wastes, which delivered by a tank lorry, shall be directly pumped into the classified storage tank depending upon type of the wastes.

(4) In Facility Transportation

A small size truck can transport the solid wastes between facilities, however a mid-size dump truck is utilized between the landfill site. Drum-packed wastes are transported by a forklift and/or a mall size truck equipped with a drum lifter.

(5) PCT Facility

The PCT facility shall be operated for 8 hours in weekdays, but no operation on the Saturday and Sunday. All equipment of the PCT is designed to manually operate, however these can be individually operated as necessary. All liquid wastes

delivered at the PCT shall be pumped into an appropriate reactor tank. An operator shall determine desirable volumes of chemicals to be required for a basic PCT reaction depending upon data of toxic concentrations, levels of acid and alkaline, and etc. which has been pre-analyzed.

The PCT process that is a series of the chemical reactions, such as "Neutralization", "Coagulation/Precipitation", "Oxidation/Reduction" is continuously reacted in a single reactor tank until its completion. The reacted waste that contains crystallized slurries (solids) is drained out from the bottom of the reactor tank after completion of the reactions and then transferred into the filter-press. The waste is manually dehydrated.

A dehydrated cake (Sludge) is discharged in a waste-bin and normally transported to the landfill site by a small truck whenever it is fully loaded. However a waste, if contaminated with heavy metals shall be transferred to the solidification facility.

(6) Solidification Facility

The solidification facility shall be operated for 8 hours in weekdays, but no operation on the Saturday and Sunday. All equipment of the solidification facility is designed to manually operate, however these can be individually operated as necessary. A waste as well as a cake (sludge) from the PCT that shall be solidified shall be dumped into a mixing pit. An operator shall determine desirable volumes of sands and cements to be required for the solidification process. Then these are fed into a cement mixer by a belt conveyer. However ashes that are contaminated with such as heavy metals shall be once into an airtight measuring hopper until an appropriate volume of ashes will be accumulated per a batch operation. Ashes shall be directly loaded in the cement mixer from the hopper.

These wastes can be mixed with pre-determined volume of sands and cements in the cement mixer and then a cement mixer can be manually stared to operate until the wastes will be completely solidified. However wastes, if contaminated with such as mercury shall be additionally mixed with desirable volume of chelating agents depending upon concentration levels to be completely stabilized

(7) Thermal Treatment Facility

The thermal treatment facility is basically designed to operate for 24 hours per 300 days annually. However a regular inspection work shall be scheduled for a week every 3 months as well as an annual maintenance work for 30 days within a year shall be required.

The thermal treatment facility shall be daily continuously operated for 24 hours except processes of wastes feeding and slag discharging. An operator can control fully automatically the rotary kiln furnace by monitoring conditions of thermal destruction on the display control panel at the central control room

The delivered wastes shall be mixed with other wastes having various caloric values in the bunker pit to adjust the total calorie to obtain the maximum heat load for the thermal destruction. The mixed wastes are fed into the hopper by crab type crane and then intermittently transferred into the kiln furnace through the inlet while an operator in processing shall monitor discharge conditions of slag. Drum-packed wastes on the other hand are directly fed into the kiln furnace, however sealed drums shall be opened by the lid opener then fed. Wastes oils shall be directly sprayed in

the kiln furnace by operating of the pump system.

Slag shall be manually discharged out from the kiln furnace by the slag-discharger when the thermal destruction has been affirmed completely. The flue gases after a completion of the thermal destruction are flowed into the quick quenching and flue gas treatment system through the secondary combustion chamber. The toxic substances within the flue gas shall be stabilized by spraying of the limes and activated carbons and then fed into the bag-filer to separate as ashes from the flue gases.

The separated ashes shall be transferred to the solidification facility while the ashes shall be prevented to diffuse into the atmosphere in transporting. If the level of Hcl and/or Sox would be exceeded the emission standards, the flue gases shall be automatically treated through the scrubber system to reduce lower than the standard levels, then can emit into the atmosphere.

(8) Landfill Facility

The landfill facility shall be scheduled to operate for 8 hours in weekdays except the Saturday and Sunday to treat both wastes that will be directly delivered from generators as well as discharged from the solidification facility. But the landfill shall accept the slag for 24 hours per day while the thermal treatment is operated.

(9) Monitoring

The facility shall monitor periodically the leachate conditions and shall immediately take an action to control an abnormal discharging through a year

4.6.3 Manpower for Facility Operation

The facility is planned to operate by the following manpower allocation under normal condition through a year.

(1) Treatment Department (Operation, Panning, Storage Control)

1) Management
   Manager : 2 persons

2) PCT Facility
   Chief Engineer : 1 person
   Chemistry : 1 person
   Technician : 3 persons

3) Solidification Facility
   Chief Engineer : 1 persons (assigned as PCT)
   Chemistry : 1 person (assigned as PCT)

4) Thermal Treatment Facility
   Chief Engineer : 2 persons
   Chemistry : 2 persons
   Technician : Total 16 persons (4 groups per 3 shifts per day)

5) Landfill Facility

Chief Engineer	: 1 person (assigned as thermal treatment)
Civil Engineer	: 1 person
Technician	: 2 person

6) Other Supporting Staff : 3 persons (technician)

Total : 34 persons

(2) Laboratory (analyst for waste reception and treated waste)

Chief Chemistry	: 1person
Chemistry	: 3 persons
Total	**: 4 persons**

(3) Maintenance Department

Manager	: 1 person
Engineer	: 3 persons
Technician	: 4 persons
Worker	: 4 persons
Total	**: 11 persons**

4.7 Consumable Parts and Materials

The facility cannot operate without utilizing of consumable parts and materials as well as the utilities in daily operation of each treatment process. Lime and activated carbon are major consumable materials in the flue gas treatment system. The wet scrubber gives a dose of caustic soda for neutralization of process water, which washes out HCl in the flue gas. The PCT facility requires various kinds of chemicals and agents that are essential factors to treat various types of wastes. And also the solidification facility consumes cement and lime. In addition, lubricant, greases or anti-wearing agents are necessary in daily operation for most of mechanical equipment and driven machines.

4.7.1 Consumables for Thermal Treatment Facility

The following items show typical consumable materials for the thermal treatment facility.

1) Lime: for the flue gas treatment system
2) Activated Carbon: for the flue gas treatment system
3) Caustic Soda: for the wet scrubber
4) Lubricants: for waste feeder, slag conveyer, driving mechanism of rotary kiln, ID fan, quenching water feed pump, cooling water pump, etc.
5) Refractory:

For Rotary Kiln: replacement will be required every $1 \sim 1^1/_2$ years

For SCC: replacement will be required every $2 \sim 2^1/_2$ years

4.7.2 Consumables for PCT Facility

The following items show typical consumable chemicals and materials for the PCT facility.

1) Sodium Hypochlorite
2) Aqueous Sulfuric Acid
3) Slaked Lime
4) Ferrous Sulfate
5) Sodium Hydroxide (Caustic Soda)
6) Sodium Sulfide
7) Ferric Chloride
8) Flocculant
9) Activated Carbon
10) Lime
11) Lubricants: for driving mechanism, pumps
12) Filter Cloth
    For Filterpress: replacement will be required every 3~5 years

4.7.3 Consumables for Solidification Facility

The following items show typical consumable materials for the solidification facility.

1) Lime
2) Cement
3) Lubricants: for driving mechanism, pumps

4.7.4 Consumables for Other Facility

1) Lubricants: for loading equipment at storage area
2) Testing Chemicals: for laboratory
3) Other Consumable Materials: for laboratory

4.8 Operation Cost

4.8.1 General Assumptions of Cost Estimate

The cost of the Project is estimated based on the following assumptions:

- Cost: adjusted by the market price in the year of 2001.
- Imports: estimated by cost, insurance and freight (CIF) Price, and exchange rate for peso below:
  P1=¥2.5
  P51.3=$1
- Import duty: exempted from the import duty as priority project of the government.
- VAT: 10%
- Land cost: included the cost of developing site, infrastructure and the like
- Physical contingency: 20% of Total Civil Work Cost
- Operation Period: 25 years for the plant, 10 years for the landfill

- Compensation: Not estimated landfill
- Investment cost for the renewal of the landfill after the completion of the operation period is not estimated in the pre F/S as the landfill treatment will be contracted out after 10 years.

4.8.2 Operation Cost of Treatment Facilities (Except Landfill)

(1) Cost Items

Operation costs for treatment facilities except landfill are comprised of the following items (for landfill, see 4.8.3.):

Item	Descriptions
Utilities	Electric Power, Water, Gas and Others
Chemicals and Agents	Flue Gas Treatment System, PCT, Solidification, Laboratory and Others
Fuels	Auxiliary Fuels for Furnace, Material Handling Vehicles and Equipment
Maintenance and Repairing	All Facilities
Personnel related	Administrators, Managers, Engineers, Technical Supporting Staff, Operators and Other Supporting Employees
Transportation	Waste Collection, Waste Handling (within the facility) and Corporate Vehicles
Safety and Medical related	Fire Fighting, Inert Gas System (unti-explosion for the rotary kiln and SCC) and First Aid Goods and Facilities
Other Expenses	Effluent Discharges Fee, Access Road Fee and others

(2) Cost Estimate

1) Electricity
P4 per kWh
Total Consumption: 460 kWh x 24 hrs x 300 days x P4/kWh
= P13,248,000

2) Water
P11~12 per ton
Total Consumption: 300 ton /day x 300 days x P11/ton
= P990,000 per Year

3) Chemicals and Agents
(a) Thermal Treatment related Chemicals
- Caustic Soda: P10 per kg (48% solution)
  Total Consumption: 350 kg /day x 300 days x P10/kg
  = P1,050,000 per Year
- Activated Carbon:P40 per kg
  Total Consumption: 300 kg /day x 300 days x P40/kg
  = P3,600,000 per Year
- Lime: P4.0 per kg
  Total Consumption: 6,000 kg/day x 300 days x P4.0/kg
  = P7,200,000 per Year

Table 4.8.1 Total Cost of Chemicals for Thermal Treatment

Items	Cost per Year
	Peso
Caustic Soda	1,050,000-
Activated Carbon	3,600,000-
Lime	7,200,000-
Total	11,850,000-

(b) PCT related Chemicals

- Sodium Hypochlorite: P7.2 per kg
- Aqueous Sulfuric Acid: P8.0 per litter
- Slacked Lime: P4.0 per kg
- Ferrous Sulfate: P13.0 per kg
- Sodium Hydroxide (Caustic Soda): P10.0 per kg (48% solution)
- Sodium Sulfide: P25.0 per kg
- Ferric Chloride: P40.0 per kg

Total Chemical Consumption:
250 kg/day x Average Chemical Cost P15.30/kg x 250 days
= P956,250 per Year

- Flocculant: P7.50 per kg

Total Consumption: 200 kg /day x 250 days x P7.50/kg
= P375,000 per Year

- Activated Carbon: P40 per kg

Total Consumption: 50 kg /day x 250 days x P40/day
= P500,000 per Year

- Lime: P4.0per kg

Total Consumption: 1,000 kg /day x 250 days x P4.0/kg
= P1,000,000 per Year

Table 4.8.2 Total Cost of Chemicals for PCT

Items	Cost per Year
	Peso
Chemicals	956,250-
Flocculant	375,000-
Activated Carbon	500,000-
Lime	1,000,000-
Total	2,831,250-

(c) Solidification related Chemicals

- Cement: P4.0 per kg

Total Consumption: 3,260 kg /day x 300 day x P4.0/kg
= P3,912,000 per Year

- Sand: P4.0 per kg
  Total Consumption: 3,260 kg /day x 300 days x P4.0/kg
  = P3,912,000 per Year

Table 4.8.3 Total Cost of Chemicals for Solidification

Items	Cost per Year
	Peso
Cement	3,912,000-
Sand	3,912,000-
Total	7,824,000-

4) Fuels

Auxiliary Fuels (Diesel): P12.0 per litter
Total Consumption: 11,100 L/day x P12.0/L x 300 days
= P39,960,000 per Year

5) Maintenance and Repairing

(a) Thermal Treatment Facility (Except replacing refractory)
Plant Cost x 1.5% = P12,000,000 per Year

(b) PCT Facility
Plant Cost x 1% = P520,000 per Year

(c) Solidification
Plant Cost x 1% = P280,000 per Year

(d) Other Facilities (Material Handling Equipment & Vehicles)
Total Cost x 1% = P800,000 per Year

6) Manpower

Based on the organization plan of the project implementation and O/M body given in Chapter 5, the annual manpower cost is estimated as shown in Table 4.8.4 below.

Table 4.8.4 Manpower Cost

Unit: Peso

Position	Unit cost (peso/psn./month)	Number of person	Total (peso/year)
Executive	264,000	3	9,504,000
Manager	88,000	10	10,560,000
Engineer	52,800	6	3,801,600
Technical Staff	35,200	25	10,560,000
Operator & Worker	22,000	26	6,864,000
Office Clerk	26,400	5	1,584,000
Total	**-**	**75**	**42,873,600**

7) Transportation

The project plans to contract out HW collection haulage to private HW collectors and haulers. The annual cost of HW collection and haulage to be paid to the contractors is estimated as follows.

Annual amount of HW collected: 38,500 tons/year
Average unit cost of HW collection & haulage: 1,200 pesos/ton of HW

8) Others

- Safety and Health related: 860,000/year
- Refractory Replacement
  Kiln Reactor: P12,000,000 /2year
  P6,000,000 /year
  Secondary CC: P16,000,000 / 3 years
  P5,400,000 /year
  Total Replacement Cost: P11,400,000 /year
- Laboratory Equipment & Computer Repairing/Renewal
  P1,200,000 /year
- Storage & Office Equipment
  P800,000 /year
- Wastewater Discharge Fee(Facility at Lima Technology Center)
  P12.5 per ton
  Total Discharge: 300 ton x P12.5/ton x 300 days
  = P1,125,000 per year
- Access Road Fee
  P200/trip
  Total: 30 trips/day x P200/trip x 300 days
  = P1,800,000 per Year

Table 4.8.5 Total Cost for Others

Items	Cost per Year Peso
Safety & Health Related	860,000-
Refractory Replacement	11,400,000-
Lab. & Computer Repairing	1,200,000-
Storage & Office Equipment	800,000-
Wastewater Discharge Fee	1,125,000-
Access Road Fee	1,800,000-
Total	17,185,000-

(3) Summary of Operation Cost Estimate

Operation cost of the facilities except for the landfill is summarized as shown in Table 4.8.6 below.

Table 4.8.6 Total cost of operation

Cost Items	Operation Cost per Year (Peso)
Utilities	**14,238,000-**
* Electricity (460kWh x 4 peso)	13,248,000-
* Water (300 ton/day x 11 peso)	990,000-
Chemicals and Agents	**22,505,250-**
* Thermal Treatment	11,850,000-
* PCT	2,831,250-
* Solidification	7,824,000-
Fuels	39,960,000-
Maintenance and Repairing	**13,600,000-**
* Thermal Treatment	12,000,000-
* PCT	520,000-
* Solidification	280,000-
* Others	800,000-
Manpower	42,873,600-
HW Collection & Haulage	**46,200,000-**
Miscellaneous Cost	**17,185,000-**
* Safety & Medical related	860,000-
* Refractory Replacement	11,400,000-
* Labo Equipment, Computers	1,200,000-
* Office Equipment	800,000-
* Wastewater Discharge Fee	1,125,000-
* Access Road Fee	1,800,000-
TOTAL	**196,561,850-**

4.8.3 Operation Cost of Landfill

(1) Summary of Landfill Operation

1) Waste covering

Daily disposal volume is estimated at 34.7 m^3 incoming. Assuming the landfill depth is 3.25 meter, the required area for daily landfill becomes 10.7m^2.

The material of daily covering waste is the slag produced in the thermal treatment plant. Therefore, all-weather sheets cover the working face to reduce a generation of the leachate. When the top level of the landfilled waste reached the planned level, the waste will be covered by a 50cm thick layer of impermeable soil obtained in the site.

2) Miscellaneous

The leachate collection pipes will be placed at the bottom of the landfill pit during the construction. In addition to these facilities, drainage pipes and leachate collection pipes will be will be extended according to the progress of the landfill operation.

4.8.4 Operation Cost

Total O&M cost for disposal facility estimated considering the followings is presented in Table 4.8.7.

(1) Extension of the leachate collection and drainage pipes
(2) Unloading and leveling of the waste
(3) Final covering soil
(4) All-weather plastic sheet for daily covering

Table 4.8.7 Quantity and Specification of the Items for Operation

Items	Specification	Unit	Qnt.
Material			
Leachate collection pipe	RC-D150	m	40
Drainage pipe	RC-D300	m	20
All-weather Sheet	Plastic sheet	m^2	100
Fuel	Diesel	l	5,500
Covering soil		m^3	4,100
Equipment			
	Wheel loader ($1.2m^3$)	no.	1
	Dump truck (4ton)	no.	1
	Bulldozer (3.5ton)	no.	1
Personnel expenses			
Foreman		Person	1
Operator		Person	1
Labor		Person	2

Annual O&M cost estimated is 5.3 million. In addition to the annual cost, the expenses for final covering soil, surface drainage and planting will be necessary for every 5 years after commencement of the operation. Therefore, the total O&M cost for ten years estimated as 55.6 million pesos.

Table 4.8.8 Estimated Total Cost of O&M of Disposal Facility

(Unit : million Pesos)

	Year / Total Cost	1	2	3	4	5	6	7	8	9	10
O&M Cost	55.6	5.3	5.3	5.3	5.3	6.6	5.3	5.3	5.3	5.3	6.6

Chapter 5

Project Implementing Organization and Business Operation Plan

5 PROJECT IMPLEMENTING ORGANIZATION AND BUSINESS OPERATION PLAN

5.1 Project Implementing Organization

Although DENR/EMB is proposed to be the proponent of the project, it is difficult for DENR/EMB to be the applicant of ECC of the project as it is the ECC issuing body as well. Therefore, Natural Resources Development Corporation (NRDC), a public corporation under the control of DENR is responsible for conducting the EIA and applying for ECC.

DENR/EMB, as the project proponent will be responsible for planning and managing the project including procurement of local counterpart fund for the project as well as application for NEDA (National Economic Development Authority) approval of the project.

NRDC is currently responsible for development of natural resources including minerals and forest. The Board of Directors of NRDC is chaired by DENR Secretary and organized by the representatives from Department of Finance, Trade and Industry, NEDA, and so forth.

Since NRDC has no experience in building such facilities as proposed in the project, organizational supports from DENR/EMB and other relevant government agencies are required for proper management of facility construction (see Section 8.4).

As to operation and management of MIF, NRDC also needs supports from those who have enough experience and know-how in HW treatment facilities. In this regard, the Study proposed to consign it to private O & M contractors by tendering. Taking into account that the experience and know-how in O & M of HW treatment facilities are very limited in domestic private treaters, the Study recommended to invite foreign experienced contractors in the tendering.

5.2 Operation and Management Body

5.2.1 Organizational Structure

To ensure smooth implementation of the facility construction, a project taskforce will be established within the NRDC as shown in the organizational chart on next page.

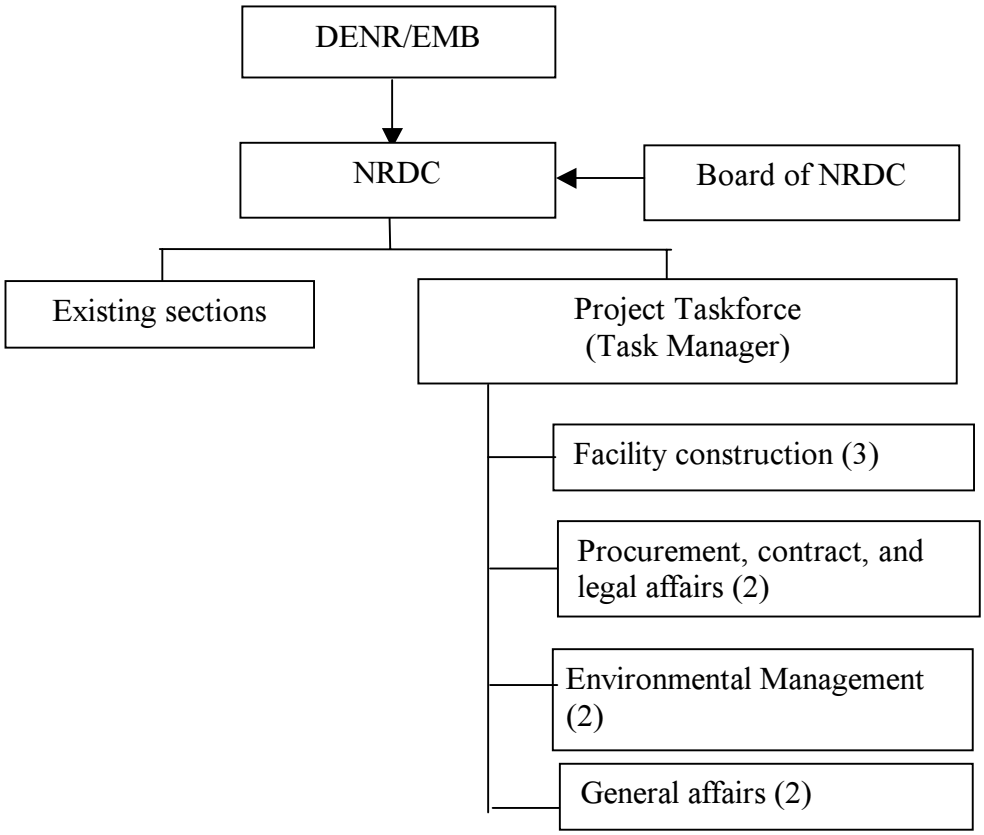


Figure 5.2.1 Chart of Organizational Structure

(1) Organization for Facility Operation

To supervise MIF operation by the consigned private O & M contractor, NRDC will set up a management section for MIF within it, whose main duties are as follows:

- Conducting contract affairs of O&M company
- Supervising O&M company
- Necessary coordination activities on the project with the competent authorities and other relevant government agencies and LGUs.
- Reporting the business results to the president of NRDC
- Auditing of O&M company's accounts

On the other hand, the O&M Company will take the following responsibilities:

- Guaranteeing NRDC of the proper operation of the TSD facilities
- Guaranteeing NRDC of the lease payment of the facility
- Periodical reporting of the business performance to NRDC
- Management of the facility operation business.
- All the risks arising from operation of the TSD facilities

(2) Organization of O&M

O&M Company will have an organizational as shown in Table 5.2.1. Waste collection and transportation will be contracted out to other companies.

Table 5.2.1 Proposed organizational structure of O & M Company

Dept./Section	Duties
President's office	➢ Secretary ➢ Personnel affairs ➢ Financial affairs ➢ Planning, collecting information ➢ Public relations
Treatment Department	➢ Operation of the treatment facility ➢ Storage management
Technical Department	➢ Maintenance of the facility, its repairing plan ➢ Supervision of the treatment operation ➢ Seminar for generators ➢ Preparation of reports on the business performance ➢ Consulting service for waste minimization ➢ Security management
Sales Department	➢ Client development ➢ Client management ➢ Preparation of collecting and transporting plan, contract out for the collection and transportation ➢ Issue of invoice
Account Section	➢ Supervision of the credit and debit ➢ Financial report
Information Section	➢ Management of the related information ➢ Management of the web-site ➢ Management of the network in the facility
Laboratory Section	➢ Analysis of wastes ➢ Monitor of the treatment facility ➢ Monitor of the landfill

5.2.2 Organization of Collection and Haulage

The collection and transportation will be contracted out to other companies. The contracted waste collectors/haulers will provide the following services:

- Collection and transportation of wastes
- Temporary Storage of wastes
- Provision of waste containers and pallet

The collectors/haulers are responsible for all the accidents arising in the process of waste collection and transportation.

The contracted collectors/haulers will be responsible for procurement of the necessary vehicles, intermediate transmission storage facility, vehicles depot, and warehouse for containers. To increase transport efficiency, the project will apply the car location system in which the real-time vehicles' location, supervision of vehicles' arriving time, freight information, emergency sensors, and command transmission are all integrated.

In addition, the project will provide the drivers with the following trainings:

- Safe driving,
- Basic knowledge of hazardous wastes,
- Legal knowledge of hazardous waste management, and
- Client relations to identify its complaints and demands.

Since the relationship with the clients is of great importance in waste collection and haulage services, the project will encourage drivers to actively take the complaints and demands of the clients and report these to the management.

5.3 Sales and Marketing

5.3.1 Business Strategy

To establish stable business operation and accomplish the social responsibility of being the first hazardous waste treatment and disposal facility in the Philippines, the project adopts following business operation policies.

(1) Business Philosophy

The project aims at contributing to society by eradicating the threat of environment pollution through proper management of hazardous wastes. It also raises public awareness and understanding on the necessity of proper hazardous waste management through its business operation. Environmental consideration will be maximized so as to secure the environmental safety of the project operation.

(2) Provision of secure services to the customers

The project will provide the customers with safe hazardous waste management services from the collection and transportation to treatment and final disposal.

(3) Establishment of the mutual trust with the customers

Through clearly defined, fair and equitable contracting conditions, the project will establish mutual trust and respect with every customer. The project will disclose all the necessary information to the customers as well as provide training and consulting services regarding on-site waste management useful to the customers such as waste minimization, on-site recycling, etc.

(4) Transparent business operation

To secure financial transparency of business operation, the project will establish an independent account in which all the project income and expenditure is clarified and generally accepted accounting procedures are used. The statement of accounts will be annually released to the public in the form of annual business performance report, including an environmental performance. The board of directors meeting of NRDC will be responsible for these activities.

(5) Establishment of mutual trust and good neighborly relations and contribution to the development of surrounding communities

To obtain social acceptability by the neighboring communities of the operation of TSD facilities, the project will make an environmental agreement with them as well

as relevant local government units (LGUs). It will also support the establishment of a community-based environmental monitoring committee to supervise operation of TSD facilities. The project will also contribute to the socio-economic development of surrounding communities through provision of new job opportunities or establishment of a community development promotion fund.

(6) Promotion and support of private HWM business

Being a leading advocate of proper HWM in the Philippines, the project will support the existing recyclers and treaters as well as the potential investors in this field through seminars, workshops and other information dissemination activities.

(7) Compliance management

Being a public corporation imbued with social responsibility and corporate citizenship, the project will strictly conduct business operations in compliance with the relevant laws, rules, and regulations concerning environment, health and safety and best practices for industrial operations, and so forth.

(8) Partnership with the relevant public and private bodies

The project will establish close cooperation with the relevant public and private bodies such as DENR/EMB, BOI, PEZA, industry groups, etc.

5.3.2 Sales Strategy

(1) Marketing Strategy

a. Project promotion activities

To establish and maximally expand its clientele even before starting business operation, the project will start its promotion activities in 2004, or 1 year before completion of the facilities construction. At first, seminars will be held to make a presentation to the potential clients (in this case HW generators) about the services provided by the project. The presentation will include, as an important part, demonstration of the latest state-of-the-art level and the high degree of environmental compliance of HW treatment technologies employed in the project. It also has to emphasize the necessity of such treatment for proper handling of HW to the potential clients. Moreover, the potential clients are also properly informed about the specific requirement for hazardous waste acceptance at the TSD facilities of the project and the HW treatment fees.

The project will also conduct study tours of the TSD facilities, starting from the construction period so that the potential clients can better understand the technological capacity of the facilities and thereby increase their willingness to use them.

To further promote the project, HWM services will offer consultancy on waste minimization at sources, proper on-site storage measures of non-treatable HWs (such as fluorescent lamps, sludge containing large amount of heavy metals, etc.).

b. Provisional contracts with the clients and collection of HW for test run of TSD facilities

Upon the permit by DENR/EMB, the project will start collection of HW for test run of TSD facilities. Provisional contracts need to be made with some of the clients to start this test run, which will be started about a half-year before the full-scale commencement of the facility operation.

c. Establishment of proper HW treatment fees

Reflecting the state-of-art level of HW treatment technologies applied in the TSD facilities of the project, its treatment cost will be higher than the conventional technologies presently applied in the Philippines. The treatment fee will be set up at the level where the TSD facilities can be operated in a financially viable manner. Examples of the operations of similar TSD facilities in other countries will be referred to in setting the proper treatment fee schedule for the project.

Considering the difference in required treatment measures between types of HW, the treatment fee will be set up for each type of HW by reflecting the actual cost of treatment as much as possible. The mechanism of determining the treatment fees will also be well described in the tariff table to be prepared.

d. Complaints settlement and consultation

The project will have a section to deal with complaints and consultations from the customers for smooth solution to their problems.

(2) Treatment fee

As mentioned above, the treatment fee will be determined based on the actual cost of treatment. The difference in treatment cost by types of HWs will also be considered. The final decision of treatment fee will be made at the time of concluding the contract with each client after the confirmation of HW quality accepted and required treatment based on the result of laboratory analysis.

a. Thermal treatment fee

The thermal treatment fee includes the costs of thermal treatment, landfill of slag, and landfill of solidified fly ash. The treatment fee of wastes with high calorific value such as waste oil will be discounted since they require less supplementary fuel for the treatment. In addition, halogen and non-halogen compounds will be differentiated in their treatment fees with attention to the gap in required treatment between them. The following HW categorization will be applied to set up the treatment fees.

- Waste oil
- Organic chemical wastes containing halogen compounds
- Organic chemical wastes without halogen compounds
- Pesticides
- Waste PCBs, PCB-contaminated materials

- Other organic wastes not elsewhere classified (including medical wastes)

b. Physicochemical treatment fee
The treatment fee will be determined on the basis of the cost of chemicals used for treatment. HW categorization will be as follows.

- Waste alkali containing cyanide
- Waste alkali without cyanide
- Waste acid containing chromium
- Waste acid without chromium

c. Solidification treatment fee
The solidification treatment fee will be set up based on the categorization of HW as follows.

- Sludge containing heavy metals
- Sludge containing mercury

d. Landfill fee
The landfill fee will be charged for tipping of the inert residues remaining after HW treatment

(3) User Charge

The project will provide HWM services to its clients for an adequate treatment fee based on the overhead and construction cost of the facility and the running or operating costs of treatment and disposal. The treatment fee will include waste collection/haulage fees to be paid to the contracted collectors/haulers and landfill cost to the contracted treater (after the closure of the landfill facility of the project) should be taken into account.

Reflecting the above, the Study Team describes a range of the user charge as follows:

Table 5.3.1 Range of user charge

	Unit cost/ton (peso)	Treatment Vol.(t/y)
Thermal	14,000-16,000	30,000
PCT	15,000-17,000	2,500
Solidification	12,000-14,000	2,500
Landfill	4,000-6,000	3,500

*The charges in the above table were calculated from the information described in chapters 2 and 6.

The study team recommends to use the average figures, as shown in the table below, not only to ensure viability of the project, but also to adopt the pricing practices of similar TSD facilities in other countries.

Table 5.3.2 Assumed user charge

	Unit cost/ton (peso)
Thermal	15,000
PCT	16,000
Solidification	13,000
Landfill	5,000

The above user charges were estimated for attaining financial viability of the project in Chapter 6. The result of willingness-to-pay survey showed that the above charges are mostly acceptable to foreign companies, who generate HWs. The HW generators survey, which was carried out in Phase I Study also supported this result.

On the other hand, some of the domestic companies in the Philippines showed negative reactions to the above charges. Further understanding on the necessity of proper HWM has to be promoted to their acceptance.

5.3.3 Client Management

To establish and keep mutual trust with the clients, the project will follow the following policies and measures on customer relations.

(1) Contract-based services

The project will provide services to the client on the basis of contract specifications on the responsibilities of both sides on the following items:

1) Responsibilities of the client

- Accurate notification on the types, characteristics, and components of wastes in accordance with the notification form (manifest) provided by the treater,
- Duty of accepting the returned waste from the treater in case of inaccurate or false notification of waste to the treater,
- Payment of treatment fee,
- Determination on the ability of treater to properly treat wastes,
- Proper treatment of waste according to the contract.

2) Responsibilities of the treater

- All the risks arising from the reception of waste up until its final disposal,
- Proper treatment of waste in compliance with the contract and issuance of certificate of treatment to the generator and EMB,
- Confidentiality of all the information provided by the client.

3) In addition to the above, the contract has to specify the following items:

- The laws, rules and regulations that the contract binds itself to,
- Detailed requirements for the client (HW generator) by the time of HW collection (containers, loading equipment to the transport vehicles, on-site storage, etc.),

- Guarantee by the client as to the accuracy of its notification of wastes to the treater,
- Methods of measuring and confirming waste amount and treatment fees,
- Specification of treatment fee (Items included in the fee besides the actual treatment cost such as tax, environmental fund, the additional charges in the case of necessity of special treatment, etc.),
- Detailed waste acceptance criteria,
- Refusal of waste,
- Settlement of dispute.

4) Obtaining the clients' understanding regarding the policies of the project on waste acceptance and transport

- The project will explain its policies on waste acceptance and transportation to the clients so as to obtain their proper understanding.

5) Provision of the information updates to the client such as new enactment or revision of the laws, rules, and regulations relating to HWM

- The project will keep the client posted on the new enactment or revision of laws, rules, and regulations relating to HWM by holding the seminars, publishing bulletins, and so forth.

6) Information network with the clients

- The project will establish a website for the clients where they can exchange information as well as receive online order for treatment services

7) Distribution of the annual report

- The project will prepare an annual report including the actual treatment performance of the TSD facilities, financial statements, some pieces of useful information to the clients such as the measures of waste minimization at sources, etc.

8) Provision of waste management consulting services

- The project will provide consulting services addressing the management of the wastes that are not accepted by its facilities including non-hazardous wastes. In case of non-treatable HWs that are not acceptable even to the facilities of the project, the project will conduct joint R&D activities with the clients so as to examine proper storage and treatment measures.

Chapter 6

Financial Plan

6 Financial Plan

6.1 Financing Options

The Study estimated that the initial investment cost of MIF project would be 2,570 million pesos.

The Study examined the following options of fund raising from domestic as well as foreign financial sources.

(1) Fund Raising Options from Domestic Sources

- Capital infusion by the project implementing body (DENR/NRDC)
- Fund raising through bond issuance by the project implementing body (DENR/NRDC)
- Allocation from the national budget to the Project
- Fund raising from domestic financial institutions (public/private)

(2) Fund Raising Options from Foreign Sources

- Financing from bilateral aid agencies
- Financing from multilateral aid agencies (the World Bank, ADB, etc.)

6.2 Assessment of Financing Options from Domestic Sources

(1) Capital infusion by the project implementing body (DENR/NRDC)

NRDC, the public corporation under the control of DENR, is responsible for development and management of mineral and forest resources in the Philippines. According to the financial statements of FY 1998/99 and 1999/2000, about 50 million pesos of net profit had been achieved every year. The amount of retained earning by the year 2000 reached 250 million pesos. Current balance of borrowing is also held at minimum level. Taking into account such financial situation, NRDC may have the capacity to make some capital infusion to the Project as the implementing body.

According to an interview of an NRDC official by the Study Team, 50 to 100 million pesos of capital infusion may be possible as far as the current financial performance of NRDC is maintained.

However, because this amount covers only about 2 to 4% of the total initial investment, the problem of raising the remaining funds still remains.

(2) Bond issuance by the project implementing body (DENR/NRDC)

Taking into account the good financial performance of NRDC, bond issuance is also considered to be another option of fund raising for the Project.

The result of the interview of the Development Bank of the Philippines (DBP) clarified that the following conditions for bond issuance were required to be met by NRDC:

- The bond issued by NRDC needs to be endorsed by the Department of Finance (DOF) of the Philippines,
- Redemption period of the bond will be 5 years,
- Interest rate will be set at 16.25%

Furthermore, the quarrying right in Lahar Region, that was the main income source of NRDC at the time of the above interview of DBP, was transferred to the local authority, so that the financial situation of NRDC is now totally different and makes bond issuance a difficult proposition. However, the DENR management of gold mining operations in Mt. Diwalwal in Mindanao might positively change the financial status of NRDC.

(3) Allocation of the national budget to the Project

To obtain budget allocation from the Government, a series of budget approval steps has to be overcome by the project implementing body (DENR/NRDC). Such process includes approval of project budget allocation within NRDC and DENR, approval of project proposal by NEDA-ICC, approval of Congressional appropriation for the project, Presidential approval of the General Appropriations Act (GAA), budget release by the Department of Budget and Management to DENR, sub-allotment of budget to NRDC for the project.

Even if the above procedural hurdles are cleared, the amount of the budget to be appropriated to the Project may not be higher than to 10 to 20% of the total initial investment.

(4) Fund raising from domestic financial institutions (public/private)

Due to the limited availability of lending funds and tough conditions for borrowing such as the limited term of repayment and high rate of interest, it is very difficult to tap for the Project funds from domestic financial institutions.

6.3 Assessment of Financing Options from Foreign Sources

(1) Financing from bilateral aid agencies

As the financing from bilateral aid agencies, project loan based on the agreement by both governments can be considered. In the case of Japanese Yen loan, 85% of the total project cost can be financed to the project at its maximum under the borrowing conditions shown in below. The basic conditions of the Japanese Yen loan are as follows:

Table 6.3.1 Financing Conditions of Japanese Yen Loan

Loan Category	Repayment Period	Grace Period	Interest rate	Maximum loan amount
General project	30years	10years	2.20%	85% of the total project cost
Priority project	40years	10years	0.75%	
Special terms economic purpose of special yen loan	40years	10years	0.90%	

In the case of Japanese Yen Loan, 85% of the total cost project can be financed at its maximum under longer term of repayment period and lower interest than domestic financing institutes in the Philippines. However, it should be kept in mind that the long-term loans provided by bilateral aid agencies such as Japanese Yen Loan are usually carried out in the form of the currency of lending country. Currency risk has to be duly considered in utilizing these loans.

(2) Financing from multilateral aid agencies

International Finance Corporation (IFC) and ADB are the major multilateral financing institutes.

IFC is currently very active in financing the environmental projects such as this model project. Although IFC especially encourages private participation in such projects, it also provides financial support to public-private joint ventures. However, the financing limit is set at 25% of the total project cost and its conditions are also harder than Japanese Yen Loan.

The financing conditions of ADB are more or less similar to IFC.

6.4 Overall Assessment of Financing Options

(1) Domestic Sources

Capital infusion by the project implementing body and National Budget appropriation are the currently possible domestic financing sources in the Philippines.

According to the surveys done by the Study Team, the possible financing amount from domestic sources is estimated to be approximately 600 million pesos at the maximum. It covers about 25% of the total initial investment cost of the Project.

(2) Foreign Sources

If the Project is implemented by a public body (DENR or NRDC), there is a possibility to utilize Japanese Yen loan to finance 85 % of the total project cost at its maximum.

In the case of utilizing the fund from multilateral aid agencies (IFC or ADB), the project implementing body can be private or public-private joint venture. The financing amount will be more limited than Japanese Yen Loan. Therefore, the remaining fund to be raised from other sources will be much bigger.

The model HW treatment project recommended in this Study is estimated not to be financially feasible enough to be implemented as a private sector business in the Philippines. That is why public body is recommended to be the implementing body of the Project. All of these indicate that it is difficult to utilize IFC/ADB finances since both of them requires that the Project has to be carried out by private sector.

Accordingly, use of Japanese Yen loan is considered to be the most appropriate financing option for the Project.

6.5 Acquisition of Local Counterpart Funds

Even though Japanese Yen loan can be utilized at its maximum for MIF Project, the remaining 15% of the initial investment cost has to be raised from domestic sources.

Since the Asian financial crisis, achieving financial closure has become more difficult, even for projects with proven demand and limited currency mismatch. Traditional providers of debt are reluctant to accept the risks associated with off-balance sheet infrastructure investments. Even apparently viable projects, are unable to find financing because of the lack of affordable financing flowing into the Philippines and the absence of peso-denominated long-term financing.

Given these prevailing limitations, obtaining the required local counterpart funds relies mainly on NRDC's (being the project implementing body) ability to provide these fund resources. However, it is still very difficult to raise all the counterpart fund of about 400 million pesos only by NRDC, consequently the Study Team investigated the following financing options.

- Issuance of bonds by NRDC
- Equity infusion by NRDC
- Loan and equity from multilateral finance corporations
- Local financial institutions
- Local non-banks and contractual savings institutions
- Concessionary finance from private sector companies
- GOP subsidies

Preliminary evaluations of various financing sources above are summarized in Table 6.5.1 on the next page.

Table 6.5.1 Financing Options

	NRDC Bonds	NRDC equity infusion	Multilateral finance corporation	Local Financial Institution	Local Non-bank etc	Concessionary Finance fm Private sector	GOP subsidy
Loan condition	Min. magnitude P400-500 5years with 15.5% as fixed rate 10years bond with floating rate 18-19%	Maximum infusion is P50 million Free interest	ADB: Private ownership:51% IFC: Buying the share of 5-20% of the project equity	Not certain at this moment Short term		Dependent on the market	Subsidy (but repaid by NRDC)
Risk	NRDC, DOF	NRDC	IFC or ADB	Local	Local	Private sector	GOP
Advantage	Bond with DOF guarantee is acceptable for the market	NRDC's commitment on the project is clarified, and the equity infusion makes the cash flow healthy.	None	None	None	None	Mitigate the burden on the project
Disadvantage	The high interest rate imposes a burden on the project.	None	Only for the private Equity return: 20%	Loan with GOP guarantee base is not acceptable for GOP. Prototype project is not attractive.	Their financial difficulties, lack technical and financial expertise	Restricted by DOF and JBIC	Lobbying Congressional support
Constraint/ Requirement	Guarantee and Endorsement by DOF	Approved by board of NRDC	Approved by lenders	GOP guarantee for market risk and FX risk	Approved by the board of NRDC	Approved by lenders	Approved by Congress
Evaluation	-	+	-	-	-	-	+

As summarized in the Table 6.5.1, options like commercial bank borrowings, loan from non-banks, multilateral finance corporation investments, and private sector borrowings are geared mainly for private sector investment. In addition, all these financing options may be difficult to tap due to various financial institutions' limitations, high interest rates, long tenors and restrictive policy issues. They should only be pursued as the next option.

The Study recommended that the project should first rely on the financial resources of NRDC for initial equity infusion of between P50 to 100 million. The project should also work toward justifying a budget appropriation for the required counterpart fund by highlighting its economic and social benefits. This would ensure the project's long-term viability and sustainability in addressing the country's hazardous waste problem.

6.6 Schedule of Finance

Assuming that the initial cost of the project is covered by the foreign long-term loan at the ratio of 85% while the remainder is covered by local counterpart fund, the distribution of financing amount between foreign long-term loan and local counterpart fund will be as shown in Table 6.6.1 below.

Table 6.6.1 Distribution of Finance by Sources

	Amount (thousand pesos)	%
Initial Cost of the Project	2,567,059	100
Foreign long-term loan	2,182,000	85
Counterpart fund	385,059	15

Remark: Interest arising during the construction period is excluded from the figure above.

In this case, the following cost items are covered by local counterpart fund, i.e.:

- Value added tax and import duties
- Cost related to land acquisition

Taking into account the disbursement conditions above, Table 6.6.2 below shows the annual disbursement plan in the 3-year initial investment stage of the project.

Table 6.6.2 Disbursement Plan

Unit: thousand peso

	Total	1st year	2nd year	3rd year
1) Land	153,900	153,900	-	-
2) Plant	1,532,000	486,880	613,120	432,000
3) Landfill	268,000	164,800	95,200	8,000
4) Engineering	188,000	77,080	56,400	54,520
3) Physical contingency	117,600	29,400	29,400	58,800
4) Price escalation	78,296	0	30,126	48,170
VAT	206,177	72,876	79,426	53,875

5) Reserve for starting operation	23,086	0	0	23,086
Interest during construction	51,492	0	16,680	34,813
Total	**2,618,551**	**984,936**	**920,351**	**713,264**
Foreign Long-Term Loan	**2,182,000**	**758,160**	**824,246**	**599,594**
Counterpart	**436,551**	**226,776**	**96,105**	**113,670**

Remark: Interest during construction period is covered by counterpart fund in the figure above.

In the 1st year, the total cost of about 758 million pesos are covered by the disbursement of foreign long-term loan while the remaining 227 million pesos, the sum of the cost of land purchase and the payment of VAT has to be covered by the local counterpart fund. In the 2nd year, all the cost arising in the 2nd year are covered by the foreign long-term loan except for the payment of VAT, which has to be covered by the local counterpart fund. Finally in the 3rd year, the amount of JBIC loan and the local counter part fund will be disbursed.