whether the project is eligible for the soft loan, and setting criteria which are to be applied by OEPP when it allocates the Environment Fund to CT projects.

- To consider incentives for CT. The incentives currently available are those given through IFCT and OEPP as aforementioned.
- To develop human resources in CT, including the introduction of a CT auditors and advisors system and CT training programs. The latter has already started.
- To establish a CT Information Center. The IT Center of DIW is establishing a database of information on CT.

**b. Industrial Cluster**

IEAT had not had a particular intention to promote waste exchange between factories within an industrial estate (IE) on the development of the IE, except for the Map Ta Phut IE, where by-products circulate among factories since its main industry is petrochemical. Recently, however, IEAT started an Eco-Industry Project, which can be one of the examples of the attempt to formulate an industrial cluster. IEAT is promoting this project with the collaboration of the University of Chulalongkom in Thailand, the GTZ in Germany, and other organizations. The participating industry estates are the Amata Nakorn and Eastern Seaboard Industrial Estates, which are joint ventures with the private sector, in addition to the Map Ta Phut, Banpoo, and Lampoon Industrial Estates, which are under the direct control of IEAT. The outline of their action programs of each fiscal year is as shown below.

| | |
|---|---|
| 2001 | Preparatory Stage (holding workshops, organizing a working team and a management team ) |
| 2002 | Drafting 5 year A/P in the five industrial estates, Formulation of 3-year master plan |
| 2003 | Data analysis and investigation, Implementation of projects |
| 2004 | Evaluation |
| 2005 | Consideration of future development |

As shown above, main activity in 2001 and 2002 is to formulate a master plan for the Eco-Industry Project and hold seminars. It is going to put the plan into operation in and after 2003. The team had an impression that the plan is still in the conceptual stage and still unsubstantial as a whole. Utilization of wastes, by-products and heat recovery mainly inside the Map Ta Phut Industrial Estate are part of the A/P. The IEAT is planning to transfer the experience of the Map Ta Phut Industrial Estate to other industrial estates in and after 2005, but the details will be studied from now on.

## 4.3 Off-site IWM

### 4.3.1 Collection and Transportation

The team recognizes the following characteristics of waste collection/transportation from the waste flow.

- Non-HW generated is 2.365 million ton/year and 70% (1.657 million ton/year) is discharged from factories. 69% (1.148 million ton/year) of discharged non-HW is taken out by waste buyers, 29% (474,000 ton/year) is collected by

private waste collectors/transporters and the rest 2% is collected by local administrative organizations.

- On the other hand, HW generated is 557,000 ton/year and 43.7% (244,000 ton/year) is discharged from factories. 80%, 19%, and 3% of the discharged HW is collected by the private collectors/transporters, waste buyers and local administrative organizations, respectively.

As suggested above, the amount of waste collected by local administraton is rather small. The answers obtained in the factory survey agree this, in that:

- The most popular waste collection service provider is private companies with which the factories contracted, as 54% answered, followed by waste buyers (50%) and local administrative organizations.
- The collection service by local administrative organizations is more frequent than by that by the private sector.

However, the answers to the questionnaires sent to 94 local administrative organizations showed different conclusion.

- Local administrative organizations in the study area collect 3.972 million ton/year of waste in total.
- The team estimated the proportion of industrial waste to their total collection amount at 5.3% based on their estimation. Using this figure, industrial waste collected by them comes to 211,000 ton/year.

Industrial waste that the local administrations collect is non-HW. Therefore, non-HW amount collected by the local administrations is 35,000 ton/year according to the factory survey and 211,000 ton/year according to the questionnaires to them. The disparity will be because the latter includes waste collected by the private companies under the contract with the local administrations.

It is to be noted that the transport permits were issued only for 94,000 tons of non-HW and 6,400 tons of HW in 2000.

### 4.3.2 Reuse and Recycling

From the result of the survey on waste reuse/recycling companies and waste flows explained earlier, the following features can be drawn in regard to waste reuse/recycling of non-HW and HW.

**a. Non-HW**

From the Non-HW waste flow, it is proved that 70% of the non-HW is brought out off-site, and the reuse/recycling rate of off-site accounts for 64.8% when assuming the waste received by waste buyers (Por Kha Khong Gao) is reused/recycled.

The team compared the reuse/recycling rate of the JICA study and the JCI (Japan Consulting Institute) study in IEAT Ladkrabang Industrial Estate. The external selling/recycling rate of wood, paper, cloth, metals, and plastics studied by JCI range from 50% to 85%, indicating that the reuse/recycling rates of these non-HWs are very high as found in the present study.

When checking the off-site reuse/recycling rate of non-HW by type listed in Table 4-24, over 90% of plant roots, leaves (C01-01), animal bones, skins (C01-02), paper (C03), etc. is recycled, followed by the reuse/recycling rates of 70 to 80% of trees (C02), plastics (C04), cloth (C05), and metal (C08). As for the off-site reuse/recycling amount, metal (C08) occupies one-third, followed by animal bone and skin (C01-02), wood (C02) which respectively account for nearly 20%, and plastics, 8.7%. These four types of wastes account for some 80% of total waste reused/recycled off-site.

Table 4-24: Reuse and recycling rate of Non-HW by type

| Non-HW Code for the Study | Descriptions | % of Reuse/Recycle | |
|---|---|---|---|
| | | On-site | Off-site |
| C01-01 | Parts of plants such as roots, barks and leave | 0 | 100.0 |
| C01-02 | Parts of animals such as bones, skins, hair and excreta | 9.3 | 90.6 |
| C02 | Parts of wood | 21.2 | 77.1 |
| C03 | Paper waste | 1.1 | 96.7 |
| C04 | Plastics or synthetic rubbers | 5.8 | 81.1 |
| C05 | Cloth, thread and fabric | 21.3 | 69.5 |
| C06 | Animal's fat and oil and vegetable oil | — | — |
| C07 | Natural rubbers | 61.5 | 31.0 |
| C08 | Metals and metal alloys (not in salt form) | 11.1 | 70.4 |
| C09-01 | Ceramics | 0 | 0 |
| C09-02 | Glasses | 35.1 | 55.3 |
| C10 | Stone, cement, sand or materials consisting of clay, sand or stone e.g. tile, brick gypsum and concrete | 10.8 | 7.9 |
| C11 | Mixed waste | 0 | 0 |
| C12 | Others | 38.4 | 38.1 |
| Total | | 13.6 | 64.8 |

**b. HW**

When checking HW flow, it is proved that that 43.7% of the HW is carried out off-site. Waste buyers (Por Kha Khong Gao) deal with 7.8% of HW. Including this figure, the off-site reuse/recycling rate is 14.2%. Table 4-25 lists the reuse/recycling rate of HW wastes by type. The reuse/recycling of each HW is described below.

- Waste acid (W01) is all treated and disposed of off-site. Conversely, over 80% of waste alkali (W02) is reused/recycled on-site, and the remaining alkali is treated by the private sector in the off-site.
- The reuse/recycling rate of heavy metal compounds (W03), acid wash waste liquids (W10), and other wastes (W12) are about 40%, a relatively higher percentage among HWs. It seems that heavy metals in heavy metal compounds (W03) are melted and then reused as metals.
- All of solid inorganic compounds (W05) are treated by licensed companies in the private sector. Over 90% of organic compounds (W06) are also brought out, and some 25% of the total organic compounds are reused/recycled off-site.
- Over 90% of polymers (W07) is also brought out of factories, most of which is treated and disposed of. Thus, the reuse/recycling rate is low.

- The reuse/recycling rate of waste oil is generally expected to be high, but it is only 15.6% (12.9% off-site).
- Some two-thirds of inorganic and organic sludge is dehydrated and dried on-site and most of the remaining sludge is treated (and stabilized) off-site for final disposal. It is hardly reused/recycled.

Table 4-25: The reuse and recycling rate of HW by type

| HW Code for the Study | Descriptions | % of Reuse/Recycle to total generation | |
|---|---|---|---|
| | | On-site | Off-site |
| W01 | Acid | 0 | 0 |
| W02 | Alkalis | 82.5 | 0 |
| W03 | Heavy Metal Compounds | 0 | 41.2 |
| W04 | Liquid Inorganic Compounds | 0 | 0 |
| W05 | Solid Inorganic Compounds | 0 | 0 |
| W06 | Organic Compounds | 7.4 | 24.8 |
| W07 | Polymer Materials | 0 | 4.1 |
| W08 | Fuel, Oil and Grease | 2.7 | 12.9 |
| W09 | Fine Chemicals and Biocides | 0 | 0 |
| W10 | Pickling Waste | 0 | 39.7 |
| W11 | Filter Materials, Treatment Sludge | 1.2 | 0.2 |
| W12 | Other Toxic Substances (besides W01-W11) | 10.4 | 41.8 |
| Total | | 4.0 | 14.2 |

The next table shows the amounts of reuse/recycle of HW by type and their rates to total quantities.

- The off-site reuse/recycling amount of other wastes (W12) records 50,000 tons per year, which accounts for about two thirds of the total quantities of waste reused/recycled off-site.
- The reuse/recycle of waste oils (W08) in the on-site amounts to some 20,000 tons per year. In addition, part of waste oil which is treated at private licensed companies is likely to be reused/recycled.
- Other waste categories which are well reused/recycled are 3,600 ton/year of organic compounds (W06) and about some 2000 ton/year of heavy metal compounds (W03).

Table 4-26: Amount of Reuse and Recycle of HW by type

| HW Code for the Study | Descriptions | Total Generation Amount (ton/year) | On-site Reuse/Recycle Amount (ton/year) | Off-site Reuse/Recycle Amount (ton/year) | Total Reuse/Recycle Amount (ton/year) |
|---|---|---|---|---|---|
| W01 | Acid | 1,881 | 0 | 0 | 0 |
| W02 | Alkalis | 2,956 | 2,439 | 0 | 2,439 |
| W03 | Heavy Metal Compounds | 4,555 | 0 | 2,080 | 2,080 |

| | | | | | |
|---|---|---|---|---|---|
| W04 | Liquid Inorganic Compounds | 51,774 | 0 | 0 | 0 |
| W05 | Solid Inorganic Compounds | 585 | 0 | 0 | 0 |
| W06 | Organic Compounds | 14,579 | 1,070 | 3,622 | 4,692 |
| W07 | Polymer Materials | 18,331 | 0 | 756 | 756 |
| W08 | Fuel, Oil and Grease | 159,690 | 4,211 | 20,711 | 24,922 |
| W09 | Fine Chemicals and Biocides | 18 | 0 | 0 | 0 |
| W10 | Pickling Waste | 1,419 | 0 | 563 | 563 |
| W11 | Filter Materials, Treatment Sludge | 180,238 | 2,175 | 393 | 2,568 |
| W12 | Other Toxic Substances (besides W01-W11) | 121,430 | 12,560 | 50,757 | 63,317 |
| Total | | 557,456 | 22,455 | 78,882 | 101,337 |

### c. Comparison with Past Study Data

Table 4-27 shows the comparisons between JICA study and the PCD study[2] in terms of recycled waste quantities.

In the JICA Study, the team obtained the figure of reuse/recycling amount of waste discharged only from factories, but PCD did not specify the generation source, which can be factories, households, shops or others. This is because non hazardous recyclable wastes usually come together regardless the generation sources.

It is not straightforward to estimate how much each generation source contributes to the recycling amount. From the hearing during the Study on Waste Reuse/Recycling/Treatment Companies, the team found that 30% of iron scraps is discharged from factories while the remaining 70% of iron scraps is discharged from the generators except factories. In case of recyclable waste, if we presume that waste discharged from household, shops and communities is much more than waste discharged from the factories, we can say that the data collected by JICA are consistent with the data collected by PCD.

[2] Final Report of the Study on Guideline to Reduce Pollution by Recycle, PCD, MOSTE, March 1998

Table 4-27: Comparisons between JICA study and the PCD study in terms of recycled waste quantities

(1,000 ton/year)

| | PCD Survey 1994 | | JICA 2001 | | | |
|---|---|---|---|---|---|---|
| | Generator | Amount | Reuse/Recycler/Treatment Company Survey | | Factory Survey | |
| | | | Generator | Amount | Generator | Amount of off-site Reuse/ Recycle |
| | Area: Nationwide | | Area: Nationwide | | Area: BKK,SP,PT,NT,SS | |
| Iron+Al | H,F,C,S,O | 1,959 | N/A | 2,060 | F | Metal;507 |
| Paper | H,F,P,O | 676 | - | - | F | 88 |
| Plastic | F | 235 *2 | - | - | F | 133 |
| Glass | H,F,S,O | 285 | - | - | F | 40 |
| Tires | H,F,T,O | 1,804 *1 | - | - | - | - |

(Note) H: Home, F: Factory, C: Construction, S: Shop, P: Printing Shop, T: Tire Shop, O: Others

*1: Thousand tires/year, *2:1995～1996

### d. Problems on Reuse and Recycle

Major problems on the reuse and recycling of industrial waste in the on-site and off-site are as follows:

- As a whole especially for the HW, the reuse/recycling rate in the on-site is low (Non-HW: 13.6%, HW: 4.0%). On-site waste reuse/recycling should be promoted further.
- There were found inappropriate cases of waste and residue treatment discharged from the process of reuse/recycling off-site.
- For example, in the local secondary aluminium recycling factory, the discharged dross seemed to be dumped or landfilled on-site. In case of iron scrap recycling, the electric furnace dust that contains hazardous heavy metals is also dumped and landfilled in the on-site. Electrical components are recycled but lead is used in the form of solder of waste printed circuit boards. Waste printed circuit boards must be therefore dealt with as HW but are often regarded as non-HW. Thus, reuse/recycle control must be exercised more strictly.
- The standard or criteria to control the process of reuse/recycling is required.
- The recycling rate of inorganic sludge (W11) is very low compared to other waste recycled off-site. The inorganic sludge that contains useful metals could be reused by non-ferrous metal smelters or furnaces that are designed for a recycling purpose although there is no such furnace yet in Thailand.
- It is a serious problem that at least 22% of HW is directly dumped or landfilled on-site or at public landfill without any intermediate treatment such as stabilization. For example, about 75% of waste oils (W08) are dumped or landfilled on-site. In Japan, waste oils except tar pitch are forbidden to landfill without any treatment.

### 4.3.3 Treatment and Final Disposal

#### a. Present Situation of Exiting Facilities in the Survey Area

Existing facilities in the study area are explained below, divided into those outside of industrial estates of IEAT and those inside of them.

#### a.1 Intermediate Treatment and Final Disposal Facilities outside IEAT Industrial Estates

Facilities outside of IEAT industrial estates in the study area are listed in Table 4-29. They are in two groups.

- Facilities with DIW registration
- Municipal waste landfills receiving non-HW

#### a.1.1 Facilities with DIW Registration

#### i. Samae Dam Center

DIW Samae Dam Center is the first hazardous waste treatment center in Thailand. It locates the western suburb of Bangkok, Samae Dam sub-district, Bangkhuntien district. The area is about 10 hectares and the facility comprises a physical-chemical treatment plant for wastewater and sludge stabilization. DIW established this center in 1989 and operation & maintenance (O&M) has been subcontracted to GENCO since 1996. The treatment plant for wastewater is treating wastewater from electroplating industry, dye & textile industry, etc.. The outline of the treatment process is mentioned below.

Table 4-28: Waste Treatment at Samae Dam Center

| Wastewater | Hazardous Substances | Process |
|---|---|---|
| Electroplating industry | Cyanide<br>Heavy Metal | Alkaline-Chlorination<br>Coagulation-precipitation |
| Dye & textile industry | (BOD, COD, SS etc.)<br>Chemical | Coagulation-precipitation |
| Alkali wastewater | Heavy Metal | Neutralization<br>Coagulation-precipitation |
| Acid wastewater | Heavy Metal | Neutralization<br>Coagulation-precipitation |

Wastewater is transported in tank trucks or drums from factories that have no wastewater treatment plants to the center. After the physico-chemical treatment, the effluent is discharged to the nearby waterway. The sludge from this wastewater treatment plant is dewatered by drying beds and then stabilized with chemicals such as lime. They also receive and stabilize the sludge from factories that generate sludge but have no facility for stabilization. The stabilized sludge is transported to Rachaburi secured landfill for landfilling. This secured landfill was established by DIW and its operation was subcontracted to GENCO.

#### ii. Others

Two other facilities with MOI registration are:

- Waste organic solvent recycling factory of a company Refine Tech, located in Samut Prakarn registered as a HW recycling facility of code 106 in 2002 (see Annex 3.5 for details).
- A company named Exhaust in Samut Prakarn registered as a non-HW incinerator of code 101 in 1996 without an incineration facility as of the end of June 2002.

### a.1.2 Municipal Waste Landfills

There are 5 municipal waste landfills that receive non-HW from factories. Out of those, the Kam Paeng Saen landfill is in Nakhon Pathom, outside of the study area, but is listed since it serves as a municipal waste landfill for BMA.

Table 4-29: Current IWM Facilities (1): In the Study Area and Outside Industrial Estate under IEAT

| DIW Regis. | Name | Location (Prov., Dist.) | Category | Function of the Facilities | | | Capacity (tons/year) | Ownership | Operator |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Target Wastes | Work Contents | | | | |
| Yes | DIW Samae Dam Center | Bangkok, Bangkhuntien | HW Treatment | 1. Wastewater (WW) | WW from mainly plating factories<br>EP WW; 200 t/d<br>D&T WW; 800 t/d | Sludge is treated. | 110,000<br>Actual amount (2000): 100,171t | DIW | GENCO |
| | | | | 2. Sludge stabilization | Chemical stabilization 100 t/d | Treated sludge to Rachaburi landfill | 30,000 | | |
| Yes | Refine Tech | Samut Prakarn | HW Treatment | Waste solvent | Treatment of waste iso-propyl alcohol | | 5 $m^3$/d<br>1,800$m^3$/y | Private | Private |
| Yes | Exhaust | Samut Prakarn | Non-HW Treatment | NA (not available) due to no existence of facility | | | NA | | |
| No | Racha Thewa Landfi | Samut Prakarn | MSW (1) | Non-HW | Non-HW from Bangkok | | 76,457 | Private | Private |
| | | | | MSW | MSW from Bangkok | | 1,353,358 | | |
| No | Kam Paeng Saen Landfill | Nakhon Pathom | MSW (1) | Non-HW | Non-HW from Bangkok | | 90,466 | Private | Private |
| | | | | MSW | MSW from Bangkok | | 1,606,597 | | |
| No | Sai Noi Landfill | Nonthaburi | MSW (1) | Non-HW | Non-HW of Nonthaburi | | 5,743 | Nonthaburi Province Sanitary Management Organization | Nonthaburi Province Sanitary Management Organization |
| | | | | MSW | MSW of Nonthaburi | | 281,407 | | |
| No | Preksa Mai Landfill (3) | Samut Prakarn | MSW (1) | MSW including non-HW | MSW of 12 Municipalities among 15 in Samut Prakarn | | 292,000 | Private | Private |
| No | Bo Ngun Landfill (4) | Pathum Thani | MSW (1) | MSW including non-HW | MSW of 6 Municipalities among 13 in Pathum Thani | | 146,000 | Municipality of Muang Pathum Thani | Municipality of Muang Pathum Thani |

(Note) 1. MSW: Municipal Solid Waste
2. Disposal Amount was estimated based on the answers to the questionnaire survey to the districts in Bangkok and the Municipalities
3. There may be another landfill site in Samut Rakarn area on the western bank of Chaopraya River.
4. There may be another landfill site serving for the other 7 municipalities in Pathum Thani. Please refer to Chapter 3.5.2.
EP WW: Electroplating Waste water, D&T WW: Dye & Textile Waste water

## a.2 Treatment and Final Disposal Facilities inside IEAT Industrial Estates

### a.2.1 IEAT

In almost all of the industrial estates directly controlled by IEAT, IEAT provide the operational utility services like industrial water supply, sewage treatment and solid waste treatment and so on.

Table 4-30 is the capacity of existing IWM facilities of IEAT inside study area. Actually, there are five IEAT industrial estates in the study area. However ,Bangchan Industrial Estate is old and has no centralized wastewater treatment nor small incinerators. Therefore Bangchan Industrial Estate is excluded from this list. Since all the centralized wastewater treatment plants employ a biological process, the wastewater that contains hazardous substances such as heavy metals cannot be treated at those. The influent is mainly consists of domestic wastewater from the offices and canteens. The process wastewater that comply IEAT standard of wastewater also can be received at the treatment plants in order to lower the BOD.

Among the non-HW industrial wastes, the recyclable industrial waste are sorted at the factories and transported to recyclers and waste shops directly from the factories. The remaining non-HW from the factories are collected and transported to the landfill sites run by BMA (Bangkok Metropolitan Administration), municipality, district administration and/or private sector. In the process of collection and transportation, and even in the landfill site, so-called "Scavengers" recycle recyclable waste.

Figure 4-4 is the waste collection flow of Bangpoo Industrial Estate and Figure 4-5 is the waste collection flow of Bangpoo Industrial Estate in 1998[3]. In these two industrial estates, the sorted recyclable industrial wastes are basically sold to transportation companies. On the contrary in case of garbage and/or mixed wastes, the factories pay the transportation and dumping fee. The payment contract form of recyclable wastes has many varieties: for example, monthly or yearly lump-sum contract, specific weight contract by type of industrial waste, and contract by bidding for every collection of industrial waste. According to the hearing from the reuse/recycle/treater survey the number of contracts by bid seems to be increasing.

Figure 4-6 illustrates the image of waste flow in the IEAT industrial state excluding wastewater[4]. As a service for factories inside the estates, most of the estates have the incinerators for combustible solid wastes like waste paper, waste plastic, wooden waste and so on. Usually these incinerators are fix bed type incinerators and have small capacities with a few hundreds kg per hour. However these incinerators are not fully operated since the tipping fee of incineration treatment is higher than the fee of dumping. For example, in case of Bangpoo Industrial Estate, the fee of dumping is 150 baht/$m^3$. This value is equivalent to 1,000 baht/ton using the basic design standard of IEAT (waste density: 0.15). On the contrary, the service fee of these incinerators is 2,500~3,500 baht /ton. Since this type of incinerator is a batch type and industrial wastes are fed manually in the combustion chamber, the temperature in the combustion chamber and the temperature and volume of discharge gas fluctuate significantly. The control of the combustion temperature generally becomes very difficult. Like the present condition, if industrial wastes are not collected as expected,

[3] "Feasibility study report: Waste to steam model plant", 1998, NEDO
[4] ibid.

the continuous or collective introduction of wastes is difficult. As a result, dioxins are generated, not a small amount of inflammable residue is left in incineration ash, and part of hazardous materials remains not destroyed. Thus, these types of small incinerators are being disused in Japan. The furnaces being used by IEAT have not been furnished with a dioxin control system, nor even with an exhaust gas control system, which is posing serious problems.

IEAT actively introduces private participation in utility services provision in the estates. In 1999, IEAT established one company named "GUSCO" that is a joint venture of IEAT and the private companies as below.

- France based water supply and waste waster treatment company
- Thailand waste waster treatment company.

Presently the main services of GUSCO are following items.

- Water supply for the factories inside the contracted industrial estates
- O&M of centralized sewage water treatment plant of the contracted industrial estates
- Surface water drainage.

The bid document to call for the JC partners of GUSCO states that GUSCO will provide the service regarding waste management in the future. GUSCO will be developing and expanding the business to cover solid wastes management inside the contracted industrial estates.

Table 4-30: Current IWM Facilities (2): In Industrial Estates under IEAT of the study area

| DIW Reg | Name | Location (Prov., Dist.) | Category | Function of the Facilities | | | Capacity | Ownership | Operation |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Target Wastes | Work Contents | Notes | | | |
| No | Lardkrabang Industrial Estate | Bangkok Lardkrabang | Non-HW Treatment | Sewage | AS | Sewage from factories inside IE | 20,000 $m^3$/d | IEAT | GUSCO |
| | | | Non-HW Treatment | Combustible Ws | Batch type fix bed Incinerator | Damaged | 500 kg/h | IEAT | IEAT |
| No | Gemopolis Industrial Estate | Bangkok Sukhapiban | Non-HW Treatment | Sewage | AS | Sewage from factories inside IE | 2,000 $m^3$/d | Private & IEAT | Private |
| No | Bangplee Industrial Estate | Samut Prakarn Bangplee | Non-HW Treatment | Sewage | AS | Sewage from factories inside IE | 8,000 $m^3$/d | IEAT | GUSCO |
| | | | | Combustible Ws | Batch type fix bed Incinerator | Not full operation | 150 kg/h | IEAT | GUSCO |
| No | Bangoo Industrial Estate | Samut Prakarn Muang | Non-HW Treatment | Sewage | AL/RBC<br>AS | Sewage from factories inside IE | 22,000 $m^3$/d<br>3,600 $m^3$/d | IEAT & GETCO | GETCO |
| | | | | Combustible Ws | Batch type fix bed Incinerator | Not full operation<br>Not operation | 250 kg/h<br>750 kg/h | IEAT | GUSCO |

(Note) IE: Industrial Estate, WW: Wastewater, DWW: Domestic Wastewater, Ws: Wastes, AL: Aerated Lagoon, RBC: Rotating Biological Contactor, AS: Activated Sludge

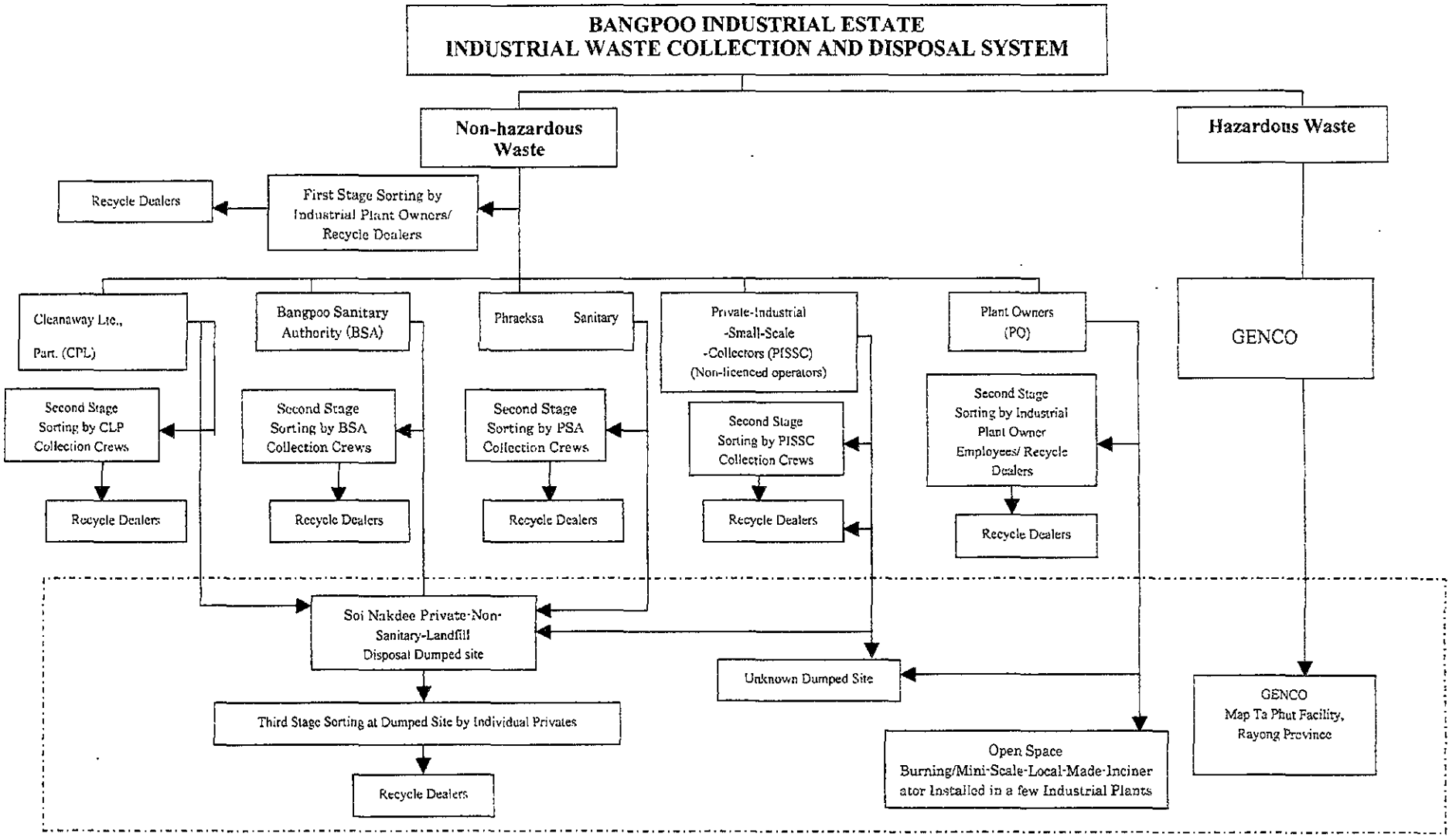



Figure 4-4: Industrial Waste Management System of Bangpoo Industrial Estate

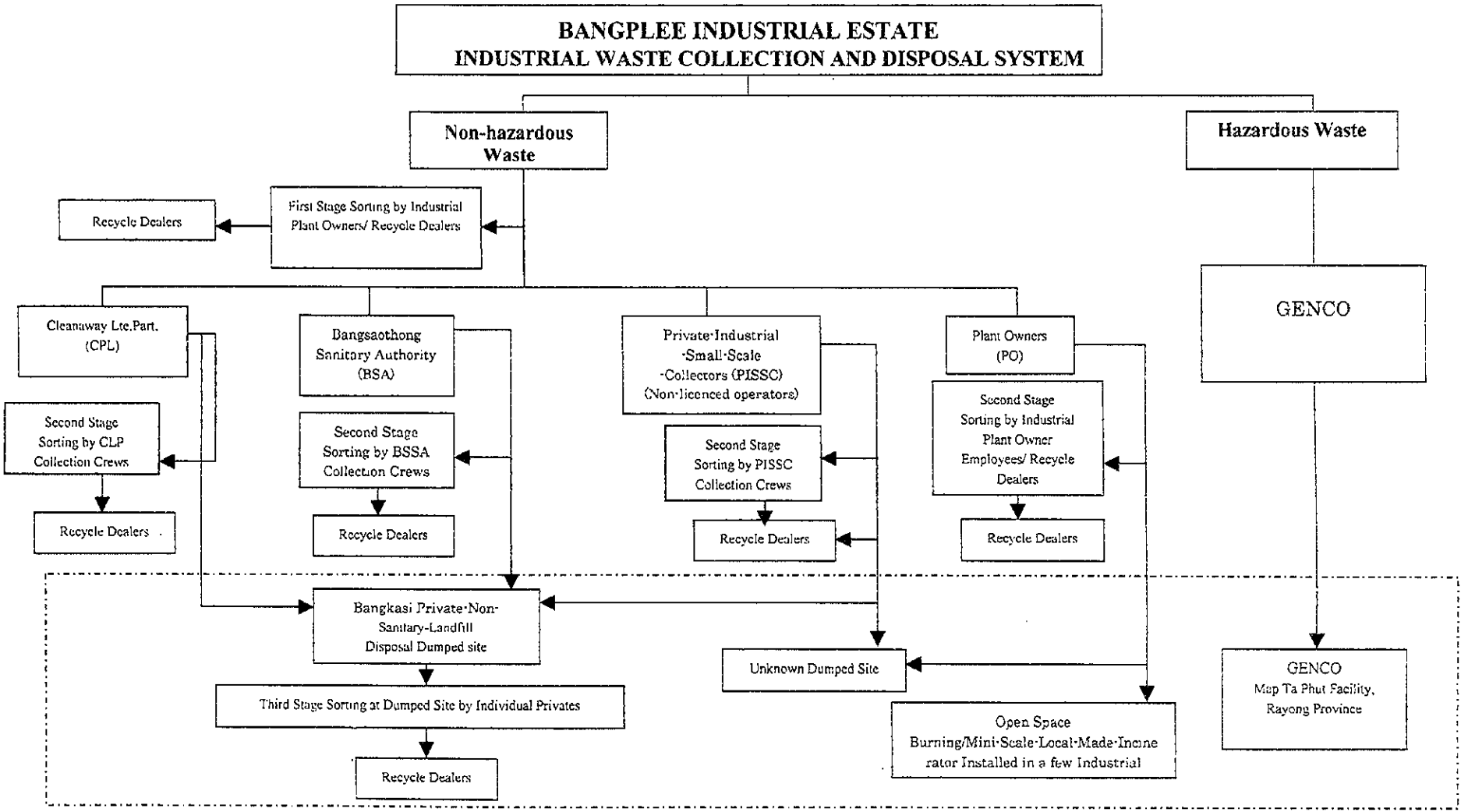
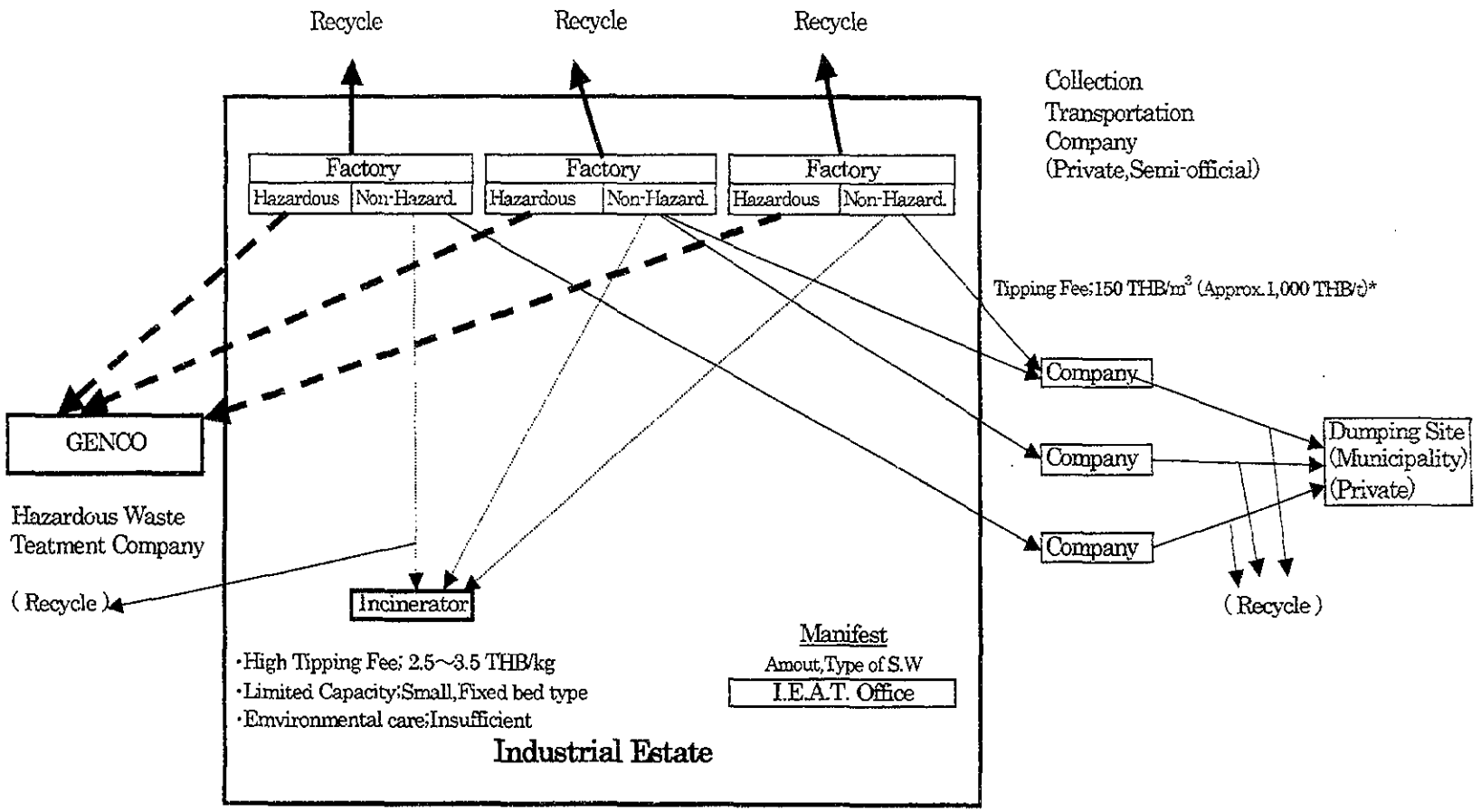



Figure 4-5: Industrial Waste Management System of Bangplee Industrial Estate




*:In case of Banpoo Industrial Estate in Samutprakarn

Figure 4-6: Industrial Waste Management Inside the Industrial Estates

### b. Future Plan

#### b.1 Expansion of Same Dam Centre

Table 4-31 shows a future plan of IWM facilities in the study area. 150,000 ton/year of wastewater containing waste acid, waste alkali, cyanide and heavy metals can be treated after the expansion of DIW Samae Dam Centre. The stabilization of sludge, dry cells and fluorescent lumps that contain mercury adding $Na_2S$ is also planned.

#### b.2 DIW Incinerator for HW

In order to address the increase of HW, Thai government (Cabinet) approved the principle of unused industrial waste management center (Industrial Waste Incinerator) with the budget of 1,200 million baht on July 2 1996. However, actual construction took much time due to the difficulty of site selection and negotiation with local people.. These kinds of work made the contractor hesitate to promote the project.

DIW finally started the construction of the incinerator for HW at Bangpoo Industrial Estate. The EIA report of the incineration construction has been already approved by OEPP under MOSTE.

The applied incinerator is the rotary kiln type incinerator with capacity of 50 ton/day. Present plan is only incinerator without waste heat generator. When waste is fed to the incinerator, waste is burned and gas and ash generate. At the end of the rotary kiln, the bottom ash is separated and conveyed to a portable bin. Exhaust gas goes to the second combustion system where compete combustion is occurred. In case of liquid waste such as like waste oil and waste solvent, it will be fed into the secondary combustion. After quenching, the fly ash is reacted with lime and is absorbed to activated carbon. Then it is settled a stabilization process.

According to the EIA report of this project, the acceptable and non- acceptable wastes for this incinerator are as follows.

a) Acceptable waste

- Clean light oil and solvent that has the flashing point of below 70℃
- Clean diesel and mixed heavy oil
- Dirty mixed solvents and chlorinated organic solvents
- Mixed organic sludge
- Hospital waste
- Soil contaminated by solvent or oil
- Mixed waste

b) Non- acceptable

- Explosives
- Radio-active wastes
- Self-flammable or highly reactive substances in normal situation
- PCB from transformer
- Dioxin

Actually, DIW thinks that the wastes to be incinerated are liquid wastes (waste oil, waste solvents), solid HW and sludge with a proportion of 20%, 30%, 20% in this order.

Table 4-31: Future Plan of IWM Facilities: In the Study Area including Industrial Estates under IEAT

| DIW Regis. | Name | Location (Prov., Dist.) | Category | Function of the Facilities | | | Capacity | Ownership | Operation |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Target Wastes | Work Contents | Notes | | | |
| – | DIW Incinerator for HW | Bangpoo Industrial Estate Samut Prakarn | HW Treatment | Liquid Waste Sludge Solid waste | Fluidized bed type incinerator (No waste heat boiler) | This incinerator will commence operation in 2003~2004. | 50 t/d | DIW | Not determined yet |
| – | DIW Samae Dam Center (Expansion) | Bangkok Bangkhuntien | HW Treatment | Wastewater Containing Acids Alkalis, Cyanides, Heav metals (Cr etc.) | Coagulation-Precipitation, neutralization, Alkaline chlorination Oxidation-reduction etc. | This facility will be completed in 2002. | 500 m3/8hrs | DIW | Not determined yet |
| | | | | Hydro-oxide Sludge<br>Mercury sludge<br>Dry Cell (Hg)<br>Fluorescent Bulb | Stabilization by lime<br>$Na_2S$ Stabilization<br>$Na_2S$ Stabilization | Ditto | 200 t/d<br>35 t/d<br>5 t/d | | |
| – | IEAT Incinerator for Non-HW | Bangpoo Industrial Estate Samut Prakarn | Non-HW Treatment | Combustible waste | Fluidized bed type incinerator with waste heat boiler | Waste Collection IE: Bangpoo, Bangplee, Lardkrabang, Bangchan This incinerator will commence operation on March 2003. | 100 t/d Max.Steam Generation; 12.8t/h | IEAT | Not determined. (Under the consideration of IEAT) |

Legend; IE; Industrial Estate, WW; Wastewater, Hg; Mercury, Cr; Chromium

The construction work began on October 2001 and will end in 2003. After the completion of facility, the test operation will conduct. The full-scale operation is supposed to be started in 2004 or 2005. Because this facility is located inside the Bangpoo Industrial Estate under IEAT, DIW applied factory registration with IEAT. IEAT issued construction permit of factory.

### b.3 IEAT Incinerator for non-HW

IEAT will have a incinerator for non-HW in Bangpoo Industrial Estate. The Japanese government, through NEDO, cooperates with IEAT to provide the fluidized bed type incinerator with capacity of 100 ton/day. Also this incinerator has the waste steam boiler with maximum steam generation of 12.8 ton/hour. They expect to provide steam to the factories inside the Bangpoo Industrial Estate for industrial use. Now it is final negotiation stage between IEAT and subcontract private company that will be in charge of construction of the incinerator and operation maintenance of the waste collection and treatment. The operation is expected to commence in March 2003. The target industrial estates are Bangpoo, Banplee, Banchang and Lardkrabang industrial estate, but IEAT is planning to collect non-HW not only from the factories inside but also from outside these industrial estates. So far, IEAT counts on the tipping fee 2,800 baht/ton and collection fee 500 baht/ton. The total cost of 3300 baht/ton is higher than the existing landfill cost. The prospect of incineration business of non-HW is said to be not promising. Since this incinerator has no electricity generator, IEAT plans to sell generated steam to the factories inside the Estate.

### b.4 HW Final Disposal Site

DIW currently tries to select a site for the construction of HW final disposal site. After selection, construction and O&M are to be contracted out to a private company.

### b.5 PCD Community Generated Hazardous Waste Disposal Centre

In 1998, PCD studied a collection and disposal system for Community Generated Hazardous Waste (CGHW). In this study, CGHW included the following.

- HW from household: Batteries, fluorescent bulbs and containers of insecticide or chemicals
- HW from seaports and airports: left over chemicals, waste oil, gasoline and grease
- Waste oils from gas station
- PCB in transformers and capacitors
- Hospital wastes
- Solid and liquid form wastes and wastewater from the laboratories
- Containers of agricultural chemicals
- Wastes generated at military base

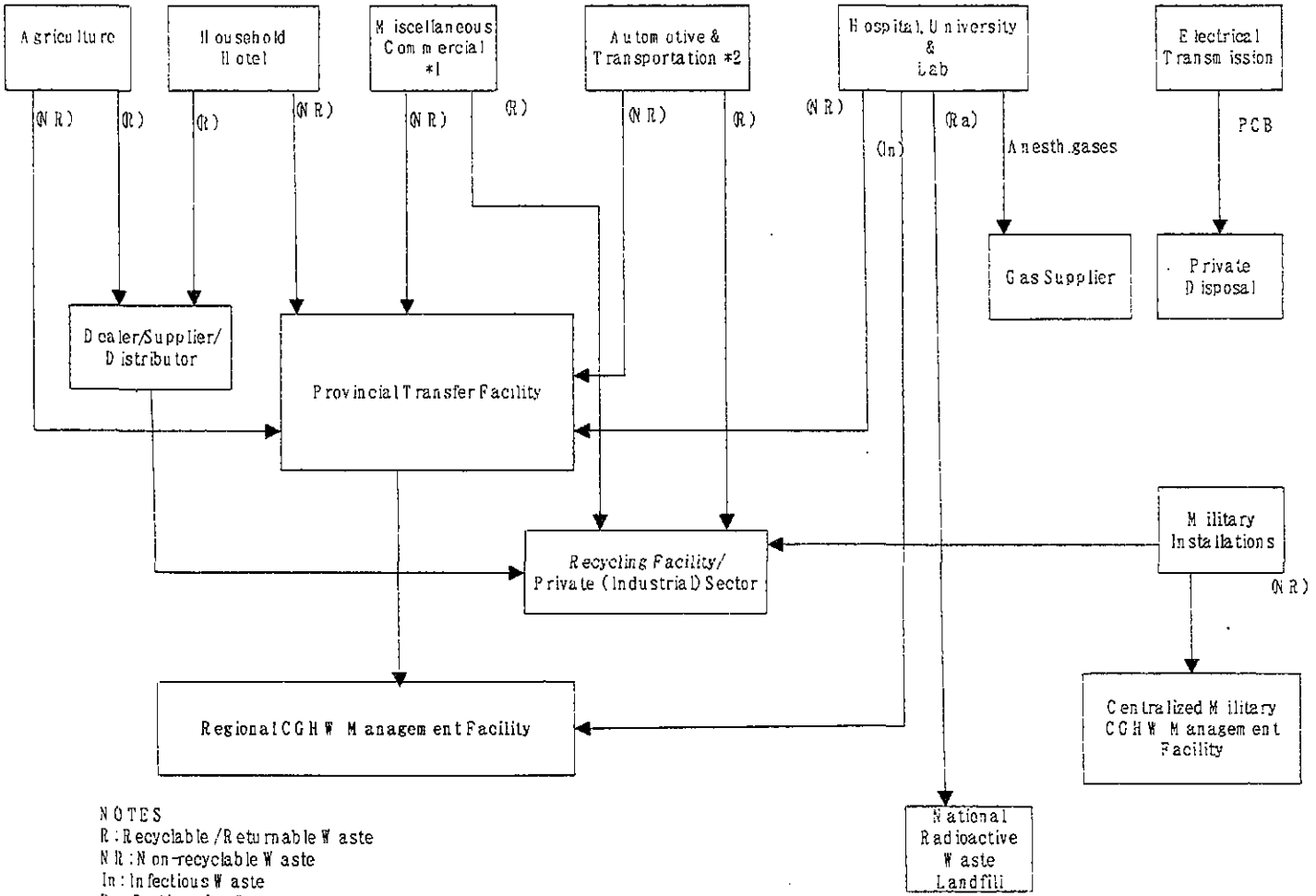
Table 4-32: Estimates of Regional CGHW by Waste Source (1996)

| CGHW by Generator | Quantity (tons/year) | | | |
|---|---|---|---|---|
| | Bangkok | Its Vicinity* | Others | Total |
| Automotive Shops | 66,670 | 9,661 | 73,146 | 149,477 |
| Photo Shops | 2,818 | 241 | 1,934 | 4,993 |
| Dry cleaning & Laundries | 169 | 18 | 253 | 212 |

| | | | | |
|---|---|---|---|---|
| Commercial Printing | 3,392 | 193 | 311 | 3,896 |
| Gas Station | 8,172 | 2,020 | 18,363 | 28,555 |
| Hotels | 238 | 13 | 651 | 902 |
| Airports | 23 | — | 17 | 40 |
| Seaports | 171 | 84 | 313 | 568 |
| Railroad Maintenance & Repair Facilities | 966 | — | 246 | 1,212 |
| Military Installations | — | — | — | — |
| Hospitals | 3,743 | 1,825 | 9,282 | 14,850 |
| Universities, Collages and Laboratories | 1,015 | 80 | 1,247 | 2,342 |
| Agricultural | 65 | 472 | 29,929 | 30,466 |
| Electric Power Transmission | 16 | 10 | 56 | 82 |
| Residential | 6,287 | 3,678 | 56,571 | 66,536 |
| Total | 93,745 | 18,295 | 192,091 | 304,131 |

(*) Note: Vicinity includes Nonthaburi, Pathum Thani, Nakhon Pathom, Samut Prakarn and Samut Sakhon.
Souce: Feasibility Study on the Collection and Disposal System for Hazardous Waste generated from Communities, Kingdom of Thailand (PCD, March 1988)

This table shows the amount of CGHW by region and type in 1996. The CGHW generated about 300 thousand ton nationwide and about 110 thousand ton in Bangkok and its vicinity. It was predicted that the amount of CGHW would increase to 390 thousand ton in 2002, and about 600 thousand ton in 2017. This value is twice as large as the value in 1996. To treat the increasing CGHW, the report said that it is necessary to construct five regional CGHW management facilities nationwide by 2017. The concept flow of regional CGHW management facilities is shown in Figure 4-7.




NOTES
R : Recyclable / Returnable Waste
NR : Non-recyclable Waste
In : Infectious Waste
Ra : Radioactive Waste
*1 : Including Photo Processing, Dry Cleaning and Commercial Printing
*2 : Including Automotive Repair, Gas Stations, Airports, Seaports and Railroad Maintenance

Figure 4-7: The concept flow of CGHW management

The treatment process of the regional CGHW management facility basically comprises incineration, stabilization and landfill. The principal composition of facilities is as follows.

- Administrative Office, Operation and Maintenance Office, Laboratory
- Receiving Facility
- Treatment Facility
  - Kiln type Incinerator for HW
  - Incinerator for Hospital Waste
  - Stabilization Facility
  - Secured landfill
- Wastewater treatment for leachate and reservoir for flood and emergency
- Transfer Station
- Monitoring system

Due to the difficulty of fund raising, the regional CGHW management facility has not been materialized yet. PCD continues the follow up for realization of the facility. Among five centres, PCD concentrate on the one in Bangkok and its vicinity area. Prior to full scale EIA in the future, PCD will conduct site selection and IEE (Initial Environmental Examination) of this location in fiscal 2001 that began in October.

### b.6 Others

DIW has a plan of two other IWM facilities as below.

- Ayuthaya Province treatment centre
- Prachinburi Province treatment centre

These centers are planned to be similar to Same Dam Centre. According to the plan, wastewater containing hazardous substances and sludge will be treated. However the plans are still in a primitive stage. After seeing how on-going projects[5] will develop, DIW may review and proceed these two plans.

[5] Incinerator for HW project and Samae Dam Centre expansion project

### c. Facilities with DIW Registration Outside the Study Area

As described in Section 3.3.3.b, facilities serving for industrial waste management authorized by DIW are 17 in the study area as of the end of April 2002.

Facilities for HW

7 Code 101 facilities, 1 Code 105 facility and 1 Code 106 facility

Facilities for non-HW

5 Code 101 facilities, 2 Code 105 facilities and 1 Code 106 facility

Each of these facilities is further described in Annex 3.5. The major ones are introduced below.

#### c.1 Map Ta Phut Facility of GENCO

GENCO is the first HW treatment company in Thailand. MOI and IEAT has 28% of share of equity. GENCO was established in 1994 and it began the first phase construction and operation of the facility in Map Ta Phut industrial estate, Rayong province in 1997. This plant is composed of the fuel blending facility of waste oil and solvents for cement kiln, stabilization facility of solid wastes and sludge and a landfill.

Presently the capacity of the fuel blending facility is 200 t/d. Mixed waste oils and waste solvents are sent to Cement industries as alternative fuel of cement kilns. On the contrary, solid HW of around 150,000 ton/year such as sludge that contains hazardous substances is stabilized and disposed of in the HW landfill. The remained life of existing landfill is nearly nil. A new HW landfill of 13.6 ha is being constructed in the same industrial estate and will start operation in December 2002. GENCO also has a plan to construct facilities for sludge stabilization and the recycling of batteries, IC parts and other types of waste.

#### c.2 Rachaburi Landfill

This landfill was constructed in 1991 by DIW as the first landfill for hazardous wastes in Thailand. As in the case of the Samae Dam Center, the O&M of this landfill has been contracted out to GENCO. The total area of this landfill is 48 hectares and the area of landfilling occupies 24 hectares excluding the buffer area. The landfill capacity is estimated at 1 million ton. As of the end of May 2002, the second cell is finished and landfilling at the third cell started. The first cell has been already covered with soil. The second cell has not been covered yet since the efficient use of land between the second and third cells is under consideration. The amount of the sludge from Samae Dam Centre is around 30,000 ton/year. There seem to have rooms for landfill at the present landfilling rate, and they also have a plan to extend the landfill to 96 ha.

#### c.3 Waste Solvent Recycling Companies

There are two waste organic solvent recycling facilities that are recognized as CODE 101 factory by DIW. Total capacity of them is 25,000 t/y, but the present actual amount is less than 10,000 t/y.

#### c.4 Cement Industries

As mentioned in Chapter 2.3, Siam Cement (Kaeng Koi) Co., Ltd. and Siam City Cement Co., Ltd got the license of CODE 101 factory. They received waste oils and waste solvents as mentioned above. The solid wastes that contain iron, aluminium and silica are mixed in the stockyard of the raw material as the alternatives.

### 4.3.4 Illegal Dumping

All the factory waste seems to be reused, recycled or disposed of properly according to the answers to the factory survey, but illegal dumping is still suspected. In fact, the study team found an illegal dumping site of industrial waste.

In some municipalities, resident complains to the municipality authorities of the illegal dumping of waste, and ask them to remove it, but it is not evidenced that it was factory waste. The municipal officers stated that it is community waste in most cases.

According to the answers to the Public Opinion Survey (POS), the illegal dumping of industrial waste is pointed out as a priority issue to be solved for improved industrial waste management. The residents said that illegal dumping adversely affects the environment seriously and that they expect the government to take actions against such illegal dumping.

PCD reported 12 cases of the illegal waste dumping from April 2000 to March 2001, as in Table 4-33. They might be only part of reality as they are those complained by the residents to the PCD. Most of them seem to be the illegal dumping of IW.

Table 4-33: Illegal Dumping of Chemical Waste From April 2000 to March 2001

| Case | Details | Action |
|---|---|---|
| 1. Soi Watcharapol, Bangkhen, Bangkok April 24, 2000 | About 160 tanks (capacity 200 litres) of used solvent and paint sludge dumped in an deserted area in Soi Watcharapol. Scavengers emptied the tanks into the nearby canal to sell tanks. It caused the spreading of odor and environmental contamination. | 1. Emergency Operation Team primarily examined type of chemical and instructed guidelines of the safety storage of chemical waste for disposal.<br>2. Coordinated with BMA by giving recommendation and monitoring of clean up by collecting contaminated soil and water for disposal.<br>3. Co-monitored on waste transport to warehouse at Bang Pa In Industrial Estate.<br>4. Supported BMA as a witness to file a lawsuit to the dumpers.<br>5. Coordinated and followed up the progress of chemical waste transport at Bang Pa In Industrial Estate for disposal. |
| 2. Behind Lam Look Ka School, Lam Look Ka Dist., Pathum Thani April 25, 2000 | About 158 covered tanks (capacity 200 litres) of used solvent and paint sludge dumped in a deserted area behind the school. No odor floated into the air to make any nuisance to the public. | 1. Emergency Operation Team primarily examined type of chemical and instructed guidelines of the proper chemical storage for disposal; and coordinated with chemical experts to re-examine and confirm the type of chemical.<br>2. Supported Lam Look Ka Municipality to file a lawsuit to the dumpers.<br>3. Coordinated with local agencies to |

| | | |
|---|---|---|
| | | inspect the potential dumping factories.<br>4. Coordinated and followed up the progress of the case and waste disposal. |
| 3. At Suklapiban Omnoi Road, Kratoomban Dist., Samut Prakarn May 1, 2000 | About 60 white fertilizer sacks (capacity 50 kg) of chemical waste which was black powder condition and mixed with $CuSO_4$ | 1. Emergency Operation Team primarily examined type of chemical and instructed guidelines of the safety storage of chemical waste for disposal.<br>2. Recommended Omnoi Tambon Administration to landfill the waste at the Municipality disposal site and informed DIW for authorized action. |
| 4. At a deserted area in Bang Bon Dist., Bangkok May 8, 2000 | 2 tanks of 200-litre were dumped in the said area. Its characteristics were liquid, light yellow and odor like glue. | 1. Emergency Operation Team primarily examined type of chemical and instructed guidelines of the safety storage of chemical waste for disposal.<br>2. Recommended Bang Bon Dist. to properly dispose of waste and informed DIW for authorized action. |
| 5. At a woodland of small trees in clumps adjacent to Sri Sawat Housing Estate, Tambon Bangyapraek, Muang Dist., Samut Prakarn | 7 tanks of 200-litre contained clear liquid, dumped at the said area. Without any environmental impact and people in the surrounding area. | 1. Emergency Operation Team primarily examined type of chemical, found that its characteristics were clear liquid, dissolvable and darkened sludge. It was assumed to be Polythylene Glycol.<br>2. Recommended Bangyapraek TAO for storage and contacted the disposal site.<br>3. Informed Samut Prakarn and DIW to take legal action. |
| 6. At Muang Ek Housing Estate, Rangsit Dist., Patum Thani August 15, 2000 | 60 paper boxes, of 2 cu.f., but containing chemical substance in a paper bag and put in another plastic bag about 70 bags. Label on the box printed "ANALYTICAL SAMPLE" and "Siam Exploration". Its condition was gray powdered substance, looked like cement. No any environment impact and no harm to the people surrounding the area. | 1. Emergency Operation Team primarily examined type of chemical, assumed to be Bentonite or synthesis clay.<br>2. Recommended disposal methods to local agencies. |
| 7. At cassava plantation on 331 Road, between Km. 118-119, Tambon Huay Yai, Banglamung Dist., Chonburi August 28, 2000 | White sludge contained in white fertilizer sacks, weighted 50 kg. per sack, about 2 ten-wheel trucks, dumped on the said area. It caused a spreading of odor and environmental contamination. | 1. Emergency Operation Team primarily examined type of chemical, found that its characteristics were cloudy white sludge, assumed that it was sludge from rubber production process of nearby factories.<br>2. Recommended the concerned to protect the substance spilled over before disposal.<br>3. Supported Huay Yai Municipality to file a lawsuit to the dumpers.<br>4. Coordinated and followed up the progress of chemical waste disposal. |
| 8. At Soi | Chemical waste was | 1. Emergency Operation Team primarily |

| | | |
|---|---|---|
| Pattanakarn 38, Suan Luang Sub-dist., Bangkok September 27, 2000 | priced Baht 12,000 sold to a recycle shop in Soi Pattanakarn 38. The substance contained in 22 red mesh bags. The seller informed that the said stuff was aluminum waste, which could be resold at good price, but no one needed to buy it. Then it was dumped on the said area nearby his house. When it rained, the odor and smoke billow floated over the area, then shop owner informed the police of Klong Ton Police Station. | examined type of chemical, found that it was metal scrap, silver grey aluminum-like fibers, light weighted, pH 8, green flammable. Strong smell and white smoke occurred when activated to water, presumed that it was mixed up with aluminum waste.<br>2. Proposed prevention guidelines the chemical substance activated to water; and blocked the villagers not to come closely to the said area or fired.<br>3. Supported Klong Ton Police Station investigated wrongdoers and proper disposal of the chemical waste. |
| 9. At Rama 8 Bridge construction site. October 13, 2000 | 5 litres of Chemical substance contained in ambler glass bottles, its severe odor smelt like pesticide chemical substance and was nuisance to the nearby people. | 1. Emergency Operation Team primarily examined type of chemical, presumed that it was outdated pesticide chemical.<br>2. Example was collected and analyzed by Department of Agriculture, it was pesticide chemical.<br>3. Proposed disposal method guidelines and examined its effects. |
| 10. Under Ram Intra-At Narong Expressway, Bangrak Dist., Bangkok | About 100 kg. of sand-like orange pellicles of chemical waste tipped down at the said area, it caused odor spread over the area. | 1. Emergency Operation Team primarily examined type of chemical, it was muscle relaxant drugs with strong smell.<br>2. Coordinated with Bangrak Dist. to collect the chemical and contaminated soil into 200-liter tanks and burned it down at On Nut incinerator.<br>3. Hydrogen Peroxide was applied on the surface of the area to deodorize the smell. |
| 11. Muang Dist., Suphan Buri Province January 23, 2001 | Chemical waste was dumped in 3 adjacent areas – 2 spots in Rai Rot TAO and 1 in Talingchan TAO. 18 old metal tanks of 200-litre disorderly left beside the shoulder of Lieb Klong Chonlapatan Road, some tanks torn out and discovered. Consequently there were some chemicals leakage to the irrigation canal. Severe odor spread over the area, but no any harm to the villagers since the sports were so far away from community. | 1. Emergency Operation Team primarily examined type of chemical, it might be used solvents – thinner, lacquer, acrylic resin, etc. Characteristics were chemical wastes both thick liquid (brown-and-red) and mixed with sludge, presumed that it would be the used chemical substances from paint coating, peeling or from iron furniture works.<br>2. Repaired damaged the ripped off tanks and properly collected the spilled over chemical to stop the impact to people and water resources.<br>3. Informed local agencies to collect the chemical tanks in one place under the shelter to reduce the temporal chemical evaporation until it was identified; and blocked it as a dangerous zone<br>4. Advised local officials to use the said chemical as fuel. |

| | | |
|---|---|---|
| 12. At Tambon Tapong, Muang Dist., Rayong Province March 7, 2001 | The incident of a chemical truck overturned (3 months ago), it was likely to be Calcium Oxide (CaO) spilled and leftover around Ban Takad Village, Moo 4, Tambon Tapong, Muang Dist., Rayong Province, caused to soil was less color and dried glass. The chemical was transported to a general waste disposal site of Tapong Tambon Administration Office. | 1. Emergency Operation Team primarily examined the fact.<br>2. Recommended local officials to collect chemical beside the road to shelters.<br>3. Supported local administration to file a lawsuit to the substance's owner. |

Source: Pollution Control Department of MOSTE

### 4.3.5 IWM by Private Sector

The present status of the private sector in the area of off-site reuse/recycling, intermediate treatment and final disposal of industrial waste is changing due to the increasing number of factories of MOI codes 101, 105 and 106. It is considered to continuously increase since there are a number of applications for the registration of those code numbers.

On the other hand, there is no registration system of waste collection/transportation companies and practically no information is available to grasp a general picture of waste collection/transportation companies other than local administration bodies. Therefore it is not known to what extent industrial waste is collected/transported by the private sector.

#### a. Collection and Transport

Article 19 of the Public Health Act, B.E.2535 (A.D.1992) provides that nobody can collect, transport and treat waste in order to be paid without a license issued by a licenser of the Local Administration (governors, or mayors for designated cities). In reality, however, there is no system of license registration, and it is impossible to tell who collects or transport waste without license.

DIW or IEAT does not have a system to register IW collectors or transporters, either. Therefore, no information is available on the number of those.

In 2000, DIW issued 202 transport permits to 159 factories. The transport permit specify the name of enterprises to which waste is entrusted, but does not state who collects or transport the waste. Hence there is no way to estimate the number of collectors/transporters In the factory survey at 215 factories, the team obtained 124 answers to the question to whom waste is discharged, and 107 are waste buyers and the rest, only 17, are collectors/transporters.

The team estimated that about 0.5 million ton/year of non-HW is collected by local administrative organizations or the public sector, and about 0.2 million ton/year of HW is collected by the private sector. As seen above, however, it is not known how many private collectors/transporters collect them.

### b. Reuse/Recycling

A ministerial regulation under the Factory Act was amended in December 2001, and new industrial sector codes 105 for waste separation and landfill and 106 for waste reuse/recycling were created. However, a large number of factories have been registered under the other code numbers and the registration of code 105 or 106 factories has just started. Therefore, it is not either known how many reuse/recycling factories exist. At present, DIW is examining the procedure of the registration of code 106.

According to the study by PCD/MOSTE[6], there are 2,231 companies which work as a waste buyer and 15,747 individual waste buyers in the country, but it is unknown that how many of them are in the study area.

The team estimated that 1.854 million ton/year of non-HW and 108,000 ton/year of HW are reused or recycled. As stated above, however, it is not known how many reusers/recyclers reuse or recycle them.

### c. Treatment/Final Disposal

#### c.1 Non-HW

In the study area, waste treatment/final disposal facilities except for those for municipal waste are four wastewater treatment works and three small batch-type incinerators with low operation rate in four industrial estates. These are operated by IEAT and two private companies.

There exist four small incinerators for industrial waste owned by the private sector outside of the study area. There are only two private final disposal sites for industrial waste, one in Saraburi and the other in Chonburi, and one under construction in Sakaeo.

#### c.2 HW

In the study area, there is only treatment facility for HW with the authorization of DIW in Samae Dam. It was constructed by DIW and the operation is entrusted to GENCO.

Even including the areas outside of the study area, there are only five treatment facilities for HW run by different private companies with the authorization of DIW. HW landfills are two, operated by GENCO, and one landfill is under construction in Sakaeo as of the end of June, 2002.

[6] Final Report of the Study on Guideline to Reduce Pollution by Recycle, PCD, MOSTE, March 1998.

# Chapter 5

## *Institutional System on IWM*

# 5 Institutional System on IWM

## 5.1 Policy on Environmental Protection

The first Enhancement and Conservation of the National Environmental Quality Act was enacted in 1975, on which the Thailand environmental policy framework has been founded. In order to improve the efficiency of the policy implementation, to tackle increasing environmental problems, and to stimulate environmental awareness among the state agencies and people, the government passed new Enhancement and Conservation of the National Environmental Quality Act (NEQA) in 1992. It also made the environmental problems be defined in an integral part of the National Economic and Social Development Plan.

### 5.1.1 National Economic and Social Development Plan

National Economic and Social Development Plan (NESDP) is the master plan that prescribes policies, objectives, strategies and development guidelines of the country. All governmental agencies must formulate their vision, objectives and aims including plans and projects based on the Plan. The Board of the National Economic and Social Development, which is under the Prime Minister's Office is responsible for directing and cooperating the state agencies in carrying out their functions as the Plan defined.

The 1st NESDP was commenced in 1961. The plan is set for every 5-year period. At the time of this study the 8th NESDP is effective (1997-2001).

The 8th NESDP has been proclaimed by His Majesty King Bhumibol on 26th September 1996. The Plan has been effective from the 1st October 1996 (Fiscal year 1997) and lasts until the 30th September 2001 (End of fiscal year 2001).

The 8th Plan composes of 5 objectives, one of which is to utilize, conserve and protect natural resources and environment to support sustainable economic and social development and quality of life (Figure 5-1).

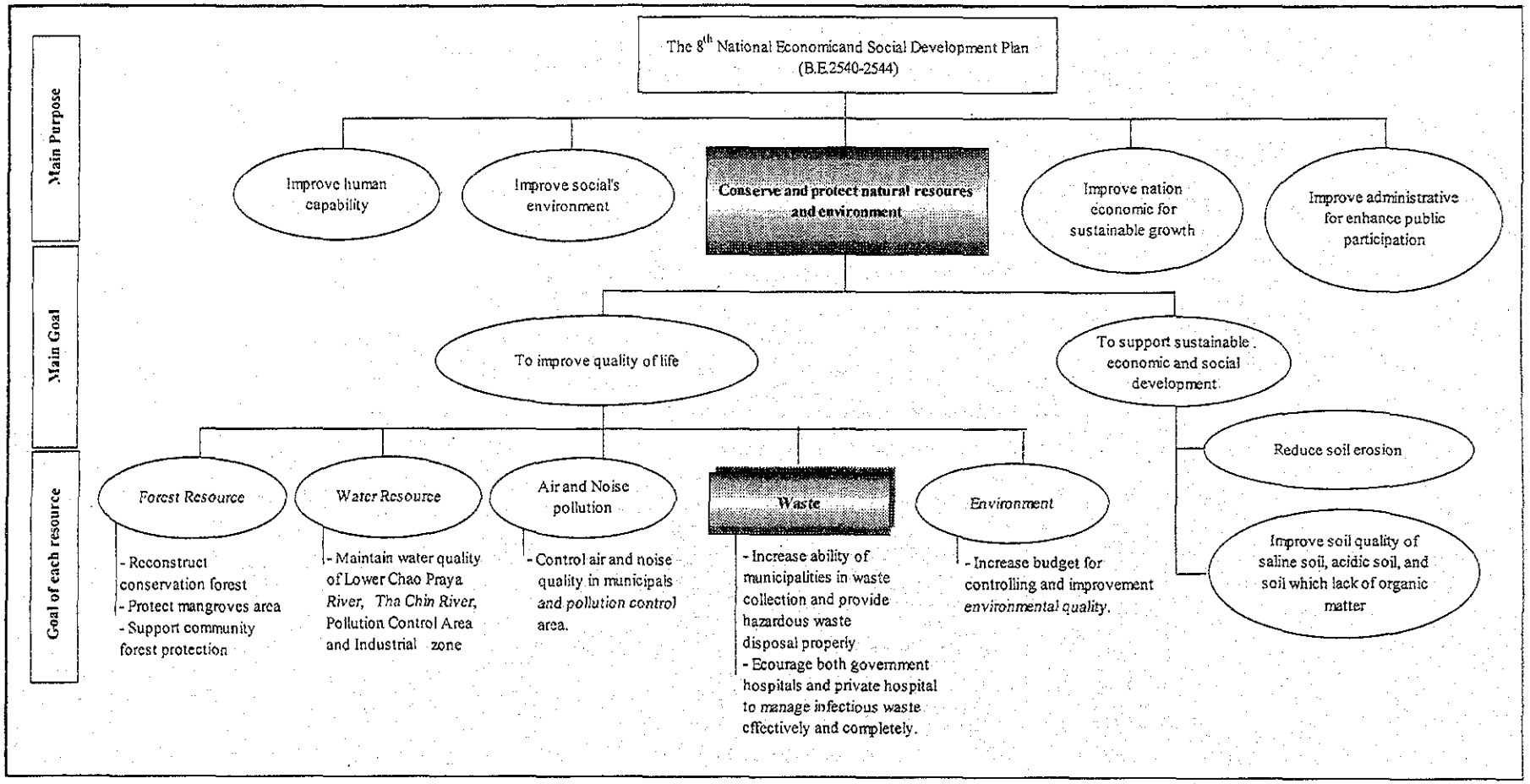



Figure 5-1: Main purpose and goals of NESDP concerning the Environment

There are 2 goals related to waste management.

(1) To upgrade the garbage collection capacity of municipality and sanitary districts, and promote safe disposal of hazardous waste.

(2) To encourage both public and private hospitals to manage infectious waste effectively and completely.

The 8th Plan proposes the following 3 major strategies to achieve the objectives and targets set for natural resource and environmental management:

(1) Rehabilitation of natural resources and environments.

(2) Promotion of the participation of local people and communities.

(3) Proper management of natural resources and environments.

There are 4 development guidelines for the rehabilitation natural resources and environments in order to promote balance in the ecosystem and upgrade quality of life. One of them is to reduce the volume and distribution of pollution in local environments by proper management of various types of pollution, such as community and industrial wastewater, air pollution, industrial waste and hazardous substances. Regarding industrial waste and hazardous substances, it particularly aims at the following.

(1) Encourage provincial authorities to seek appropriate plots to serve as long-term sites for land-fill garbage disposal, and to designate appropriate areas in urban plans.

(2) Establish appropriate criteria for garbage and waste management, which cover the processes of collection, transportation and hygienic disposal. In addition, emphasis should be placed on the processes of reducing, reusing and recycling waste.

(3) Reduce and control sources of hazardous substances, by subjecting factories that produce or utilize hazardous substances in large volumes to environmental impact and risk assessments and strict guidelines on control of the substances.

As seen above, the 8th NESDP is closely concerned with the management of waste, hazardous substances and infectious waste. Efforts toward the reduction and control of hazardous waste are expected from the industry. As mentioned above, the concerned state agencies must apply the plan as a guideline to set up their own policies, programs and projects, details of which will be given later.

### 5.1.2 Policy on Environmental Protection and Waste Management

The resolution of environment problems must work continuously and takes a long time. The NESDP covers all aspects of development and policy on the environment including waste management. The government also has issued the Enhancement and Conservation of National Environmental Policy and Plan of a 20-year term which states that the concerned agencies take the defined policies and guidelines into concrete actions by setting up the environmental quality management plan in all aspects. This part reviews the policy and plan on national environmental conservation and its quality management especially waste management.

### a. Enhancement and Conservation of National Environmental Quality Policy and Plan, B.E. 2540-2559 (1997-2016)

The Enhancement and Conservation of National Environmental Policy and Plan (1997-2016) (referred to as the Policy and Plan (1997-2016) hereinafter), is deemed as guidelines and framework of national environmental quality conservation and promotion, recommended by the National Environmental Board to the cabinet for approval.

It was approved on 20th November 1996. Its 20-year period is divided into 4 five-year consecutive terms, each of which has a plan entitled "Environmental Quality Management Plan". Each plan sets frameworks and programs. Therefore, the concerned organizations in environmental management must follow this five-year plan in order to design their own action plans for the environmental quality management or those at the provincial administration level including Bangkok. (Figure 5-2 shows hierarchy from the national environment policy to the action plans.)

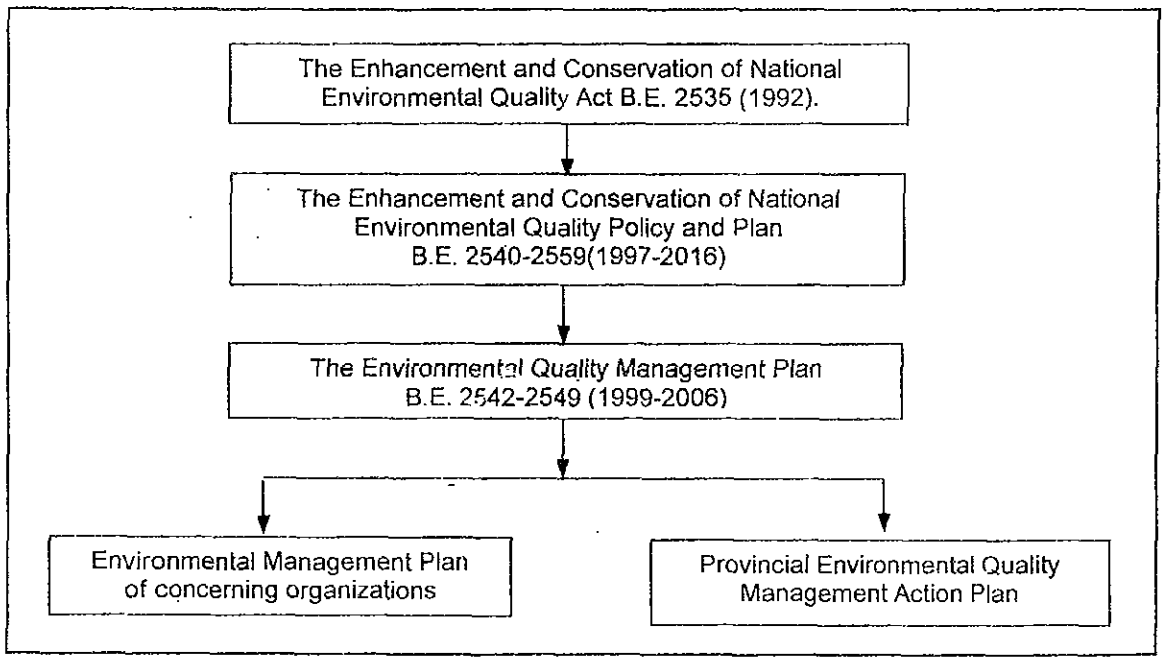



Figure 5-2: Hierarchy from the national environment policy to the action plans

The Policy and Plan (1997-2016) consists of 6 main policies. See Table 5-1.

Table 5-1: Main Policies in the Enhancement and Conservation of National Environmental Quality Policy and Plan B.E. 2540-2559 (1997-2016)

| |
|---|
| **Policy 1: Policy on Natural Resource**<br>- Increase natural resource usage effectively and reduce conflict in natural resource usage, also improve quality of natural resource.<br>- Improve administration on natural resource management effectively.<br>- Support the usage of environmental economic principle for natural resource management effectively.<br>- Improve law, regulation for supporting natural resource management.<br>- Support the studying and researching on development of natural resource data system.<br>- Increase conservation awareness of general public and people in management level of government organizations. |
| **Policy 2: Policy on Protection and Elimination of Pollution**<br>- Reduce and control pollution generated from community, agriculture, industry, etc.<br>- Enhance effective solid waste and hazardous waste management.<br>- Enhance effective administration and management of pollution. |
| **Policy 3: Policy on Natural and Scenic Site**<br>- Reserve, protect and improve natural and scenic site to be resource of nation. |
| **Policy 4: Policy on Community Environment**<br>- Prepare green area and community's environmental management for quality of life. |
| **Policy 5: Policy on Education and Public Relation for Environment**<br>- Enhance social capability in effective environment management. |
| **Policy 6: Policy on Technology for Environment**<br>- Develop and promote technology used for environmental quality management. |

In Policy 2, targets and guidelines are divided into six groups according to types of pollution such as water, air, noise and vibration, waste and sewage, hazardous substances, and hazardous waste.

Targets and guidelines of the pollution management of waste and sewage, and hazardous waste specified in the policy are summarized in Table 5-2.

Table 5-2: Environmental management goals and guidelines in the Enhancement and Conservation of National Environmental Policy and Plan B.E. 2540-2559 (1997-2016)

| **Solid waste and sewage** | |
|---|---|
| **Goal** | **Guideline** |
| 1. Reduce or control solid waste generation rate not more than 1.0 kg/person/day. | 1. Establish efficient solid waste management that will cover the processes of collection transportation, treatment and disposal. |
| 2. Solid wastes utilization in Bangkok and municipalities throughout the country must not beless than 15 % of the total solid waste generated. | 2. Control solid waste generation rate and promote recycling and reuse of solid waste. |

| | |
|---|---|
| 3. All solid waste in municipal districts is to be collected. Outside municipal districts, wastes not collected should not be more than 10% of the total solid waste. | 3. Promote and support private sector investments for construction and/or operation of solid waste and sewage management systems. |
| 4. Ensure that each province has a master plan and management plan for sanitary solid waste and night soil disposal, and every municipality and sanitation district has proper solid waste and night soil disposal system. | 4. Promote and support private sector and general public to participate in the management of solid waste and sewage. |
| **Hazardous waste** | |
| **Goal** | **Guideline** |
| 1. Reduce and control pollution from hazardous wastes from all sources in the industrial sector and in communities, not allowing impacts on to the environment and public health. | 1. Install an efficient hazardous waste management system that will cover the procesess of imports, exports, transport, separation, collection, treatment and disposal. |
| 2. Collect and dispose not less than 95% of the hazardous wastes from the industrial sector, and 90% from communities, of all hazardous wastes that are generated | 2. Establish an emergency system to prevent and mitigate major hazardous waste accidents in the industrial sector, in transportation, and in storage of hazardous waste. |
| 3. All public and private hospitals to have proper systems to manage infectious waste, including separation, collection, transportation, treatment, and disposal. | 3. Promote and support private sector investments or participation in the management of infectous wastes at all stages. |

### b. Environmental Quality Management Plan (1999-2006)

Environmental Quality Management Plan (1999-2006) has been formulated in order to transform long-term policies and essential guidelines as prescribed in the Policy and Plan (1997-2016) into actions. The Plan aims at giving advices to state agencies and state enterprises concerned for the formulation of work plans or the implementation of any actions in order to ensure that the activities comply with the objectives and goals of sustainable development. The period to implement the Plan (8 years) overlaps the last 3 years of the 8$^{th}$ NESDP (1997-2001) and 5 years of the 9$^{th}$ NESDP (2002-2006).

Environmental Quality Management Plan (1999-2006) focuses on the conservation and rehabilitation of natural resources and deteriorated environment covering 6 areas including soils and land use, water resources, forest resources, water pollution, air pollution and pollution from solid waste and night soil. There is a simultaneous amendment of the legal and regulatory framework to enable the administration to manage natural resources and the environment more effectively. Goals of the waste management plan are shown in Table 5-3.

Table 5-3: Goals of Environmental Quality Management Plan B.E. 2542-2549 related to Waste Management

| Type of Pollution or Environmental Problems | Goals |
|---|---|
| Pollution from solid waste and night soil | (1) Reduce or control solid waste generation to the rate of not more than 1.0 kg/capita/day by 2001,<br>(2) Bangkok and communities throughout the country utilize waste of not less than 10% and 15 % of the total solid waste generated by 2001 and 2006 respectively, |

| Type of Pollution or Environmental Problems | Goals |
|---|---|
| | (3) Uncollected waste is not more than 10 % and 15 % of total solid waste generated by 2001 and 2006 respectively,<br>(4) Ensure that each province has a master plan and management plan for sanitary solid waste and night soil disposal by 2001 and 50 % of them has proper solid waste and night soil disposal system |
| Pollution from hazardous waste | (1) Set waste management systems for collection, transport, recovery, treatment and disposal of hazardous waste by 2001,<br>(2) Invest in basic infrastructure for collection, transportation, treatment and disposal of not less than 80 % and 95 % of industrial hazardous waste by 2001 and 2006 respectively and not less than 50 % and 90 % of those generated from communities by 2001 and 2006 respectively,<br>(3) Support 80% of public hospitals and 100 % of public hospitals have proper systems to manage infectious waste, including separation, collection, transportation, treatment and disposal by 2001 and 2006 respectively,<br>(4) Control an increasing of hazardous waste generation rate of not more than 10 % by 2001. |

## 5.2 Industry and Industrial Waste

### 5.2.1 Classification of Factories

#### a. Individual Factory

According to the Factory Act, 1992, "Factory" means a building, place, or vehicle, which uses a machine with 5 horse powers or more or which employs seven workers or more with or without any machine, for manufacturing, producing, assembling filling, repairing, maintaining, testing, improving, altering, transporting, keeping, or destroying anything in accordance with the type or kind of factory as provided in a ministerial regulation. The regulation classifies factories into 104 categories, and also defines 3 groups according to type, kind or size under the consideration of the necessity for the control and prevention of nuisance, damage, and danger in accordance with the degree of impact on the public or environment. Those 3 groups are as follows:

(1) A factory in **Group 1** is such factory of the type, kind and size as capable of engaging in a factory business immediately upon desire of a person engaged in a factory business.

(2) A factory in **Group 2** is such factory of the type, kind, and size as, when engaged in a factory business, to be notified in advance to the Granter.

(3) A factory in **Group 3** is such factory of the type, kind, and size as to be granted a permit prior to the engagement.

Details for those 104 categories and 3 groups of factory are shown in Annex 5.1. Factories that provide services as industrial waste treatment and disposal facilities or central waste treatment plants are classified in the 101st category. Any factories in the 101st category are classified as Group 3 factory, regardless of their size. Factories for industrial waste reuse or recycling was not regarded as the central waste

treatment plants, thus not categorized under the code 101. Thus DIW created new codes in December 2001: code 105 for waste separation and landfilling facilities and code 106 for waste reuse/recycling facilities. As of February 2002, however, no factories have been yet registered at those categories.

Engagement in all groups of factory is different not only in permission condition of the engagement but also criteria relating to the location of factory. Details on the location of each group of factory are mentioned below.

(1) Groups 1 and 2 factories are not allowed to be established:

- in a residential area,
- within 50 m from public places e.g. schools, temples, hospitals, historical sites, offices and conservation areas pursuant to the governing laws related thereto.

(2) Group 3 factory is not allowed to established:

- in a residential area,
- within 100 m from public places as designated for the Groups 1 and 2. And Group 3 factory shall be situated in proper location and environment where enough space is available to run the factory depending on size and kind of factory and not causing any harmful nuisance or damage to the public and properties.

Apart from the categorization and grouping of factories above pursuant to the Factory Act 2535 (1992), the department of labour (Ministry of interior) commenced the work of establishing the "Thailand Standard Industrial Classification" (TSIC) in 1969 using the "International standard Industrial Classification of all economics activities" (1968) as a guide.

The Department of Labor considered that ISIC was inadequate and could cause inconvenience and problems in work operation, because it did not correspond completely to the characteristics of the industries in Thailand and was not fully suitable for the country's economic conditions.

Therefore, the establishment of the TSIC is aimed at classifying and defining the existing industries in Thailand in order to provide the classification standard for other organizations and the general public. It is also designed to help the understanding of the industrial structure of the nation and will facilitate uniformity in industrial statistic analyses. For the purpose of promoting international comparability of economic statistics, an attempt has been made for TSIC to be compatible with the ISIC which member countries are recommended to use by the United Nations Organization.

The industrial classification is based on the following general principles:

1. The classification conforms to the existing structure of Thai economy.

2. The units classified are establishments.

3. Major activity of establishments or units is based mainly on the principal class of goods produced or service rendered.

Units engaged in the same kind of economic activity are classified in the same group of the TSIC, irrespective of whether they are part of incorporated enterprises, individual proprietors or government, or whether or not the parent enterprise consists of more than one establishment. Similarly, manufacturing units are classified according the major kind of economic activity in which they are engaged, whether the work is performed by power-driven machinery or by hand, or whether it is done in a factory or in a household. The details of the TSIC are shown in Annex 5.1.

**b. Grouped Settlement of Factories**

Thai government has also promoted the establishment of factories in a designated area or estate in order to appropriately arrange public utility and infrastructure as well as to properly prevent, control and mitigate environmental problems. Grouped settlements of factories can be determined in different categories.

(1) **Industrial Estate:** An estate is established by the Industrial Estate Act by the Industrial Estate of Thailand (IEAT), a state body in the Ministry of Industry. Main reason and purpose of an industrial estate is to provide ample industrial area with complete infrastructure for the manufacturing industry to grow in an organized manner. An Industrial Estate in Thailand resembles an industrial town or industrial city providing complete infrastructure necessary for industrial operations such as ample electricity, water supply, flood protection, central wastewater treatment and waste disposal facility) and other incentives for investors.

Industrial Estates are classified into mainly 3 categories, which are (1) developed, owned and managed solely by IEAT, (2) developed and operated by private developers but regulated by IEAT and, (3) developed by private developers but operated by IEAT. Presently, there are 28 industrial estates in 13 provinces with total number of 1,790 factories.

(2) **Industrial Zone:** An industrial zone is generally engaged by the private sector to establish designated kinds of industry. Under Article 30, the Factory Act B.E. 2535 (A.D. 1992), DIW supports the establishment of factories within the industrial zones. There are presently 22 industrial zones nationwide. Industrial sectors designated at those industrial zones include:

- Electronic and electronic parts industry
- Auto-parts and assembly industry
- Jewelry industry
- Skilled industry such as production of lenses, watches, and eye glasses
- Agricultural industry and other related industry

(3) **Industrial Community:** Industrial community is also engaged by private sector with DIW's support. There are total 5 industrial communities throughout the country which are classified into 3 types:

- Row building factory: A row building factory is a community of factories that either generates no pollution or slight pollution. The factory must not discharge wastewater into the environment.

- Factory house: A factory house is a community of factories that generate slight or medium pollution. The factory is required to install proper on-site wastewater treatment plant and allowed to discharge not more than 5.0 cu.m. of wastewater daily. A person who owns the factory house may provide a central wastewater treatment plant.
- Factory individual building: Factory individual building can be any types or kinds of the factory but the factory must install effective on-site wastewater treatment plant or shall be served by central treatment plant.

(4) **Industrial Park:** Private sector prepares land, public utility and other necessary facilities or something else as required by the factory operators. There are in total 28 industrial parks throughout the country with total number of 2,270 factories.

### 5.2.2 Registration of Factories

Factory registrations are classified by their locations into 3 categories as follows:

(1) Factories that are located independently or located in an industrial park or industrial community must be registered at DIW. Steps and procedures required are shown in Figure 5-3. A specific certificate will be issued to each registered factory indicating classification and type of the factory.

(2) Factories located in an industrial estate will be registered by the IEAT. Steps and procedures are shown in Figure 5-4.

(3) Factories located in industrial zone do not need to apply for registration at DIW, because they have already complied with a juristic person (industrial zone company) who was registered at DIW in advance.

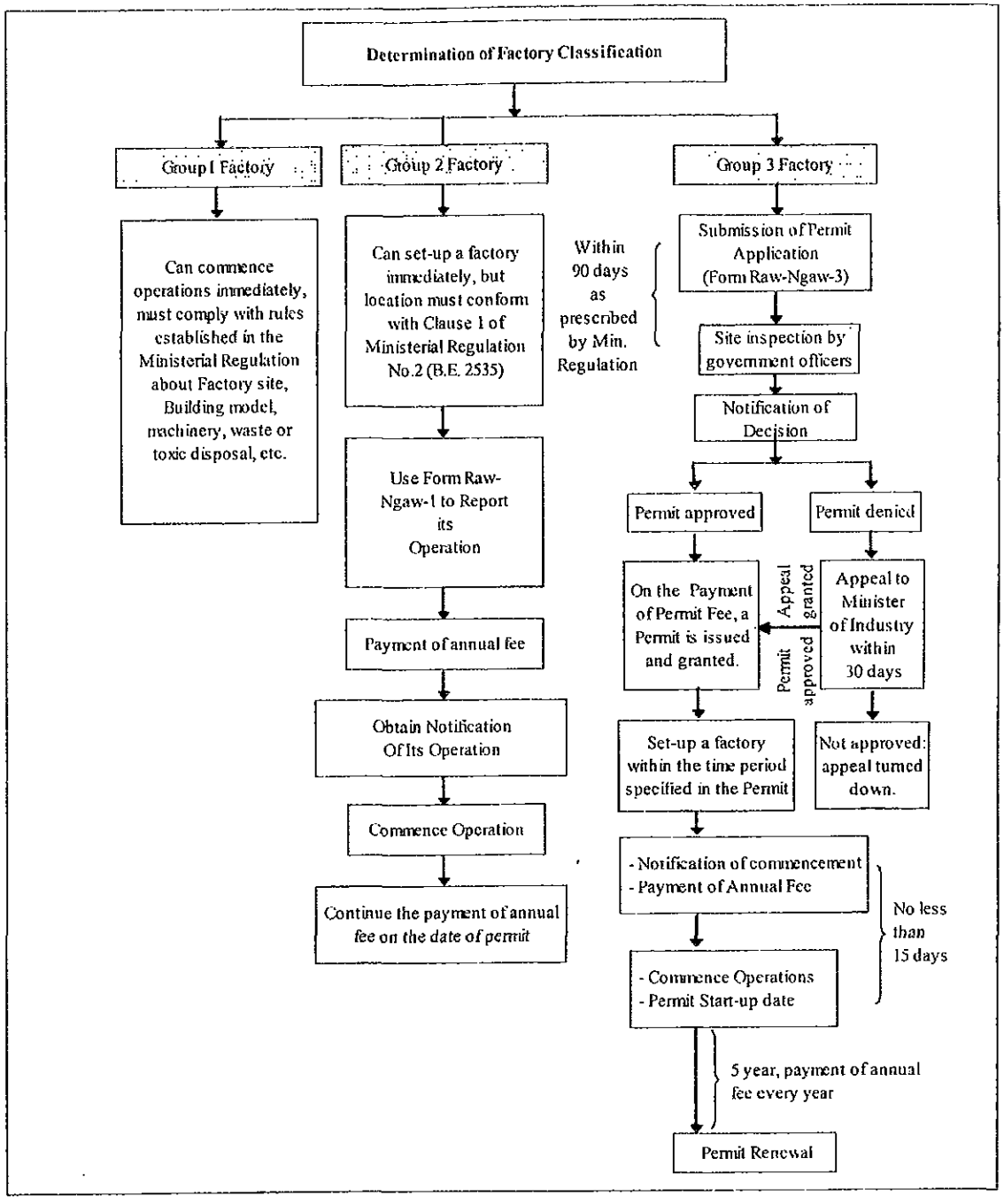
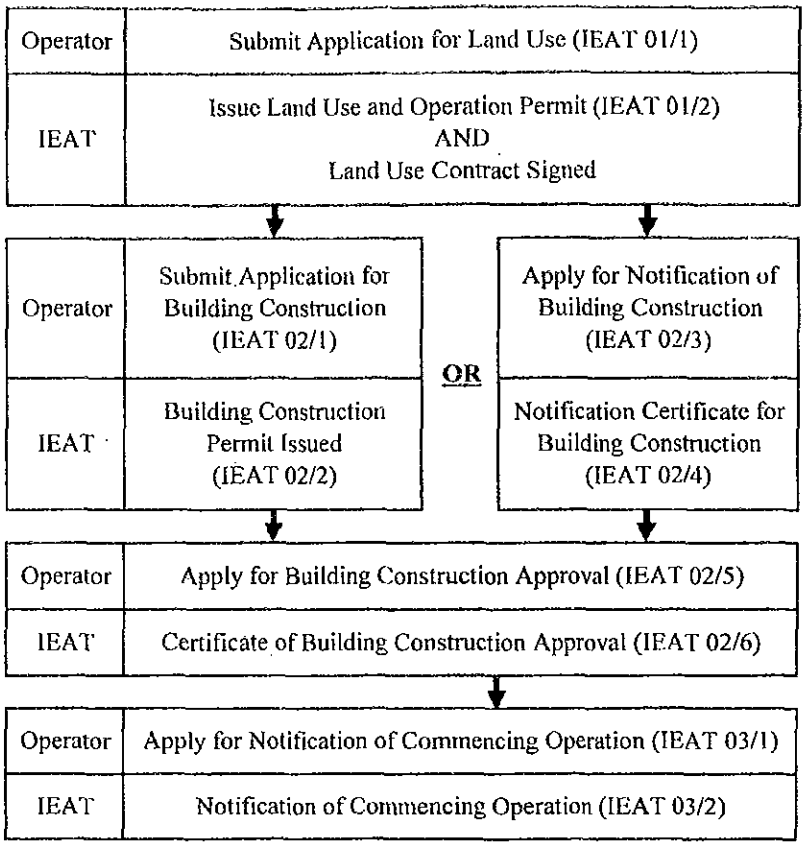



Figure 5-3: Flow Chart of Factory Permission Application to DIW




**List of Application and Permission Forms**

| | |
|---|---|
| **1 Application for Land Use and Operation** | |
| 1.1 Land Use Application Form | IEAT 01/1 |
| 1.2 Land Use and Operation Permit | IEAT 01/2 |
| 1.3 Land Application Form | IEAT 01/3 |
| **2 Application for Construction** | |
| 2.1 Building Construction Application Form | IEAT 02/1 |
| 2.2 Building Construction Permit | IEAT 02/2 |
| 2.3 Application for Notification of Building Construction | IEAT 02/3 |
| 2.4 Notification Certificate for Building Construction | IEAT 02/4 |
| 2.5 Application for Building Construction Approval | IEAT 02/5 |
| 2.6 Certificate of Building Construction Approval | IEAT 02/6 |
| **3 Application for Operation** | |
| 3.1 Application for Notification of Commencing Operation | IEAT 03/1 |
| 3.2 Notification of Commencing Operation | IEAT 03/2 |
| 3.3 Application to Expand Operation | IEAT 03/3 |
| 3.4 Permission to Expand Land Use and Operation | IEAT 03/4 |
| 3.5 Application to Renew Expired Operation Form | IEAT 03/5 |
| 3.6 Renewal of Land Use and Operation Permit | IEAT 03/6 |

Figure 5-4: Procedures for Land Use and Operation in Industrial Estates

### 5.2.3 Classification of Industrial Waste

By the Notification of Ministry of Industry No. 6 B.E. 2540 (A.D. 1997) and the Notification of Ministry of Industry No. 1 B.E. 2541 (A.D. 1998), industrial waste

can be classified into 2 types; hazardous waste (HW) and non-hazardous waste (non-HW) (those Notifications are in Annexes 5.2.1 and 5.2.2, respectively).

HW generates not only from factories but also from community activities at commercial places, households, and others. MOSTE/PCD called the latter " community generated hazardous waste (CGHW)" when they carried out a study in 1998. CGHW is, however, not legally defined as of September 2002. CGHW includes the following waste and control over CGHW is executed by several authorities such as PCD (MOSTE), Ministry of Public Health, and local administrations.

- HW from household: Batteries, fluorescent bulbs and containers of insecticide or chemicals
- HW from seaports and airports: left over chemicals, waste oil, gasoline and grease
- Waste oils from gas station
- PCB in transformers and capacitors
- Hospital wastes
- Solid and liquid form wastes and wastewater from the laboratories
- Containers of agricultural chemicals
- Wastes generated at military base

**a. Hazardous waste**

A list of characteristics of waste and unusable materials attached to the Notification of Ministry of Industry No. 6 (B.E. 2540 or A.D. 1997) classifies hazardous waste into 4 groups.

Group 1: Ignitable substance, corrosive substances, reactive substances, toxic substances and leachable substances,

Group 2: Hazardous waste from non-specific or specific sources,

Group 3: Expired or discarded chemicals, off-specification chemicals, unusable chemicals remain in containers and cleaning materials which contaminate with spillage chemicals.

Group 4: Chemical waste

A list of these 4 groups of hazardous industrial waste and analysis/identification methods are shown in Annex 5.2.3 and criteria and procedure of disposal of those hazardous waste are shown in Annex 5.2.4 and Annex 5.3, respectively.

**b. Non-hazardous waste**

According to the Notification of Ministry of Industry No. 1 (B.E. 2541 or A.D. 1998), non-hazardous wastes are those with the characteristics listed in Group 1 (but should not be contaminated with hazardous substances) or those generated from specific industrial processes listed in Group 2 (but should not possess hazardous characters).

Group 1: Non-hazardous waste characterized by type.

(1) Solid waste, unusable materials and residues from production process or manufacturing with characteristic as follows:

- Parts of plants e.g. roots, barks, leaves or parts of animals e.g. bones, skins, hair and droppings
- Parts of wood
- Paper waste
- Polymers and resins of plastic or synthetic rubber
- Cloth, thread and fabric
- Animal's fat and oil and vegetable oil
- Natural rubbers
- Metals and metal alloys (not in salt form) e.g., steel, aluminum, copper and brass
- Glass, cullet, mirror, tiles or ceramic tiles
- Stone, cement, sand or materials consisting of clay, sand or stone e.g. tile, brick gypsum and concrete

(2) Solid and unusable waste as defined in (1) which are contaminated or mixed with those wastes in the Notification No. 6 (B.E. 2540 or A.D. 1997) and has been modified its characteristics from those defined in (1) are not accounted as non-HW in the Notification No. 1 (B.E. 2541 or A.D. 1998).

Group 2: Waste from specific industrial processes.

- Ash generated from combustion process of fossil fuels, biomass and combustible material
- Automotive parts and auto shredder wastes
- Dust from air pollution control system including baghouse, electrostatic precipitator, cyclone and scrubber
- Used catalyst from petrochemical production processes
- Dust from cement kilns
- Dewatered sludge from industrial wastewater treatment plant
- Dewatered sludge from wastewater treatment plant in tannery
- Drilling mud from petroleum exploration
- Used refractory materials from industrial furnaces, kilns and ovens
- Sand from sand blasting
- Slag from coal gasification process
- Sulfur dioxide scrubber waste from air pollution control system in fossil fuel combustion processes,
- Residuals or dust from tannery,
- Tailings from extraction, benefaction and processing of ores and minerals

These waste and unusable materials not having passed any treatment process, when being tested for leachate extraction procedures prescribed in the Notification of the Ministry of Industry No. 6, B.E. 2540 (1997) must not have characteristics and properties as waste or unusable materials under such notification.

## 5.3 Organizations Relevant to IWM

The organizations involved in IWM are:

- Department of Industrial Works (DIW), Ministry of Industry.
- Pollution Control Department (PCD) of Ministry of Science, Technology and Environment (MOSTE).
- Industrial Estate Authority of Thailand (IEAT) and Other Industrial Estates.
- Bangkok Metropolitan Authority (BMA) and other Local Administrations.

Roles and responsibilities of the above organizations on IWM are as follows.

### 5.3.1 DIW

DIW, one of the departments of Ministry of Industry, has an authority to carry out various activities assigned in the Factory Act, Hazardous Substance Act, Volatile Matter Usage Act, Machinery Registration Act, Regulation of the Office of Prime Minister on the establishment of One Stop Service Center (Investment Service Center) and other related laws. Major duties and responsibilities of DIW are to control, monitor, and coordinate the engagement of industrial business where environmental conservation, safety, sanitation and energy saving should be taken into account. DIW also attempts to raise the capacity and efficiency of factory operation for sustainable development and to act as a national center of information on factories, machinery, chemicals, hazardous substance and volatile matter.

DIW is divided into 10 divisions with 876 officers. DIW's organization chart is shown in Figure 5-5. The divisions responsible for controlling HWM are Factory Control and Inspection Bureau 1 - 4, Factory Environmental Technology Bureau and Information Technology Center. The responsibilities of these organizations and the provincial industrial offices are as below.

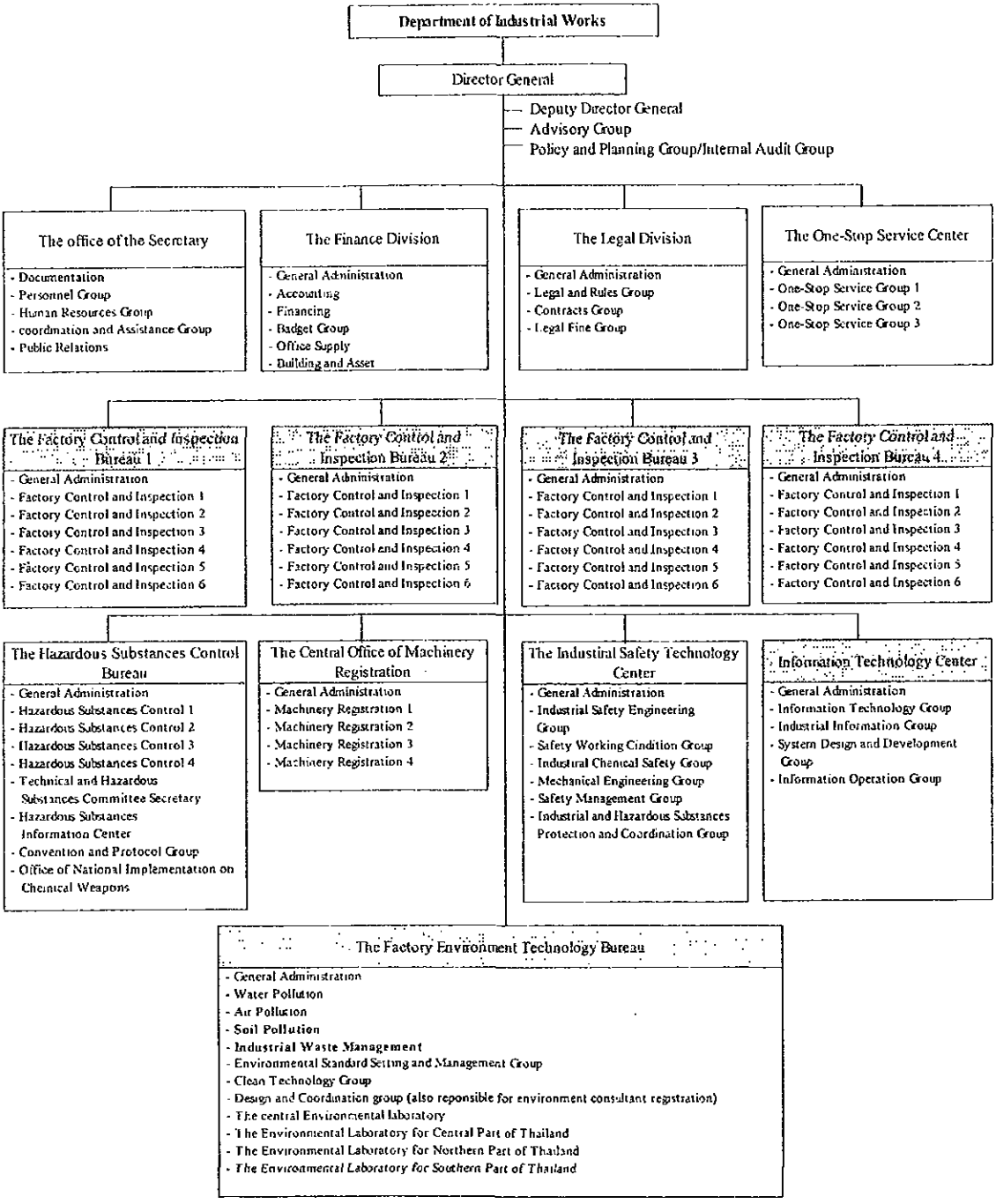



Figure 5-5: Organization chart of DIW

### a. The Factory Control and Inspection Bureau 1- 4

There are 4 Factory Control and Inspection Bureaus in DIW which are responsible for control, supervision and inspection of factories within 4 different areas as well as carrying out any activities designated in the Factory Act. There are in total 342 officers in those 4 Bureaus or about 83 – 89 officers in each Bureau. Duties and responsibilities of the Bureaus are:

(1) To control, monitor and inspect the hazardous waste management by factories and the prevention on the use of volatile substances.

(2) To conduct any activities related to factory registration (in accordance with machinery laws),

(3) To provide advises, consultation and monitoring to the private sector

(4) To perform and coordinate any activities which may be assigned by the related government agencies.

### b. The Factory Environmental Technology Bureau

The Factory Environmental Technology Bureau is responsible for the formulation of an industrial environment management plan, and development and promotion of environmental technologies applicable to industrial environment management. The Bureau also provides consultative services on industrial environment, coordination on industrial water services as well as testing and analysis of pollutants and hazardous substances.

There are in total 79 officers in the Bureau 10 of which are working for granting a permit for off-site transportation of industrial waste. The Bureau consists of 9 sections.

- General Administrative section
- Water Pollution section
- Air Pollution section
- Soil Pollution section
- Industrial Waste Management section,
- Environmental Standards Setting and Management group,
- Clean Technology group,
- Design and Coordinate group (also responsible for environment consultant registration)
- Central Environmental Laboratory and laboratories in each part of the whole kingdom.

Duties and responsibilities of the Factory Environmental Technology Bureau concerning industrial waste management are:

(1) Surveying, collecting, studying and assessing industrial waste about

- types and number of factory.
- classification of industrial waste
- amount of industrial waste.
- managerial process of industrial waste.

(2) Planning for development of industrial waste management policy.

(3) Preparing an inventory of industrial waste and collecting reports on industrial waste management from factories.

(4) Establishing regulations for factories and the Factory Control and Inspection Bureau 1-4 for proper management, i.e. collection, transport, detoxification, stabilization, incineration, and landfilling, of each type of hazardous waste.

(5) Monitoring and surveying the contamination of water and soil in surrounding areas of landfill sites.

(6) Surveying the area which is contaminated with hazardous waste for clean-up in the future.

(7) Cooperating with factories to clean-up areas which are contaminated with hazardous waste

(8) Building up awareness, and promoting industrial waste knowledge and its management

(9) Cooperating with other organizations for industrial waste management

**c. The Information Technology Centre**

The Information Technology Center provides and evaluates information and statistics on factory, environment, safety and machinery. The Center also performs as a information center for industrial administration and development in order to support policy formulation. There are in total 36 officers in the Center.

**d. Provincial Industrial Office**

The 75 provincial industrial offices are placed in provinces of the country, except for Bangkok. They have power to:

- Control, supervise and comply with respect to the Factory Law, the Mineral Law, the Mineral Tariff Rate, the Tin Control Law, the Underground Water Law, the Industrial Product Standard Law and other empowered relevant laws.
- Write, submit and coordinate with the provincial level regarding the industrial promotion and development plan, as coordinate the development and evaluate the result of the mentioned plan.
- Coordinate with or support to other relevant or assigned offices regarding the operation.

The provincial industrial offices are under the Office of the Permanent Secretary of MOI, but officers of other departments of MOI are dispatched in order to execute the responsibilities of MOI at the local level. DIW sends inspectors from the aforementioned Factory Control and Inspection Bureaus to the provincial industrial offices. The figure below shows the structure of the provincial industrial office, taking an example of the Nonthaburi office.

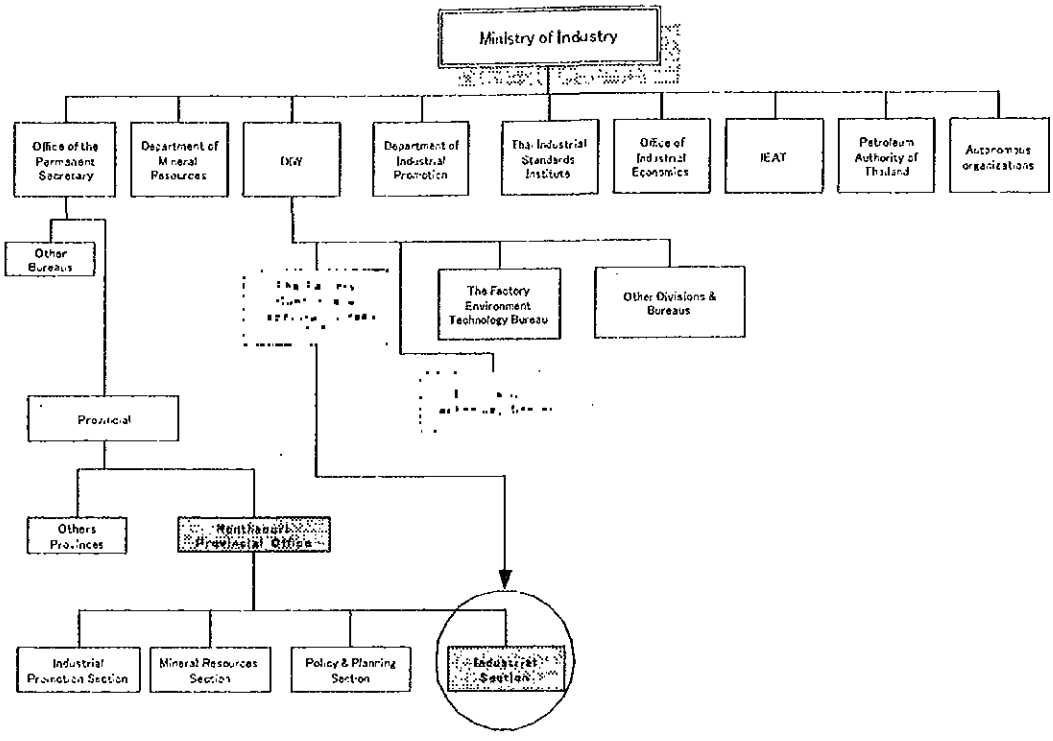


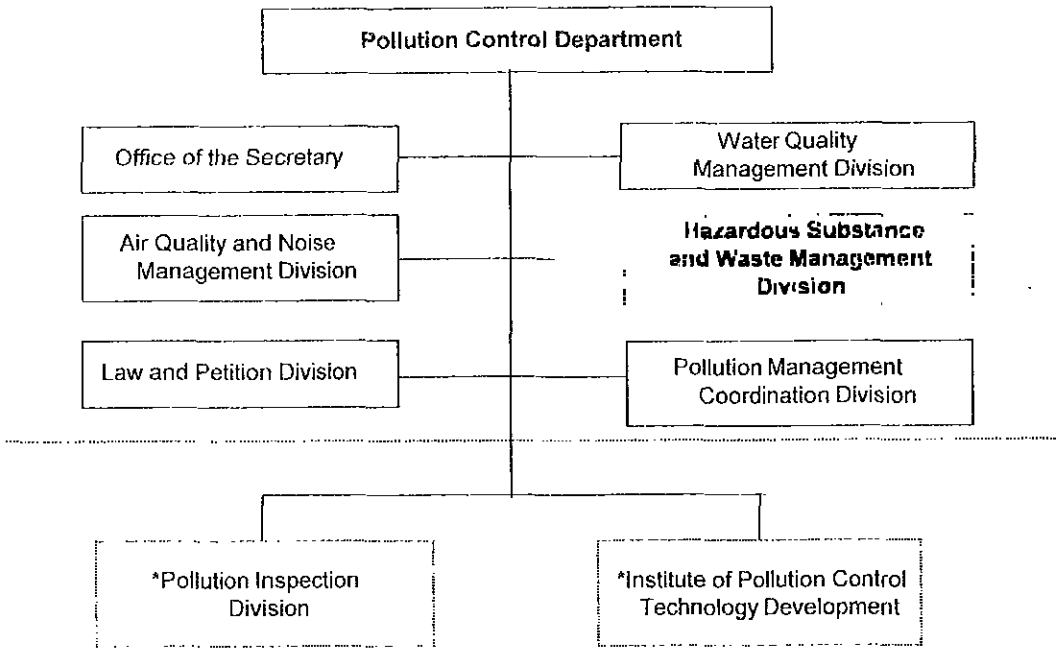

Figure 5-6: Structure of Provincial Industrial Office (in case of Nonthaburi)

### 5.3.2 PCD, MOSTE

The Pollution Control Department (PCD) is under the MOSTE. Under the legislation, PCD has the following functions:

- To put forward opinions for the formulation of national policy and plan of environmental quality conservation and promotion in respect to pollution control.
- To formulate and recommend the environmental quality standards and emission/effluent controlling standards.
- To formulate the environmental quality management plan which includes measures to control, prevent and remedy environmental problems caused by pollution.
- To monitor the national environmental quality and prepare an annual report on the state of the pollution.
- To develop systems, methodologies, and technologies which are appropriate in the applied systems for the better management of water, air, noise, hazardous substance, and solid waste quality.
- To perform any activities specified in the Enhancement and Conservation of National Environment Quality Act, B.E. 2535 or A.D.1992 concerning pollution control.
- To take action on the public complaints related to pollution.

At present, PCD has 291 governmental officers, 66 permanent staff and 150 temporary staff, and consists of 6 divisions: Office of the Secretary, Water Quality Management Division, Air Quality and Noise Management Division, Hazardous Substance and Waste Management Division, Laws and Petition Division, and Pollution Management Coordination Division (See Figure 5-7).




*Note: These divisions are temporarily provided by internal arrangement within PCD.

Figure 5-7: Structure of Pollution Control Department

The Hazardous Substance and Waste Management Division has direct responsibilities concerning hazardous waste. The Division has 77 officers. Duties and responsibilities of this division are:

1) To support the Enhancement and Conservation of the National Environmental Quality Policy and Plans about hazardous substance and solid waste management.

2) To prepare Environmental Quality Management Plan and Action Plan for hazardous and solid waste management in provinces, pollution control areas, and environmental conservation areas.

3) To prepare action plans and emergency plans to prevent and solve hazard problems caused by improper HWM.

4) To monitor and inspect national environmental quality concerning hazardous waste and solid waste and to prepare an environmental quality situation report and a report on hazardous waste and solid waste pollution situation.

5) To develop appropriate systems and technologies for better hazardous substances and waste management, including reuse / recycling.

6) To cooperate with or support other organizations for HWM.

### 5.3.3 IEAT

The Industrial Estate Authority of Thailand (IEAT) is juristic person under the Ministry of Industry according to Industrial Estate Authority of Thailand Act, B.E. 2522 (1979), Section 6. Objectives of the establishment of IEAT are:

(1) To acquire lands which are appropriate for establishing or expanding industrial estate

(2) To improve such lands in (1) and arrange proper public utilities for engaging industrial business such as road, electricity, water pipe, wastewater collection system and wastewater treatment plant.

(3) To lease or hire-purchase movable and immovable property in industrial estate.

(4) To carry out any activities which are advantages or fulfilled objectives of IEAT.

(5) To coordinate and become a partnership with other agencies in order to fulfill objectives (1), (2) and (3).

(6) To control private industrial estate and other governmental activities within industrial estates.

IEAT consists of 10 sections as shown in Figure 5-8.

The division concerned with HWM is Environmental and Safety Control Division in the Development Department. There are in total 640 officers in IEAT, 17 of whom are working for the Environmental and Safety Control Division.

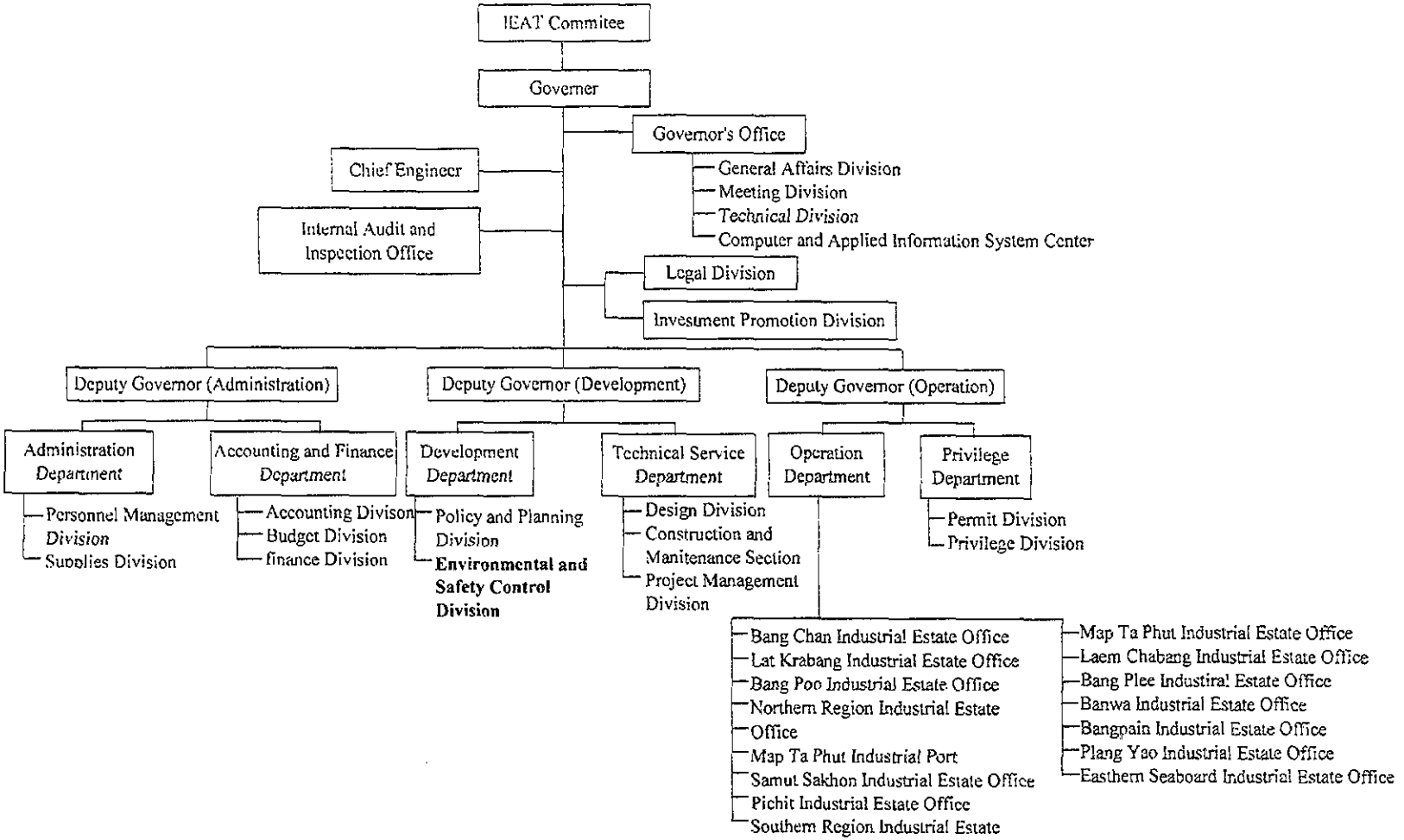



Figure 5-8: Organization chart of IEAT

### 5.3.4 BMA and Other Local Administration

Some of industrial waste is presently collected together with domestic waste by local administrative organizations, which are principally responsible for domestic waste management. The organizations consequently collect industrial waste.

Bangkok Metropolitan Authority (BMA) is a special local administrative organization and responsible for 50 districts. There is a section which is responsible for solid waste management, the Public Cleaning Department. Duties of the Department are to formulate and implement a solid waste and night soil management plan, to perform public cleaning as well as to provide mobile public restrooms within Bangkok Metropolitan area.

Total BMA officers are 59,707 with 18,537 government officers, 24,144 permanent staff and 17,026 temporary staff. There are about 2,516 officers in the Public Cleaning Department with 412 government officers, 1,549 permanent staff and 555 temporary staff. The organization chart of the Department is shown in Figure 5-9.

The Department is separated into 5 divisions:

(1) Secretarial Division is responsible for administrative works, legal, personnel, finance and public relation.

(2) Public Cleaning Services Division is responsible for an improvement study for solid waste collection and for problems from collecting Operation Sector which is not under District's responsibility such as infectious solid waste, hazardous waste, construction waste, including supporting cleansing services to district offices.

(3) Waste Control Division is responsible for night soil collection, control, disposal and management.

(4) Refuse Disposal Division is responsible for solid waste collection, control and disposal as well as carrying all activities to provide solid waste disposal facilities.

(5) Technical and Planning Division is responsible for preparing a cleaning master plan, collecting statistic data by computer, preparing an action plan to enhance solid waste minimization and separation, studying and analyzing development of waste collection and disposal systems, studying and analyzing composition of waste in laboratory, etc.

Other local administrative organizations such as municipalities in the study area also have responsibility to collect, manage and dispose of solid waste. They mostly have a cleansing department which is directly in charge of this vital task. The structure of a municipality is shown in Figure 5-10 as an example.

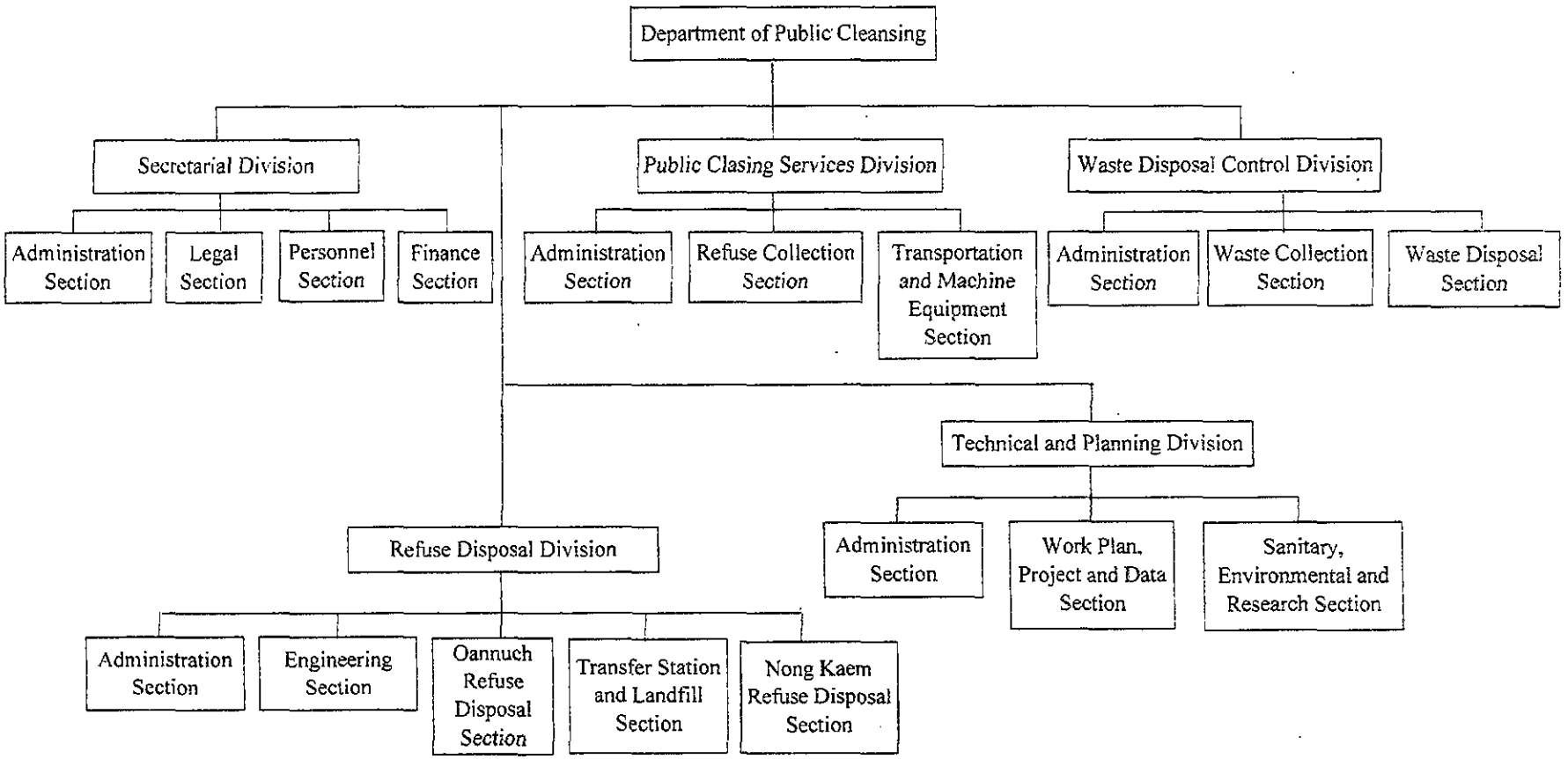



Figure 5-9: The organization chart of Department of Public Cleansing of BMA

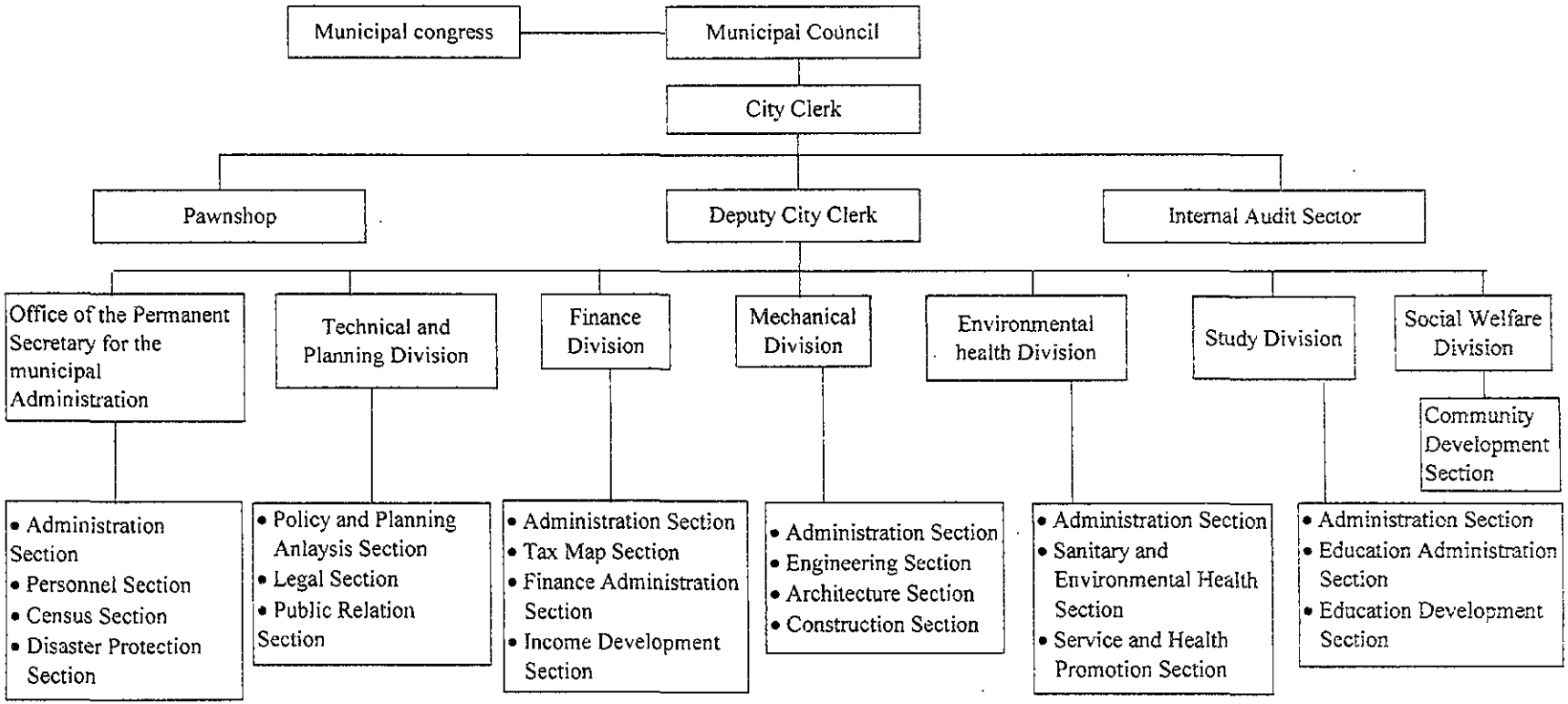
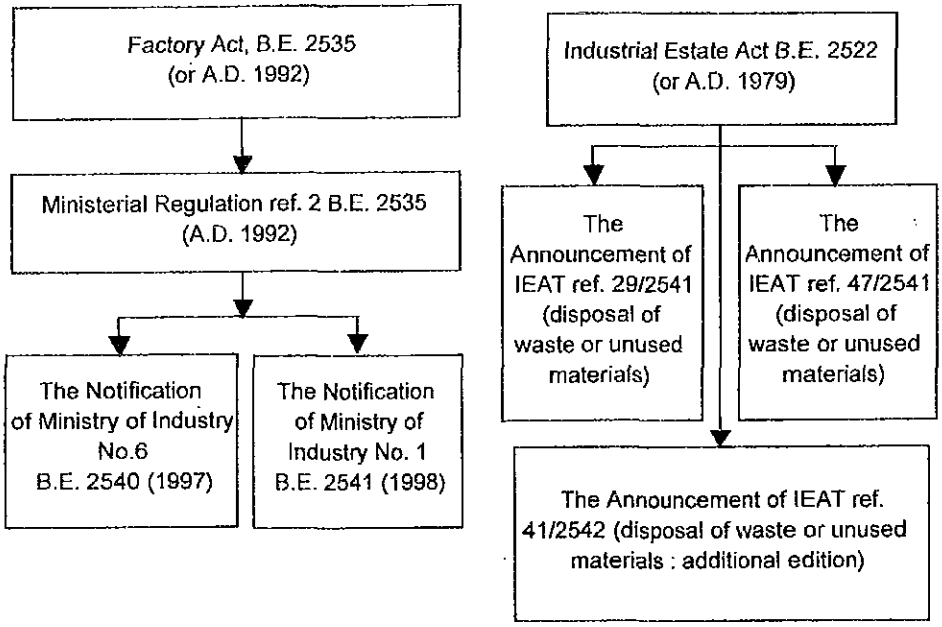



Figure 5-10: The organization chart of Municipality

# 5.4 Legislation

## 5.4.1 Acts and Regulations concerning IWM

DIW and IEAT are concerned with the control of IW. The DIW controls factories through Factory Act, while the IEAT controls only those located in the Industrial Estate by Industrial Estate Act. The following figure illustrates regulations, notifications and announcements under these acts.




**Relation of Act, Ministerial Regulation and Notification concerned with hazardous waste**

**Relation of Act and Announcement concerned with hazardous waste management by IEAT**

Figure 5-11: Relation of Act, Regulations and Notification or Announcement concerning hazardous waste management

In addition, Enhancement and Conservation of the National Environmental Quality Act empowers the Minister of the MOSTE to issue the ministerial regulations on the management of hazardous substance with respect to pollution control. PCD of the MOSTE is going to establish a Manifest System to control hazardous waste. Major acts and regulations concerning IWM are summarized in the following table.

Table 5-4: Summarized details of each law and regulation related to industrial waste management.

| Laws | Summary |
|---|---|
| 1. Public Health Act, B.E. 2535 (A.D. 1992) | Article 4: The Solid Waste means waste paper, cloth, food residue, *unnecessary articles, plastic bags, food package, ash, manure and* dead body of animals and so on.<br>Article 18: The Local Administration shall take the responsibility to |

| Laws | Summary |
|---|---|
| | manage the waste in its territory.<br>Article 19: Nobody can collect, transport and treat the waste in order to earn the fee without a license issued by the Local Administrator.<br>Rules and penalty in case of violating the licensed matter is defined in the articles 54 to 63. |
| 2. Factory Act, B.E. 2535 (A.D. 1992) | Section 8: The Minister shall be empowered to prescribe the Ministerial Regulations to specify the following matters.<br>(1) Criteria for the location of the factory, specification of buildings and the environment inside of the factory.<br>(2) Standards and methods to control discharge of waste, pollutants or anything that affects the environment as a result of the factory operation.<br>(3) Reporting on the factory operation during a specified period. |
| 3. Ministerial Regulation Ref. 2, B.E. 2535 (A.D. 1992), the Ministry of Industry | Chapter 4: Controlling the discharge of wastes, pollutants or anything that affects the environment<br>Item 13 : Treatment of solid waste and unusable materials<br>(1) A licensee of factory operation must keep the factory clean without any solid waste or unusable materials and provide proper waste storage.<br>(2) A licensee of factory operation must collect contaminated solid wastes and unusable materials separately. The factory that generates solid waste and unusable materials with specific characteristic as defined in the Royal Government Gazette must treat it by the designated methods in the Gazette. |
| 4. The Notification of Ministry of Industry No. 6, B.E. 2540 or A.D. 1997 on waste or unusable materials disposal | A factory operator shall obtain DIW's permit prior to taking the hazardous waste and unusable materials out of the factory which are specified in the annex 2 of the Notification. The factory operator must report details of the waste including type, amount and characteristic of the waste as well as methods and facility for storage, transportation, detoxification, disposal, landfilling in a form "Ro Ngo[1] 6" within 90 days after starting the operation of the factory and by Dec 30 each year. |

[1] Ro Ngo is a Thai abbreviation meaning factory. Forms "Ro Ngo 1" to "Ro Ngo 4" are those to be used for the application for factory registration or the factory license. The factories, if they are located in Bangkok, shall submit these forms to DIW in Bangkok, while the factories in the other provinces shall submit them to the provincial industrial offices. The form "Ro Ngo 5" is for reporting factory operation, which is submitted to the Office of Industrial Economics, instead of DIW. The form "Ro Ngo 6" is for reporting hazardous waste generation. This is submitted to DIW directly from the factories of Group 3. Factory classifications Group 1, 2 and 3 are explained in Section 5.2.1. Group 1 is not required a registration.

| Format | Purpose of Application | Submitters and organizations accepting the forms |
|---|---|---|
| Ro Ngo 1 | Registration of Group 2 factories | Factory owner to DIW |
| Ro Ngo 2 | Receipt for Ro Ngo 1 and registration fee | DIW to factory owner |
| Ro Ngo 3 | Application for establishment of Group 3 factories | Factory owner to DIW |
| Ro Ngo 4 | Approval for establishment of Group 3 factories | DIW to factory owner |
| Ro Ngo 5 | Annual report of the factory operation | Factory owner to Office of Industrial Economics (instead of DIW) |
| Ro Ngo 6 | Annual report of the hazardous waste generation and management | Factory owner to DIW |

| Laws | Summary |
|---|---|
| 5. The Notification of Ministry of Industry No. 1, B.E. 2541 or A.D. 1998 on waste and unusable materials disposal | The Notification is applied to the factories located in 14 provinces such as Bangkok, Samut Prakarn, Nonthaburi, Pathum Thani, Samut Sakhon, Nakhon Pathom, Chonburi, Chaochoengsao, Rayong, Prachinburi, Nakhon Ratchasima, Laumphun, Saraburi and Pra Nakorn Sri Ayudhaya. The factory operator shall obtain DIW's permit prior to taking even the non-hazardous waste and unusable materials out of the factory which are specified in the annex 1 and 2 of the Notification. |
| 6. Industrial Estate Act, B.E. 2522 or A.D. 1979 | Section 10: IEAT shall have power to control the operation of factories located in industrial estates in accordance with relevant laws and regulations as well as to take action on any activities to prevent sanitary and environmental impact.<br>Section 42: The establishment and operation of a factory in an industrial estate shall be in accordance with relevant industrial laws. Permission for establishment and engagement shall be a power of governor of IEAT. |
| 7. IEAT Announcement ref. 29/2541, 47/2541 and 41/2542 on disposal of solid waste and unusable materials in industrial estate | A factory operator shall have the IEAT's permit to transport any solid waste out of the factory. The operator must keep Waste Transport Control Sheet as defined in the Announcement ref. 41/2542 in case of official inspection as well as submit a disposal report to IEAT by 7th day of next month. |
| 8. Enhancement and Conservation of the National Environmental Quality, B.E. 2535 or A.D. 1992 | When there are no relevant regulations, Section 79 empowers the Minister, with the advice of the Pollution Control Committee, to issue ministerial regulations specifying the types and categories of hazardous wastes generated from the production and usage of chemicals or hazardous substance in the production process of industry, agriculture, sanitation and other activities which shall be brought under control. For this purpose, rules, regulations, measures and methods must also be prescribed for the control of collection, storage, safety measures, transportation, import into the Kingdom, export out of the Kingdom, and for proper and technically sound management, treatment and disposal of such hazardous wastes. |

## 5.4.2 Control Institutes Concerning IWM

### a. DIW's Control

### a.1 Hazardous Waste Control by the Notification No.6 (2540)

The Notification No.6 of B.E. 2540 pursuant to the Factory Act asks factory operators to treat hazardous waste generated in the factories properly, and to obtain the DIW's permission prior to take waste out of the factory sites. It also requires an annual report of waste generation and management according to the form Ro Ngo 6 shown in the Notification. Though the 3rd sheet of the form Ro Ngo 6 requires factories to attach the industrial hazardous waste manifest, the real Manifest System is not prescribed in any legislative documents. Actually some of waste treaters such as GENCO issue records of waste transportation similar to the manifest sheets as part of its service and they are attached to the Ro Ngo 6 report submitted by the factories.

#### (1) Transport Permit: the Permit from DIW to Take the Waste Out of the Factory

Article 2 of Notification No.6 prescribes that operators of the factories must obtain the "Transport Permit" from DIW prior to taking hazardous waste out of the factory sites. A request form for the permission is attached as an Annex 5.3.1. Kind of waste, the number of the section and article which stipulates the relevant waste in the Notification, times of transportation, quantity (ton/year), disposal methods and operators should be clarified in the request. Correspondingly, the DIW issues the Permit which defines those items above.

The Permit is, in fact, a plan of waste disposal for the coming year. It does not mean the actual amount of waste transported during the previous year.

**(2) Ro Ngo 6 (Annual Report of Hazardous Waste Disposal)**

Article 3 of Notification No.6 prescribes that operators of the factories must report the achievement of industrial waste management to DIW using the form Ro Ngo 6 specified in the Notification. The form Ro Ngo 6 is composed of 5 sheets as shown below.

(1) Details on Wastes of Unusable Materials and Disposal Method

(2) Sketch Map of Place of Storage, Detoxification, Disposal or Landfill

(3) Movement and Transport

(4) Landfill and Monitoring Plan (if any)

(5) Emergency Response Plan

Kinds of the waste, the number of the section and article that stipulates the relevant waste in the Notification, quantity and disposal method are specified in the sheet No.1. Transporters' name and address as well as a method of transport and containers used are clarified in the sheet No. 3.

The form is attached as Annex 5.3.2.

**a.2 Non-hazardous Waste Control by the Notification No.1 (2541)**

The Notification No.1 of B.E. 2541 concerns the non-hazardous waste generated in the factories in the 14 provinces as follows.

| | |
|---|---|
| Bangkok Metropolis | Chachoengsao |
| Samut Prakarn | Rayong |
| Nonthaburi | Prachinburi |
| Pathum Thani | Nakhon Ratchsima |
| Samut Sakhon | Lamphun |
| Nakhon Pathom | Saraburi |
| Chonburi | Phra Nakhon Si Ayutthaya |

Article 2 of Notification No. 1 asks factory operators to obtain the permission of the DIW's to take even non-hazardous waste out of the factory sites prior to do so.

Both the form of the request and the Transport Permit are similar to those for hazardous waste.

This Transport Permit is also a plan for the coming year, but Notification No. 1 does not require factories to submit the annual report of waste generation and management

achieved. This means that there is no way to verify the actual quantity of waste transported.

### a.3 Control over Materials

The factory listed in Ministerial Regulation No.9 B.E. 2538 (1995) must report the overall data on factory operation including material and products using a form called Ro Ngo 5. If a factory utilizes recycled material, it also must be reported in Ro Ngo 5. It is to be submitted not to DIW but to the Office of Industrial Economies of MOI.

### a.4 Enforcement

#### a.4.1 Factory Inspection

The inspectors of the provincial industrial offices execute factory inspection. All the factories as defined in the Factory Act (i.e. horsepower of 5 HP or more or employees of 7 or more) should be inspected. In principle, every factory is inspected once a year, but factories such as small ones with little potential to pollute the environment are inspected every two or three years. When complains about factory operation arise from the residents, the inspectors have to inspect the concerned factory immediately. In case of the Nonthaburi office, there are six inspectors, each of whom inspects 12 factories every month.

Factories are categorized into three groups as mentioned in Section 5.2.1 depending on the size and type. The following figures describe the procedure of inspection of group 1 factories, group 2 factories and group 3 factories.

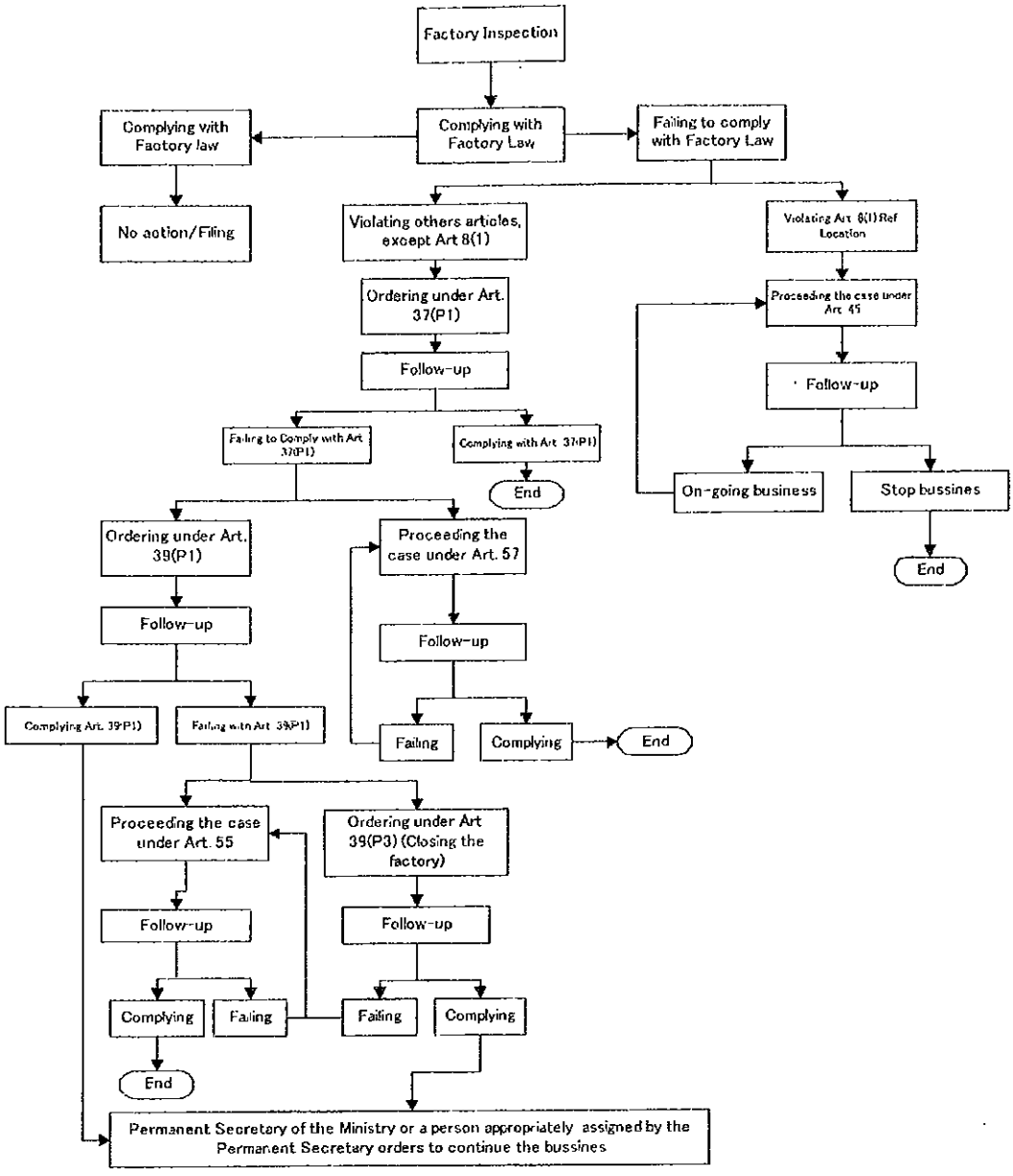



Figure 5-12: Procedure of Inspection of Group 1 Factories

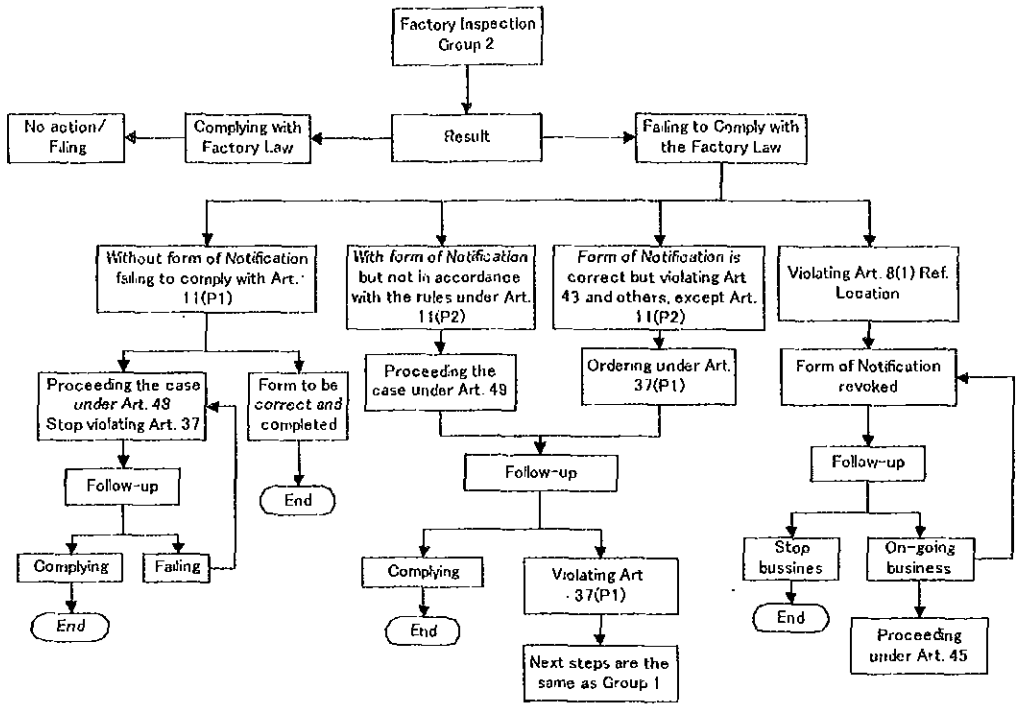



Figure 5-13: Procedure of Inspection of Group 2 Factories

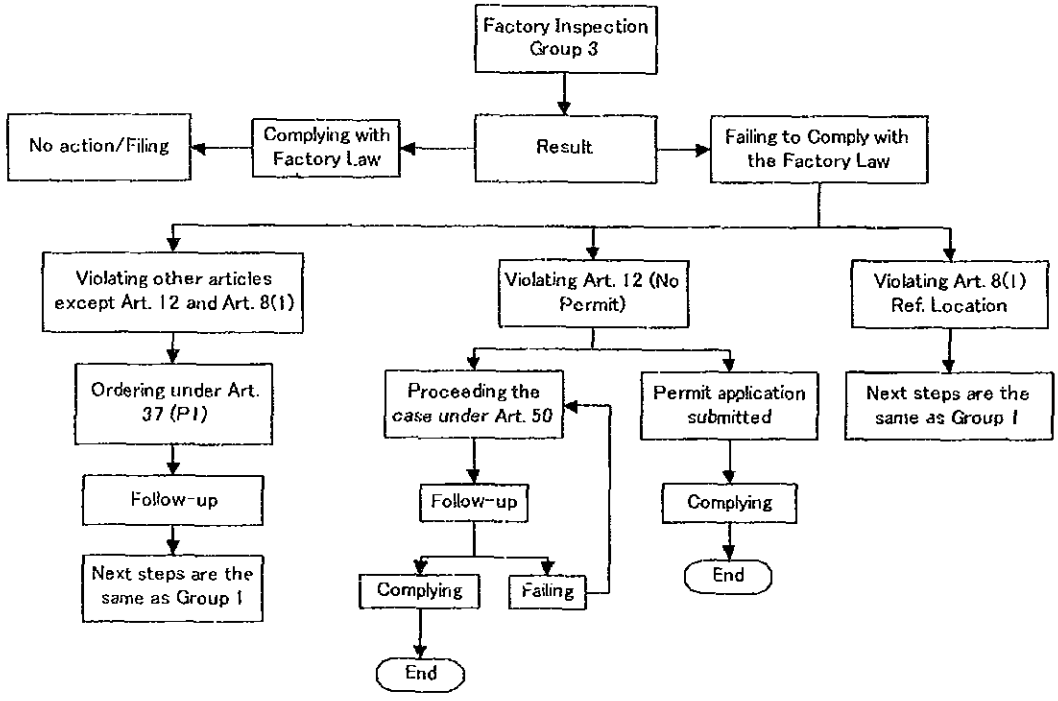



Figure 5-14: Procedure of Inspection of Group 3 Factories

### a.4.2 Punishment

Punishment is stipulated in Article 45 through Article 65 in Chapter 3 of the Factory Act. The Notification No.6 of B.E. 2540 (1997) and the Notification No.1 of B.E. 2541 (1998) are based on the Ministerial Order No.2 (1992), which is in turn based on Article 8 of the Factory Act. The violation of this article is subject to the punishment as described in Article 45 of the Factory Act. Actions taken by DIW during the fiscal year 2001, from October 2000 to September 2001, against factories with problems of noise, wastewater, dust and smoke, smell, traffic obstruction and others include prosecution (393 cases), improvement orders (1,130), temporary closure (140), case concluded (618), and further investigation (874).

### b. IEAT's Control

In case of the factories located in the Industrial Estate managed by the IEAT, it has authority to control them for all the aspects including waste management and pollution control. IEAT classifies waste generated in the factories into three categories, that is, Hazardous Waste, Solid Waste and General Waste in the Announcement of IEAT Ref. 47/2541(1998). IEAT controls the movement of these wastes by issuing the Transport Permit for each waste category and requires the factories to keep the records of Waste Transport Control Sheet as defined in the announcement.

The following tables summarize the items to be described in the request form of the Transport Permit and those in the Waste Transport Control Sheet for each category of waste. In addition, the factories are required to report reality of waste treatment to the IEAT every month.

Table 5-5: Required Items to be described in the Request for Transport Permit

| | Hazardous Waste from Factories | Non-Hazardous Waste from Factories | Municipal Waste |
|---|---|---|---|
| Category Code No. | Code No. defined in MOI Notification No. 6 (1997) | Code No. defined in MOI Notification No. 1 (1998) | Not required |
| Section number | Those of NMOI No. 6 | Those of NMOI No. 1 | Not required |
| Type of waste | Names defined in MOI Notification No.6 (1997) | Names defined in MOI Notification No.1 (1998) | Names according to Public Health Act 2535 (1992) |
| Frequency per year | Required | Required | Required |
| Quantity (ton/year) | Required | Required | Required |
| Treatment Method | Required | Required | Required |
| Name of Treater | Required | Required | Required |

Table 5-6: Required Items in the Waste Manifest System

| | Hazardous Waste from Factories | Non-Hazardous Waste from Factories | Municipal Waste |
|---|---|---|---|
| Category Code No. | Code No. defined in the NMOI No. 6 | Not required | Not required |
| Section number | Those of MOI | Those of MOI | Not required |

| | Notification No. 6 (1997) | Notification No. 1 (1998) | |
|---|---|---|---|
| Type of waste | Names defined in MOI Notification No. 6 (1997) | Names defined in MOI Notification No. 1 (1998) | Names according to Public Health Act 2535 (1992) |
| Classification (*1) | Required | - | - |
| Physical Property | Required | - | - |
| Container Capacity | Required | Required | - |
| Number of Container | Required | Required | - |
| Quantity (ton, than (*2) or $m^3$) | Required | Required | Required |
| Notes | Required | Required | Required |

(*1) *The United Nations Classification is adopted for hazard classification*
(*2) "Than" is a Thai unit equivalent to 20 liters.

### c. Local Administration's Control by the Public Health Act

Article 4 defines waste subject to the Act, but the current definition seems to be a general one that does not definitively refer to industrial waste.

Article 18 stipulates that the Local Administration such as municipalities should take responsibility to collect waste. The Local Administration can order the third parties to collect waste as well as to collect by themselves.

Thus, the responsibility of the Local Administration for industrial waste collection is not clearly stated, it has been interpreted that the industrial waste shall be collected by the Local Administration. Actually the Local Administration has collected industrial waste so far.

Ministry of Public Health is going to revise the Public Health Act. Major points of the revision are as below.

- The solid waste is classified into three types:

  Type 1: Municipal waste
  Type 2: Infectious waste
  Type 3: Non hazardous industrial waste

- Public Health Act stipulates that the Local Administration shall take the responsibility to collect and manage all these three types of waste. However, as for non-hazardous industrial waste, the MOI is in charge of it in 14 provinces due to the Notification No.1 (2541). Thus, the Local administration shall take the responsibility in principle, but it is considered that the additional regulation like the Notification above precedes the Act.

### d. PCD's Control

PCD has been trying to develop an integrated system for hazardous waste control. It is necessary to organize all the related agencies and to assign the roles to these agencies. The PCD prepared the "Handbook of Hazardous Waste Manifest System in the year 2000" to develop the system. Hazardous wastes to be covered by this system are those defined in the Notification of MOI No.6.

### d.1 Related Agencies

PCD assumes the following governmental agencies to be involved in the system.

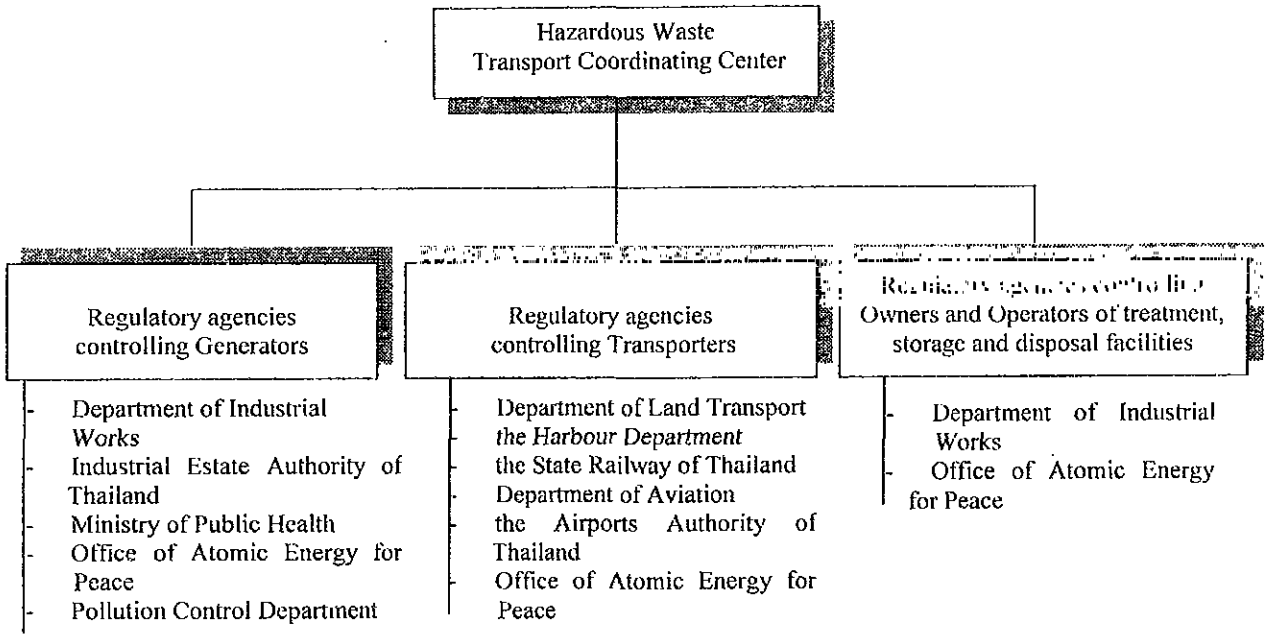



Figure 5-15: Chart of Hazardous Waste Transport Coordinating Center

Source: Handbook of Hazardous Waste Manifest System , Pollution Control Department, 2000

### d.2 Manifest System to be developed

The purpose of this system is to identify the activities of each actors through hazardous waste disposal, such as generators, transporters treaters and final disposers.

A set of the Manifest Form is composed of 6 copies and each of them is kept or sent to the each members involved.

Copy 1: sent by treaters to responsible governmental agencies
Copy 2: kept by generators
Copy 3: sent by generators to responsible governmental agencies
Copy 4: kept by transporters
Copy 5: kept by treaters
Copy 6: sent by treaters to the Generators

Movement of the Manifest Sheets can be illustrated as shown below.