

Vehicle management is rather complicated because responsibilities are divided into several agencies, such as districts, DPC, the Property and Procurement Division of the Department of Finance, and the Mechanical and Maintenance Division of the Department of Finance.

The DPC is responsible for selecting suitable vehicles for the solid waste management. After selection is made by the DPC, the Property and Procurement Division (PPD) purchases the vehicles. The vehicles purchased by PPD are distributed to the districts and the DPC in accordance with request from the districts and the DPC. After these processes, vehicles are fully managed by the districts and the DPC. When breakdown occurs, the districts and the DPC can repair their own vehicles if an expected repair cost is under a certain amount. Meanwhile, there are two methods for any repairs above this amount. One method is to get approval by the Governor and send to a private garage. The other method is to send to central workshop of the Mechanical and Maintenance Division.

#### 5) Production of Fertilizer

Production of fertilizer can not be clearly divided from the process of the solid waste management because it originally starts as a method of volume reduction of the solid waste. The process after the compost plant is managed by the BMA fertilizer office, which is a public enterprise under the BMA. The BMA fertilizer office manages the refining of fertilizer on trommel and sell several types of compost product.

### 7.2.2 Organizational Structure

#### 1) Collection and Haulage

4,381 persons were involved in the collection and haulage work in 1990. They belong to the Public Cleansing Service Division of the DPC and the districts. Among them, about 590 persons are the DPC officials, approximately 2,110 persons are permanent employees of the BMA and the other about 1,170 persons are temporary employees as shown in Table 7.2-1. Table 7.2-2 also shows number of the employees by districts. Sweepers account for approximately 4,100 persons who are about half of the total employees, approximately 3,000 persons are collectors and the others are drivers and supervisors.

Table 7.2-1 Staff Structure, 1990

	Civil Officer	Permanent Employee	Temporary Employee	Total	(Person)												
					L	E	V	E	L	1	2	3	4	5	6	7	8
DPC	3	0	0	3	0	0	0	0	0	0	0	0	0	0	0	2	1
Office of Secretary	31	34	0	65	0	6	4	9	7	3	1	1	0	0	0	0	0
Public Cleansing Service Division	44	412	50	506	3	11	18	4	3	2	2	1	0	0	0	0	0
Night Soil Disposal Division	66	573	61	700	11	9	24	15	5	0	1	1	0	0	0	0	0
Garbage Disposal Division	106	532	38	676	18	19	24	27	14	1	2	1	0	0	0	0	0
Technical Division	31	10	1	42	2	1	9	7	6	3	2	1	0	0	0	0	0
<b>Total</b>	<b>281</b>	<b>1,561</b>	<b>150</b>	<b>1,992</b>	<b>34</b>	<b>46</b>	<b>79</b>	<b>62</b>	<b>35</b>	<b>9</b>	<b>8</b>	<b>5</b>	<b>2</b>	<b>1</b>			

Source: DPC, BMA

Table 7.2-2 No. of Employees engaging SWM of Districts

District	Driver		Collector		Sweeper		Supervisor		Total		
	Permanent	Temporary	Permanent	Temporary	Permanent	Temporary	Permanent	Temporary	Permanent	Temporary	
1. Phra Nakhon	31	187	31	218	207	45	252	0	425	84	509
2. Pom Prab	2	22	14	136	110	21	131	15	267	37	304
3. Sam Pan Thawong	14	16	6	60	96	30	126	11	175	38	213
4. Phatum Wan	33	34	29	155	124	45	169	6	289	75	364
5. Bang Rak	22	22	17	108	84	57	141	6	203	74	277
6. Yannawa	12	13	34	62	36	47	83	6	82	82	164
7. Sathon	24	24	38	87	78	26	104	9	160	64	224
8. Bang Kho Laem	16	19	33	70	57	27	84	6	116	63	179
9. Dusit	34	52	58	166	160	62	222	13	315	138	453
10. Bang Sue	22	26	39	85	59	47	106	10	137	90	227
11. Phaya Thai	20	22	34	112	132	80	212	3	233	116	349
12. Rat Thewee	19	20	14	114	110	31	141	12	241	46	287
13. Huai Khwang	23	26	30	117	96	102	198	2	208	135	343
14. Phra Khanong	20	27	7	85	95	29	124	9	202	43	245
15. Klong Toi	14	44	118	178	80	140	220	2	156	444	600
16. Pra West	15	16	4	57	18	26	44	3	89	31	120
17. Bang Khen	9	12	31	45	21	29	50	3	47	63	110
18. Dong Muang	1	13	28	56	4	14	18	4	48	43	91
19. Jatujak	27	30	46	113	74	96	170	2	170	145	315
20. Bang Kapi	18	23	48	86	60	92	152	3	119	145	264
21. Lad Phaow	9	11	30	45	4	6	10	1	29	38	67
22. Bung Kum	10	12	11	36	3	23	26	0	38	36	74
23. Nong Chok	2	4	6	11	20	12	32	2	29	20	49
24. Min Buri	9	12	19	42	18	51	69	1	51	73	124
25. Lad Kra Bang	6	7	9	25	16	34	50	2	40	44	84
26. Thon Buri	15	21	31	90	124	47	171	0	198	84	282
27. Klong San	19	20	21	62	123	43	166	13	196	65	261
28. Bangkok Noi	4	21	76	79	76	32	108	5	88	125	213
29. Bang Plat	11	16	15	72	72	22	94	0	140	42	182
30. Bangkok Yai	10	11	3	51	70	17	87	8	136	21	157
31. Pasi Charoen	22	9	46	92	130	50	180	9	207	105	312
32. Bang Khun Thian	22	24	16	72	55	38	93	0	133	56	189
33. Jom Thong	14	17	18	48	30	14	44	0	74	35	109
34. Taling Chan	16	17	31	59	33	21	54	3	83	50	133
35. Rat Burana	8	11	13	42	14	34	48	1	52	50	102
36. Nong Khaem	7	7	19	25	29	73	102	2	44	92	136
Total	589	153	742	2,961	2,518	1,563	4,081	172	5,220	2,736	7,956

## 2) Compost Plants and Disposal Sites

The BMA officials engaged in the compost plants and the disposal sites are approximately 151 persons according to the DPC data, and 38 are employees in the offices. Among them, 56 persons work for On Nut Disposal Plant Section, 31 persons work for Ram Intra Disposal Plant Section and 47 persons work for Nong Khaem Disposal Plant Section. 106 are engineers. Table 7.2-3 shows the distribution.

There are 528 permanent employees in three disposal sites, of which 313 are workers, 87 are operators of machines, 14 are foremen. Fig. 7.2-2 shows this graphically

## 3) Others

### (1). Fertilizer Office

Fertilizer office had 123 staff in 1990, including 50 administrative staff and 73 labors in the compost plants.

### (2). Maintenance and Mechanical Division

Maintenance and Mechanical Division had 567 staff in 1990, including 73 temporary employees as shown in Table 7.2-4.

Table 7.2-3 Manpower Allocation of Garbage Disposal Division, 1990

	Director	Chief	Engineer	Admi.-staff	(Person) Total
General Administration & Engineering Section	1		7	9	17
On Nut Solid Waste Disposal Plant Section		5	43	8	56
Ram Intra Solid Waste Disposal Plant Section		3	22	6	31
Nong Khaem Solid Waste Disposal Plant Section		5	34	8	47
<b>Total</b>	<b>1</b>	<b>13</b>	<b>106</b>	<b>31</b>	<b>151</b>

Source: DPC

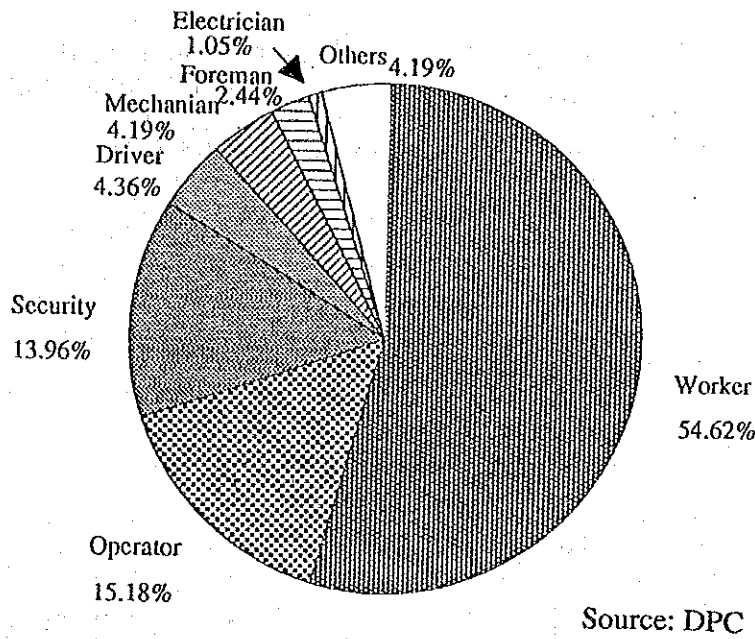


Fig. 7.2-2 Structure of Permanent and Temporary Employees working in Disposal Sites

Table 7.2-4 Staff of Maintenance and Mechanical Division

Section	BMA Officials	Parmanent Employee	Temporary Employee	Total
Finance		25	18	43
Administration	24	80	11	115
Engineering	9	125	17	151
Repair Workshop	21	222	15	258
<b>Total</b>	<b>54</b>	<b>452</b>	<b>61</b>	<b>567</b>

Source: MMD

#### 4) Salary Level

The BMA officials follow the official salary rate for civil officers set by central government. Salary is set by class and level as shown in Table 7.2-5. This rate is revised annually and applies to all public officers except military officers.

Table 7.2-5 Salary Rate for Civil Officer, 1989

18	4,950										
17	4,700										
16	4,450										
15	4,200										
14	3,950	5,800	7,200	8,950	11,150	14,300					
13	3,750	5,500	6,850	8,450	10,550	13,600	16,700	19,250			
12	3,550	5,200	6,400	8,000	9,950	12,950	15,850	18,400	21,350	23,000	25,000
11	3,350	4,950	6,150	7,600	9,450	12,350	15,050	17,550	20,150	22,000	24,000
10	3,150	4,700	5,800	7,200	8,950	11,750	14,300	16,700	19,250	21,350	23,000
9	3,000	4,450	5,500	6,850	8,450	11,150	13,600	15,850	18,400	20,150	22,000
8	2,850	4,200	5,200	6,400	8,000	10,550	12,950	15,050	17,550	19,250	21,050
7	2,700	3,950	4,950	6,150	7,600	9,950	12,350	14,300	16,700	18,400	20,150
6	2,600	3,750	4,700	5,800	7,200	9,450	11,750	13,600	15,850	17,550	19,250
5	2,500	3,550	4,450	5,500	6,850	8,950	11,150	12,950	15,050	16,700	18,400
4	2,400	3,350	4,200	5,200	6,400	8,450	10,550	12,350	14,300	15,850	17,550
3	2,300	3,150	3,950	4,950	6,150	8,000	9,950	11,750	13,600	15,050	16,700
2	2,200	3,000	3,750	4,700	5,800	7,600	9,450	11,150	12,950	14,300	15,850
1	2,100	2,850	3,550	4,450	5,500	7,200	8,950	10,550	12,350	13,600	15,050
Class/Level	1	2	3	4	5	6	7	8	9	10	11

Source: BMA

### 7.2.3 Relationship Between the DPC and the Other Relevant Agencies

#### 1) District

There is a clear division of responsibility for garbage collection between the DPC and the districts, and there is no relationship between them on daily work. Moreover, because the district office is under the office of the permanent secretary of BMA, the DPC can not directly attach to district 's tasks. However, even if there is no relationship between them, mutual assistance is occasionally available in terms of providing reserved collection vehicles from the DPC.

#### 2) Fertilizer Office

The Fertilizer Office obtains materials of fine compost, which consist of fermented waste, from the DPC free-of-charge under an agreement between them. However, the DPC cannot deliver 2,000 tons/month of compost which is mentioned in the agreement, consequently, it is a reason why the Fertilizer Office can not produce enough of the fine compost. The Fertilizer Office, therefore, thinks that it is one reason why the office cannot generate the expected profits. Table 7.2-6 shows compost given to the Fertilizer Office from the DPC.

Table 7.2-6 Compost Given to Fertilizer Office from DPC

YEAR	1986	1987	1988	1989
Amount/month(Tons)	769	1,444	1,409	1,155
No. of months with more than 2,000 t/m	1	4	4	3

Source: Fertilizer Office

On the other hand, the DPC has 2 seats on the Committee Board of the Fertilizer Office. Through the committee, the DPC can be involved with management of the Fertilizer Office.

### 3) Maintenance and Mechanical Division (MMD)

According to the BMA regulation, repair of vehicle and machine is classified at roughly three levels in terms of the amount of repair cost, which are: less than 20,000 Baht, more than 20,000 Baht and more than 200,000 Baht. A repair of less than 20,000 Baht of cost is done by the district or DPC by itself or by a private workshop. A repair of 20,000 Baht to 200,000 Baht of cost is basically done by the MMD. However, in an emergency case, the district and DPC can take bids from private garages with the approval of the BMA governor. A repair of more than 200,000 Baht of cost is also basically done by the MMD, but the district or DPC can use a private workshop by open bidding with the approval of the governor.

In cases of minor repair, the district and DPC are sometimes not willing to use the repair service of the MMD, because it takes long time. The MMD repairs about 500 vehicles a month, accordingly, along with a lack of spare parts and difficulty of repair, it results in taking a long time to complete repairs. Moreover, since regular check and proper maintenance are not provided in the districts and the DPC, level of breakdown is getting worse.



### 7.3 Legislation regarding Solid Waste Management

There are four main items of legislation regarding the solid waste management in Thailand:

- Public Cleansing Act, BE2484
- Act for the Cleanliness and Orderliness of the Country, BE2503
- The Bangkok Metropolitan Administration Ordinance  
Re: The Disposal of Refuse, Waste and Filth, BE2521
- Mischief and Pending in accordance with the BMA Ordinance for Sanitation and Orderliness in Bangkok Metropolis, BE 2523

The legislation regarding the SWM would generally include five important aspects in terms of responsibility and management such as:

1. Responsibility of cleanliness of people
2. Responsibility of government
3. SWM plan, guideline of operation and fee
4. Guideline of relevant facilities
5. Miscellaneous matters

#### 7.3.1 Purpose of legislation

Legislation regarding the SWM in Thailand are mainly subject to keeping cleanliness in the city area. Such legislation is established from the traditional public health point of view. The legislation is not, therefore, stipulating the solid waste management point of view.

#### 7.3.2 Contents of Legislation

##### 1) Responsibility of Cleanliness of People

Act for the cleanliness and orderliness of the country stipulates householders obligation for maintaining cleanliness of dwellings in Section 4 and prohibition of illegal disposal of the solid waste in Section 18.

The BMA ordinance Section 17 stipulates householders's responsibility of cleanliness at house front, designating solid waste containers, prohibition of illegal disposal and retrieval of utilizable materials.

## 2) Responsibility of Government

Public cleansing act stipulates that the solid waste management shall be the sole authority of the local authority of its jurisdiction in Section 6. It also stipulates that the local authority permits someone to undertake the solid waste management. The BMA ordinance also stipulates the responsibility of the solid waste management on the line with the public cleansing act.

## 3) SWM Plan, Guideline and Operation and Fee

There is no section regarding necessity of the SWM plan and technical guidelines for operation. However, Public Cleansing Act stipulates that the local authority shall set forth the laws or regulations regarding rate of collection fee.

## 4) Guidelines for Relevant Facilities

There is no section regarding necessity of setting guidelines for the relevant facilities such as the structure of a disposal site and Leachate treatment facility.

## 5) Miscellaneous Matters

Penalties and punishments of illegal disposals and discharges are stipulated in many sections:

Fig. 7.3-1 shows structure of legislation regarding the SWM.

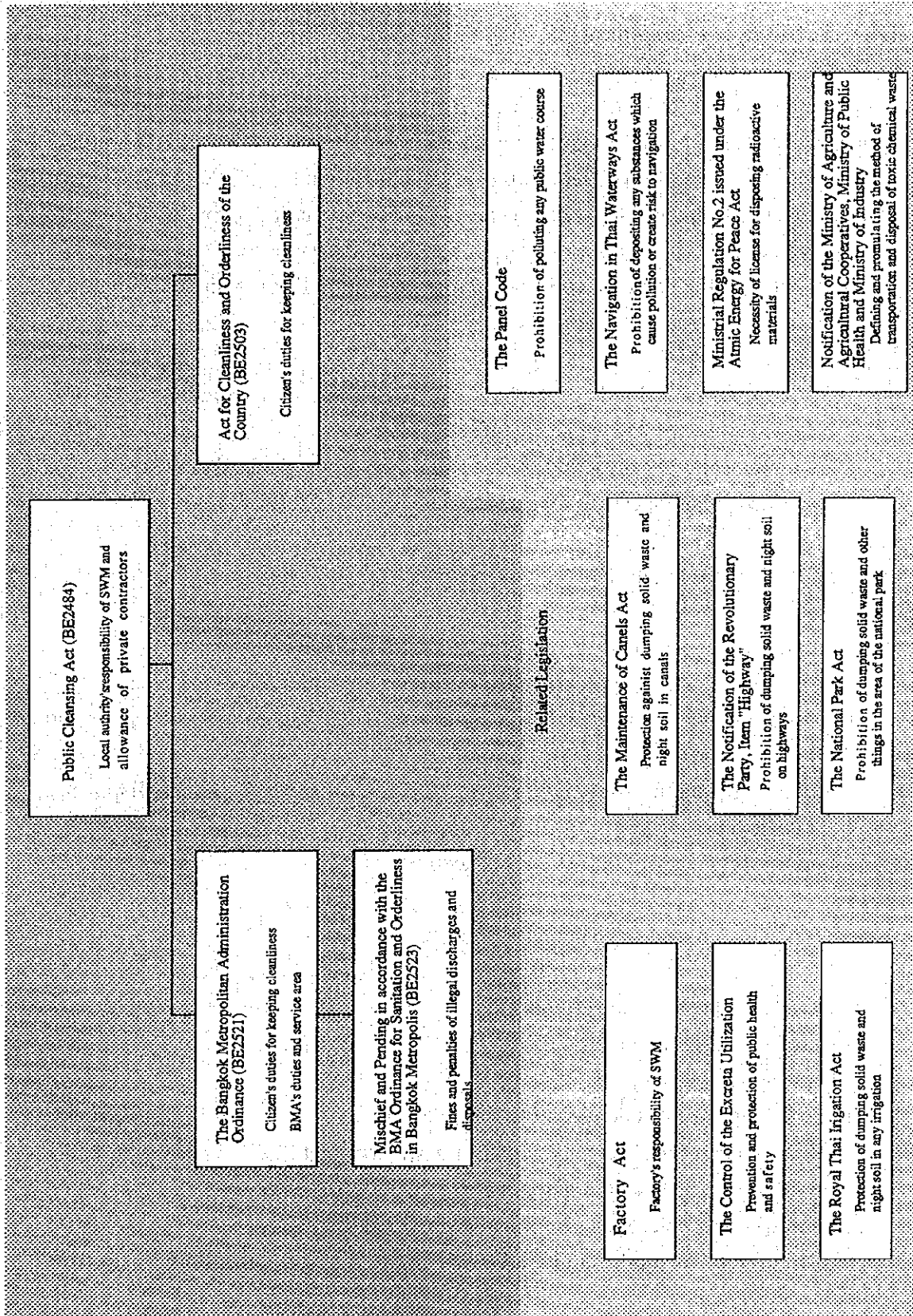


Fig.7.3-1 Structure of Legislation regarding SWM

## 7.4 Policies and Projects

### 7.4.1 Solid Waste Management

Encouraging public cleansing is one of the major policies emphasized by the BMA at present. The cleanliness of Bangkok has been much improved under the BMA policy given during the second BMA Development Plan, then, the third BMA Development Plan (1989-1991) which addresses the necessity of continuously improving solid waste management and the significance of projects pending from the Second Plan .

To tackle with problems of the solid waste management, the following objectives are set up:

- To provide many kinds of garbage collection services, including night soil collection, to cover the whole city area
- To implement waste disposal services appropriate to the demand of the city
- To reduce pollution caused by garbage dumping.

For the above objectives, the BMA gives five policies:

- Improve efficiency in waste disposal to cover the whole city area
- Promote and support appropriate technology as a Public Cleansing Project
- Acquire private co-operation in joining with waste disposal projects, under the BMA's supervision
- Encourage people to separate several types of garbage before disposing. Garbage bins should be provided in most areas
- Improve efficiency of the officials concerned.

To this end, eight projects to be implemented are:

- Private contracts in garbage collection
- Garbage transfer terminal
- Garbage vehicle terminal
- Toxic garbage collection, e.g. from hospitals
- Private contracts in setting up garbage transfer terminal
- Private contracts to collect garbage along canals
- Private contracts for final disposal in sanitary landfill
- Incinerators for both municipal waste and toxic and hazardous waste from hospitals

#### 7.4.2 Privatization

Privatization is one of the main issues in Thailand to minimize the expense of public sector, utilizing private abilities as well as achieving efficient governmental organization.

The sixth National Economic and Social Development Plan emphasizes promoting and encouraging the private sector to participate in development.

- Encourage the private sector to participate in public services such as roads and bridges, bus services in some areas, housing, water treatment plants, cargo depots, garbage collecting and waste disposal, sewage and drainage systems by granting concessions, renting or sub-contracting.
- Increase public and private sector co-ordination in acquiring land and raising funds for the development of public parks.

The BMA follows this national policy. Projects in the Third Plan relevant to the solid waste management, some of which are private contracts, are affected by the policy.

#### 3) Management and Organization Development

The Third BMA Development Plan emphasizes the upgrade of BMA's capability of administration by improving its work efficiency

The plan points out three problems:

- Publication of offices and little flexibility of organization
- Little co-ordination among Intra-organizations, in particular, between Department and District.
- Lack of a continuous working system caused by changing council policies.

To overcome these problems, the Third Plan states three important targets:

- Improve and clarify regulations, laws and orders concerning the role of Department and District offices
- Improve the working system of Department and District office through<sup>2,30</sup> standardization re-arrangement of District Offices

The last target was completed in 1989, and the new arrangement of districts consists of 36 districts, began in the 1990 fiscal year.

## 7.5 Private Contract

### 7.5.1 Background

The DPC is employing private contractors for waste collection and final disposal as pilot projects in order to follow the privatization policy of both the central government and the BMA.

In 1981, the BMA invited the private sector for collection of garbage in Phya Thai and Phra Kanong districts, but this finished in 1983. After that, a private contract method was applied to the Klong Ton sub-district as a pilot project, which served Sukhumvit Soi 1 to 71 of Phra Kanong district. The private company completed the work successfully during the contract period of 1984 - 1986, then, private contract method has been identified as important pilot projects for the Third BMA Development Plan. Private contract has been expanded to be applied to Klong Ton, Klong Toi of Phra Kanong district, and Bangkok Noi district from 1987.

### 7.5.2 Operation

Private contractors served 7 % of the population in Bangkok from 1987 to 1989. As shown in Table 7.5-1, 84,451 households or 354,280 persons were served by the private contractors in Klong Toi, Klong Ton sub-districts and Bangkok Noi district.

Table 7.5-1 Area and Population served by Private Contractor

Area	No. of Households	No. of Population
Klong Toi Sub District	27,676	103,790
Klong Ton Sub District	13,017	52,496
Bangkok Noi District	43,758	197,976
Total	84,451	354,280

Source: DPC,BMA

During five years of private contracting, 467.9 tons/day was collected, which represents approximately 13 % of the total solid waste amount in 1989. The average

tonnage was 4.04 tons/day in 1989. At the same time, the BMA average 3.75 tons/day, as shown in Table 7.5-2 and Table 7.5-3. As a result, the performance of private contractors was not so different from the performance of the BMA in terms of collection amount per trip.

Table 7.5-2 The Amount of Garbage Collection by BMA and Private contractor (Tons/day)

	1985	1986	1987	1988	1989
BMA	3,196.36	3,661.0	3,737.17	3,796.24	3,640.12
Private Contractor	63.86	121.43	452.93	440.17	467.9
- Klong Ton	63.86	121.43	190.87	145.58	138.69
- Klong Toi			113.32	110.60	137.32
- Bangkok Noi			148.74	183.99	191.89

Source: DPC, BMA

Table 7.5.3 Comparison of Tons/Trip between BMA and Private Contractor (Tons/Trip)

	1987	1988	1989
BMA	3.83	3.92	3.75
Private (average)	4.25	3.62	4.04
- Klong Ton	4.58	3.24	3.49
- Klong Toi	3.71	3.46	4.38
- Bangkok Noi	4.32	4.13	4.29

Source: DPC, BMA

### 7.5.3 Contents of Contract

Contracts between the BMA and private contractors include agreements on fees, fines, and terms of work as well as supervision and advice. In the case of Bangkok Noi district, there are 20 sections in contract. Terms of work and fees are stipulated in



sections 1 to 5. The Private contractor has to finish collection before 6:00 pm except in certain areas with not less than 23 vehicles. Payment is made at the rate of 202 Baht/ton, but not exceeding 33,178,500 Baht. The private contractor must also give a guarantee to the BMA, which is 5 % of total payment.

Fines are stipulated in section 7. For instance, the private contractor has to pay 1,500 Bahts per day if he cannot arrange collection vehicles as stated in the contract. Right of supervision and inspection by the BMA are stipulated in section 11 to 15. The BMA can appoint an inspection committee for inspecting, advising and ordering the private contractors.

#### 7.5.4 Evaluation of Private Contractor

The biggest advantage of employing a private contractor is obviously cost reduction. It is, therefore, concluded that initial expectation for employing a private contractor has been fully proved. However, several problems have arisen with the private contractor. Firstly, private contractors cheat the amount of collected waste by adding stones and water to it because the BMA pays fees by weight. Secondly, workers of private contractors have a low consciousness of public cleansing; thereby, some garbage has been left on the streets. Workers with insufficient knowledge and inadequate training also resulted in uncollected garbage and mis-operation. Thirdly, the private contractors do not have enough equipment, and it is not well maintained.

As a conclusion, from several years' experience in three areas, the BMA found that the private contract for collection and haulage is effective in cost reduction, however, there were some problems in performance.

## 7.6 Issues

The BMA has traditionally tried to improve public cleansing, as mentioned in the first section of this chapter. In particular, collection work is effectively done at the present. However, there are several problems on organizational and institutional aspects. To resolve them, the following issues are pointed out :

### 7.6.1 Private Contract

Since the central government and the BMA promote privatization policy, the private contract of collection and disposal of the solid waste is an important project for the DPC. The BMA has experienced some contracts successfully at pilot project level, but the private contract method has not been standardized yet. To expand the private contract method to districts, a standardized method of using private contractor must be developed. Without it, the districts can not handle the private contractor properly. For this end, appropriate technical guidelines, standardized evaluation procedures and standardized methods for evaluating the applicants should be prepared.

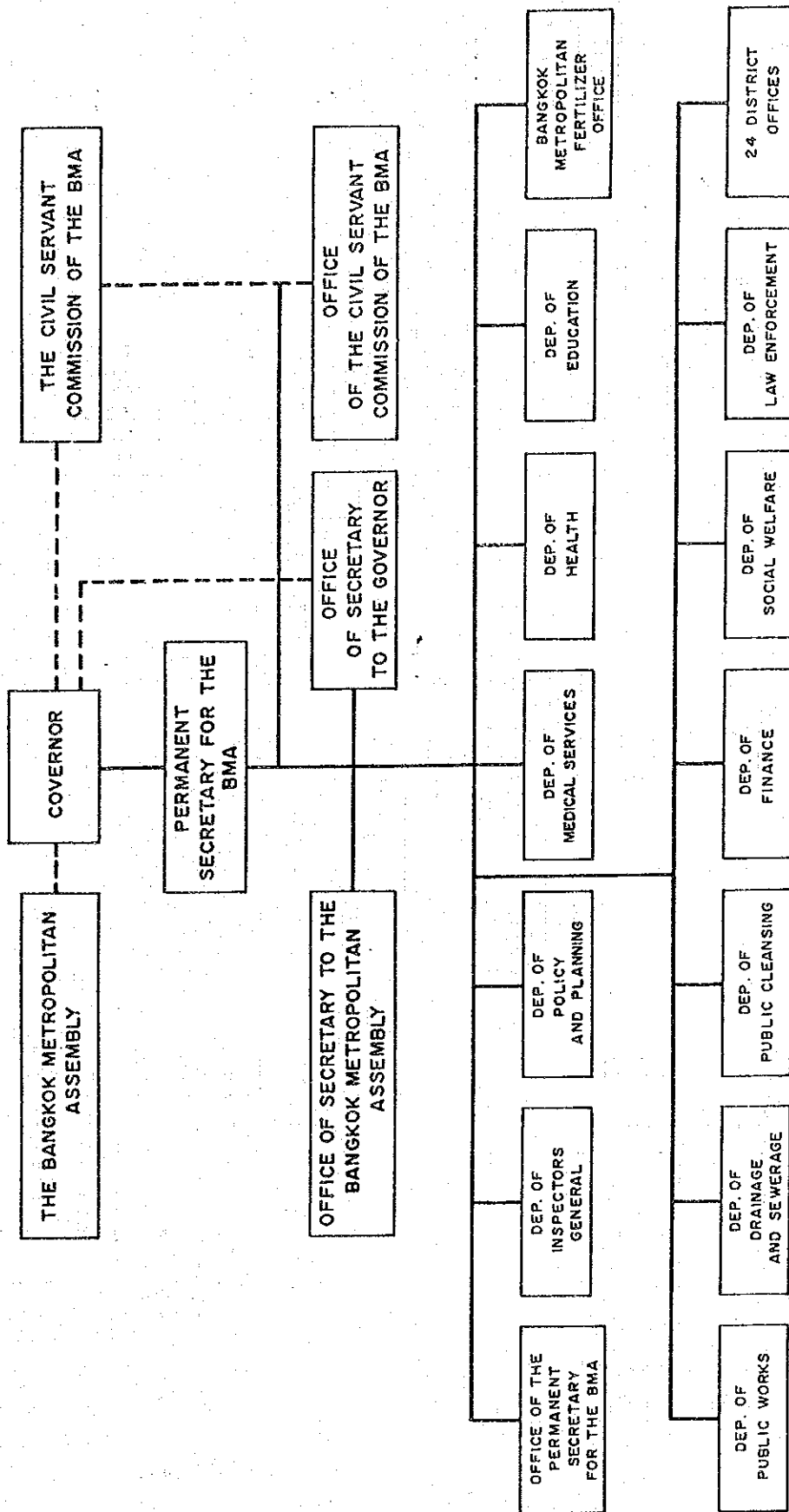
### 7.6.2 DPC's Responsibility on the SWM

Although the DPC has responsibility of the SWM in the BMA, several agencies who are involved in the SWM are not under the DPC, so that the DPC can not control whole SWM in Bangkok. Therefore, the responsibility of each relevant agencies should be made clear. In particular, responsibility of the Public Cleansing Service Division who collects market waste and hospital waste at present, and responsibility of Technical Division must be reconsidered for efficient utilization. Moreover, effective manpower allocation among the final disposal sites and the compost plants must be considered in accordance with the future intermediate treatment plan and final disposal plan.

### 7.6.3 Modification of Present Legislation regarding the SWM

Since the legislation regarding the SWM in Thailand aims traditionally at keeping cleanliness, the legislation does not enough set out the SWM requirements. Under the population growth and rapid economic development, the requirements of a stable SWM system with minimum environmental effects will be increasingly important because peoples's attention to environmental matters will grow rapidly.

Fig. A7-1 Organization of Bangkok Metropolitan Administration



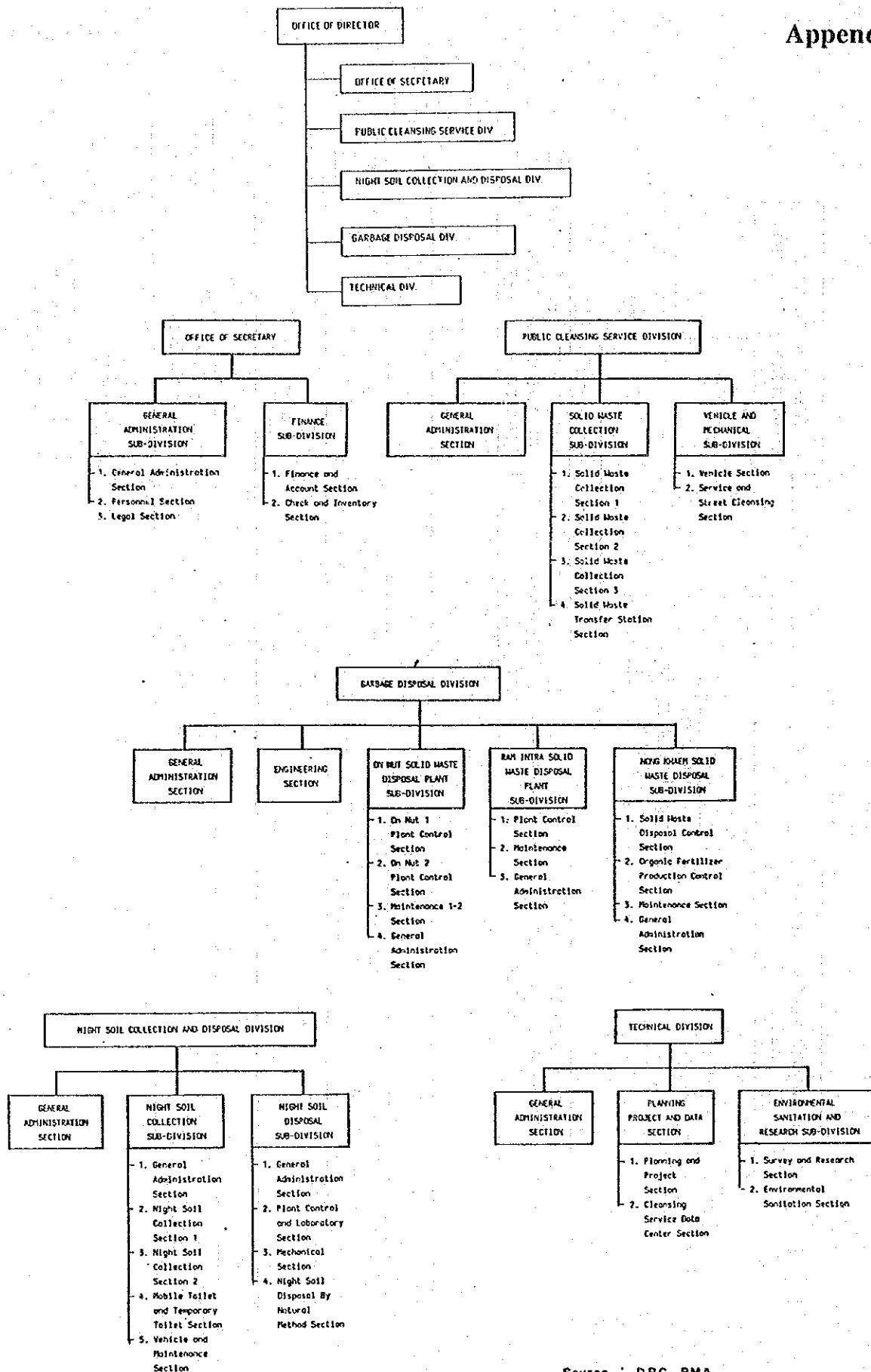
ABBREVIATIONS

BMA - BANGKOK METROPOLITAN ADMINISTRATION

DEP. -- DEPARTMENT

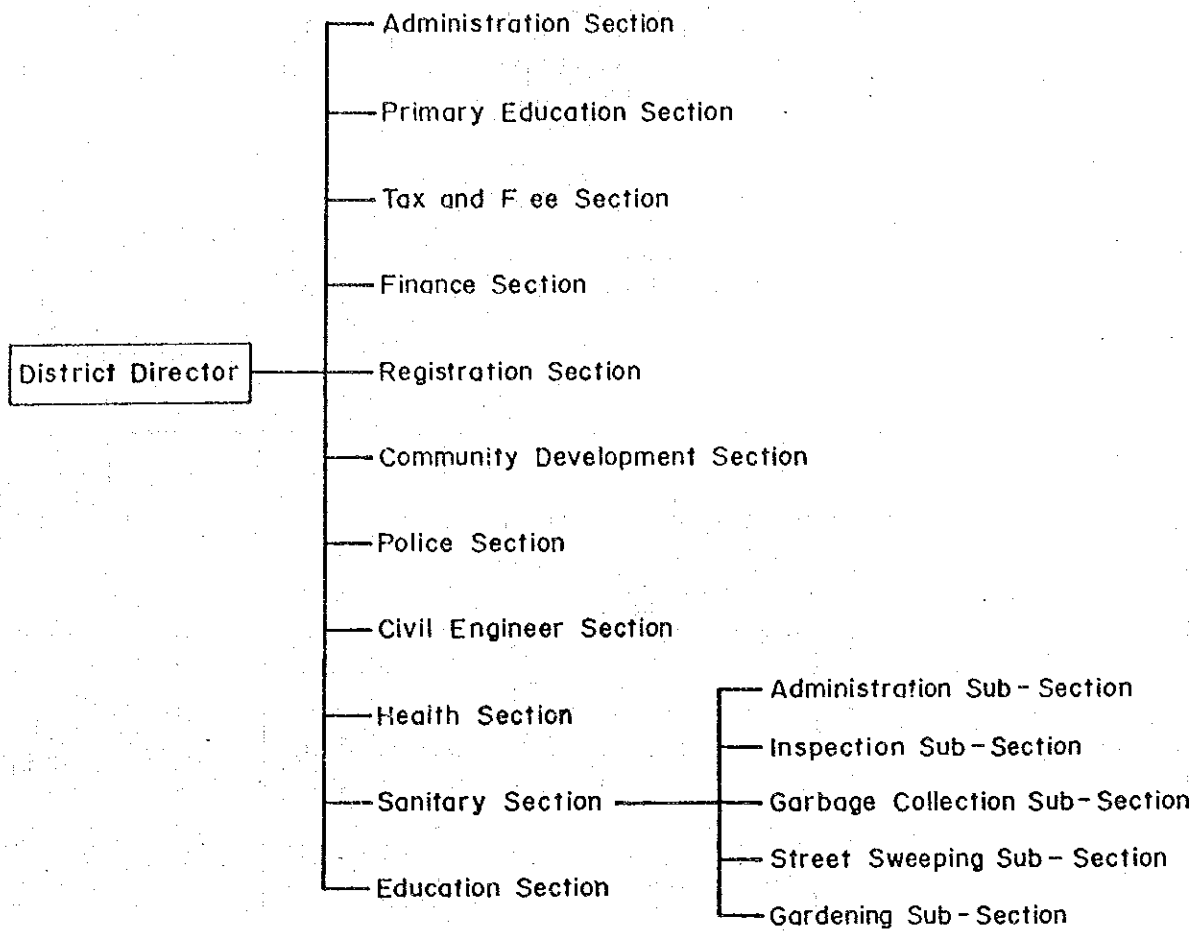
SOURCE : DPC, BMA

1988 TECHNICAL DIVISION DPC, BMA



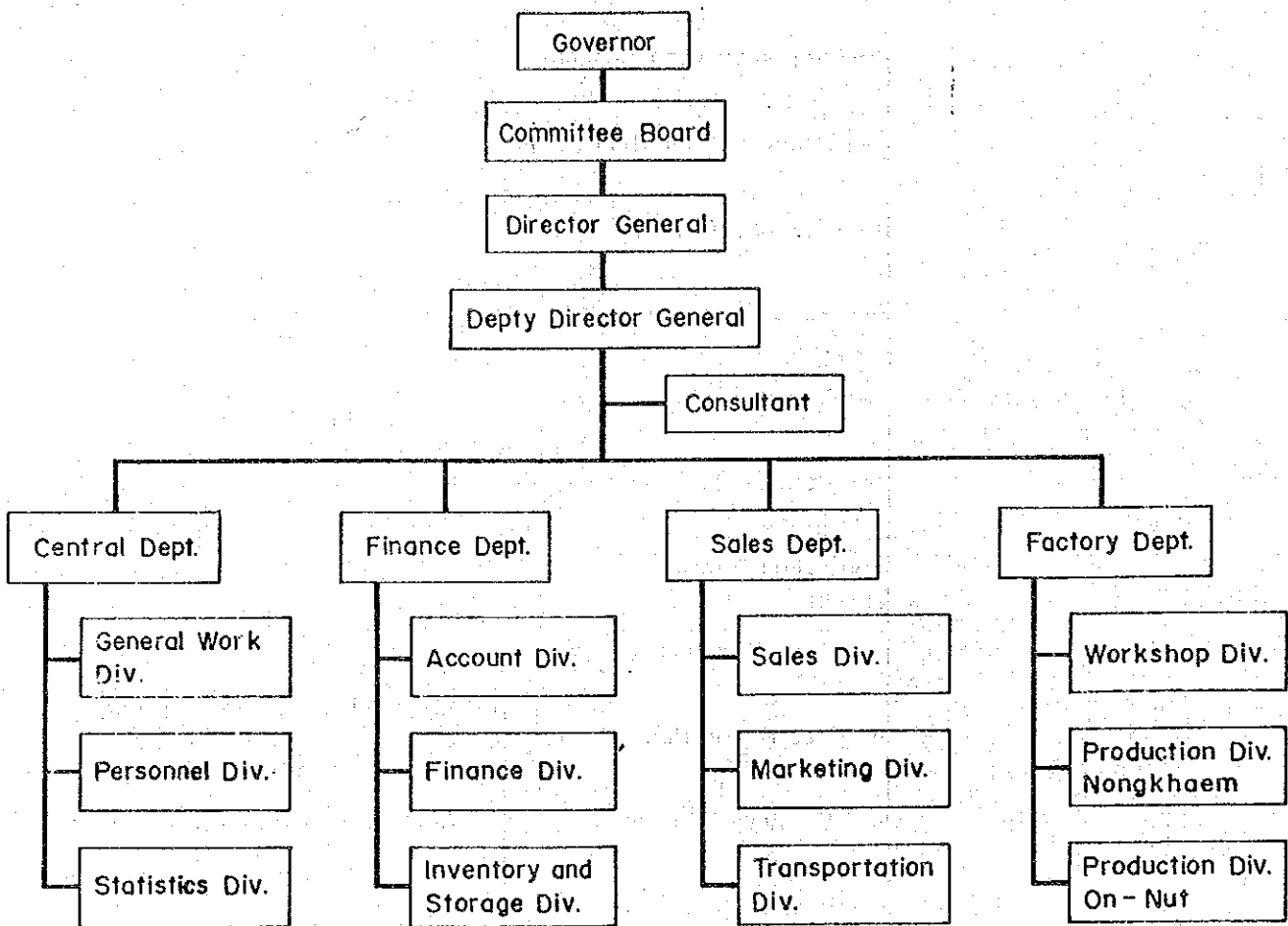
Source : DPC, BMA

Fig. A7-2 Organization of Department of Public Cleansing  
2-62



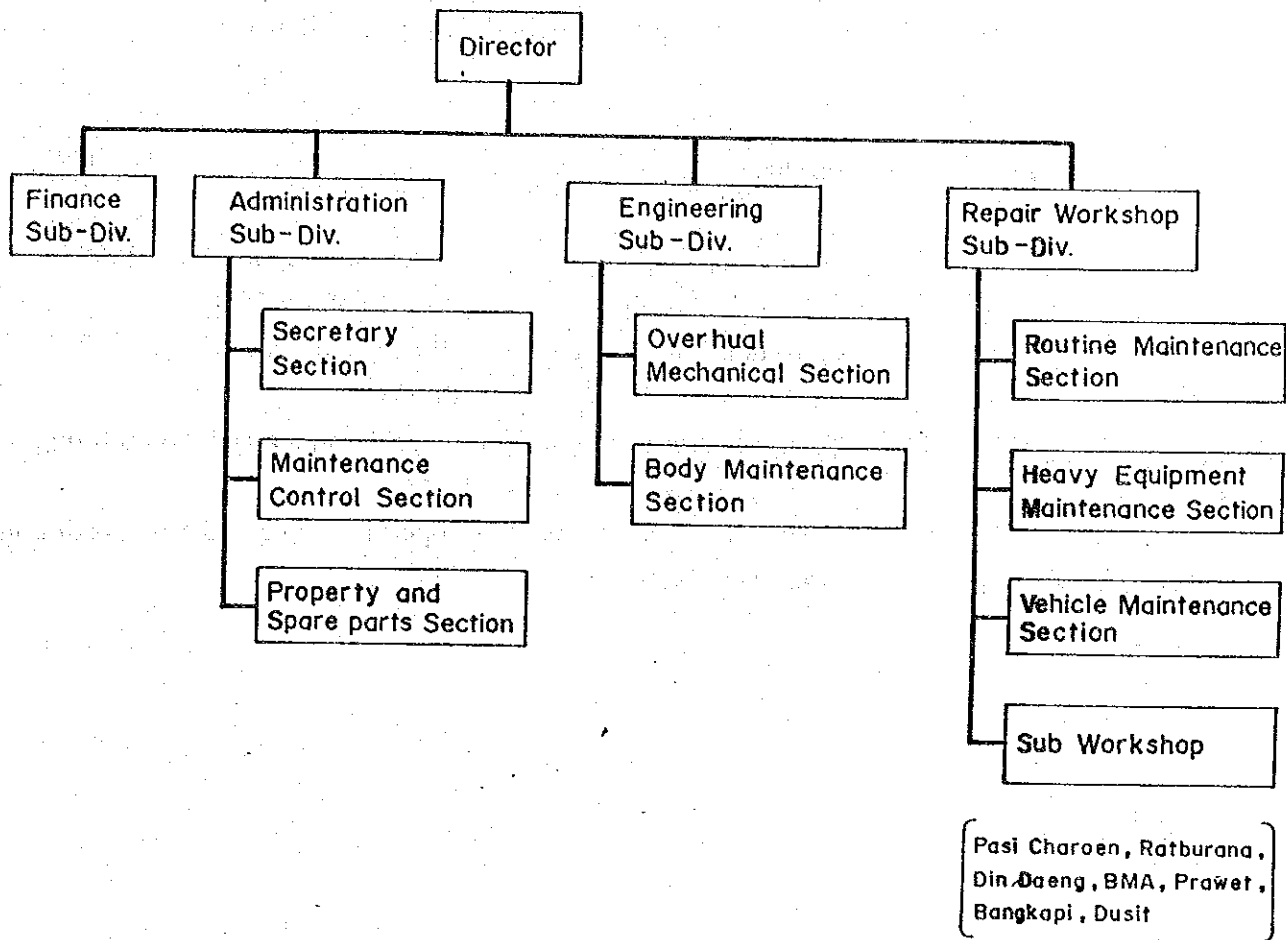
Source : BMA

Fig. A7-3 Organization of District Office



Source : Fertilizer Office

Fig. A7-4 Organization of Fertilizer Office



Source : MMD

Fig. A7-5 Organization of Maintenance and Mechanical Division

## **Chapter 8. BMA's Budgets and SWM Cost Data**

This chapter contains the following 6 tables:

- Table 8.1-1 Comparison of Estimated Revenue for Fiscal Years 1983 - 1990
- Table 8.1-2 Collection Costs by DPC and 24 District offices 1988
- Table 8.1-3 Collection Costs by DPC and 24 District Offices 1989
- Table 8.1-4 Repair Cost of Garbage Truck (1988)
- Table 8.1-5 Costs and Waste Amounts of Open Dumping and Compositing in Fiscal Year 1988
- Table 8.1-6 Costs and Waste Amounts of Open Dumping and Compositing in Fiscal Year 1989



Table 8.1-1  
Comparison of Estimated Revenue  
Fiscal Year 1983 - 1990

Items	Fiscal Year							
	1983	1984	1985	1986	1987	1988	1989	1990
<b>A. Regular Revenue</b>								
1. Tax	3,266,000,000	3,732,000,000	4,294,100,000	4,794,000,000	4,563,000,000	4,825,500,000	6,280,000,000	7,695,500,000
- Collected by BMA	[656,500,000]	[321,500,000]	[824,500,000]	[1,133,500,000]	[1,219,500,000]	[1,343,500,000]	[1,478,000,000]	[1,641,500,000]
- Collected by other other agencies	[2,609,500,000]	[3,010,500,000]	[3,469,600,000]	[3,660,500,000]	[3,343,500,000]	[3,482,000,000]	[4,802,000,000]	[6,054,000,000]
2. Fee and License	100,171,000	105,931,000	119,531,000	125,112,000	164,067,000	164,867,000	180,957,000	219,687,000
Fine and service charge								
3. Properties	185,305,000	224,655,000	235,652,000	425,968,000	408,488,000	408,488,000	347,103,000	593,203,000
4. Commerce and Public Utilities	8,900,000	10,300,000	8,800,000	6,300,000	6,700,000	6,700,000	20,215,600	17,650,000
5. Miscellaneous	197,247,000	84,417,000	84,880,000	131,080,000	111,600,000	111,600,000	91,724,400	73,960,000
Total of Regular Revenue	3,755,623,000	4,157,333,000	4,762,963,000	5,482,460,000	5,254,655,000	5,517,155,000	6,980,000,000	8,600,000,000
<b>B. Extra Revenue</b>								
1. ....	-	612,000,000	-	63,534,148	60,000,000	226,953,330	-	1,316,781,500
2. Supporting money from the government	921,203,374	1,577,134,322	1,382,773,945	1,118,000,200	1,122,087,800	-	-	-
Total of Extra Revenue	921,203,374	2,189,134,322	1,382,773,945	1,181,534,348	1,182,087,800	226,953,330	-	1,316,781,500
<b>Grand Total</b>	4,676,826,374	6,346,467,322	6,145,736,945	6,663,994,348	6,436,742,800	5,744,108,330	6,980,000,000	9,916,781,500

Table 8.1-2 Collection costs by DPC and 24 District offices

1988

Fiscal Year 1988 (1)

District	Salary Cost (Baht)	Welfare Cost (Baht)	Fuel Cost (Baht)	Equipment Cost (Baht)	Repair Cost (Baht)	Depreciation Cost (Baht)	Sum of Collection Cost (Baht)	Amount of Solid Waste (ton)	Collection Cost (Baht/ton)
1. Phra Nakhon (PNK)	8,117,087	823,122	2,595,916	422,976	3,156,420	3,126,696	18,242,217	70,000	261
2. Pom Prab (POP)	5,322,088	657,587	1,333,254	126,557	1,048,571	2,293,644	10,781,701	34,502	312
3. Sempantawong (SPW)	4,290,061	770,532	1,901,867	208,958	1,704,696	3,027,444	11,903,558	51,033	233
4. Phatumwan (PTW)	3,756,274	438,361	983,429	87,096	1,793,180	233,412	7,291,752	24,220	301
5. Bang Rak (BAR)	6,473,755	997,943	1,779,168	131,083	1,336,032	2,170,164	12,588,145	44,807	281
6. Yannawa (YAW)	8,481,945	744,384	4,070,397	258,633	5,646,851	4,630,344	23,832,564	114,363	207
7. Satorn (SAT)	7,122,814	680,070	5,131,992	344,216	3,887,617	3,785,112	20,951,821	126,508	165
8. Bang Kho Luang (BKL)	8,505,225	980,206	3,139,941	285,465	2,787,131	6,296,052	21,994,020	129,536	170
9. Dusit (DUS)	3,817,274	468,206	2,611,001	114,165	887,864	2,311,296	10,209,806	71,883	142
10. Bang Sue (BAS)	9,768,343	1,415,908	3,168,783	354,593	3,700,663	4,756,656	23,164,946	97,499	238
11. Phya Thai (PT)	7,395,716	1,039,625	3,592,199	284,221	2,251,009	5,103,708	19,666,478	158,108	124
12. Ret Thevee (RTV)	4,759,569	581,931	2,999,656	233,866	1,631,766	4,684,860	14,891,648	113,778	131
13. Huey Khwang (HUK)	342,855	12,299	180,790	5,005	51,883	326,472	919,304	1,955	470
Sub : Ding Deang (DIN)	1,428,387	106,864	778,949	27,878	302,482	1,468,104	4,112,664	13,359	308
14. Phre Khanong (PKN)	1,012,304	24,709	288,082	36,510	314,733	653,004	2,329,342	9,484	246
Sub : Suang Luang (SUL)	3,602,438	187,381	869,747	89,799	665,974	1,969,656	7,384,995	48,567	152
15. Klong Toi (KIT)	2,567,433	156,780	1,879,993	85,331	1,410,587	1,816,164	7,916,288	42,927	184
16. Pre Wate (PWA)	2,124,032	151,534	839,133	66,221	616,394	1,220,256	5,017,570	22,710	231
17. Bang Khen (BAK)	2,152,003	153,467	557,720	4,321	621,186	1,129,104	4,700,601	23,553	134
Sub : Dong Muang (DM)									
18. Jatujek (JTJ)									
20. Bang Kapi (BKP)									
21. Lad Prawn (LAP)									
22. Bung Kum (BUK)									
23. Mong Chok (MOJ)									
24. Min Buri (MBR)									
25. Lad Krabang (LKB)									
26. Thon Buri (TBR)									
27. Klong San (KLS)									
28. Bangkok Noi (BKN)									
29. Bang Plet (BAP)									
30. Bangkok Yai (BKY)									
31. Pasi Charoen (PSJ)									
32. Bang Khun Thian (BKT)									
33. Jom Thong (JOT)									
34. Taliang Chan (TLC)									
35. Ratburana (RBN)									
36. Mong Khaem (MOC)									

Table 8.1-2 Collection costs by OPC and 24 District offices

Fiscal Year 1988 (2)

1988

District or PPC	Salary Cost	Welfare Cost	Fuel Cost	Equipment Cost	Repair Cost	Depreciation Cost	Sum of Collection Cost	Amount of Solid waste (Ton)	Collection Cost (Baht/Ton)
119 BKT	3,287,479	266,614	1,653,841	24,854	1,338,984	2,266,560	8,838,532	43,099	205
120 PSJ	3,020,358	8,457	1,334,870	116,638	1,512,078	2,062,620	8,055,021	42,354	190
121 RBN	3,531,342	260,757	1,201,263	44,464	824,858	1,523,172	7,385,856	32,509	227
122 TLC	2,033,427	33,652	548,653	21,309	553,905	652,452	3,843,398	7,452	515
123 NOD	854,720	120,092	216,322	91,220	363,862	824,688	2,470,844	10,920	225
124 OPC	5,270,320	577,304	1,960,489	139,066	2,805,176	2,933,088	13,685,443	40,541	338
Total	108,738,649	11,667,735	45,617,455	3,684,445	41,213,902	61,264,728	272,186,914	1,378,653	197

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หมายเหตุ 1. แถว (1) และ (2) หมายถึง ค่าใช้จ่ายเงินเดือนค่าจ้างค่าตอบแทน และ สวัสดิการของ เจ้าหน้าที่บริหารงานรักษาความสะอาด ( คิดเฉลี่ยเฉพาะงานด้านรักษาความสะอาดเท่านั้น ) , ผู้ควบคุม, พ.ช.ร. และคนงาน

2. เขตบางกอกน้อย จ่ายเหมาเอกชนเก็บขยะมูลฝอยโดยเหมาจ่ายในราคา.....บาท/ตัน  
จึงนับโดยมาคิดค่าจ้าง

1989

Table 8.1-3 Collection Costs by DPC and 24 District Offices.  
Fiscal Year 1989 (1)

District or DPC	Salary Cost	Welfare Cost	Fuel Cost	Equipment Cost	Material Cost	Office material Cost	Repairing of office material	Repairing of Vehicle	Depreciation Cost	Sum of Cost	Amount of Solid waste (Cans) Collected
1. PNK	2890000	2932758	2588371	311909	-	-	2920295	2755848	20279956	20279956	66063
2. POP	7118246	1554120	1366527	156624	-	-	1183700	1919205	12080527	12080527	38939
3. PTW	6461973	1727009	1846856	192124	-	-	1841271	2504112	14575705	14575705	22534
4. SPV	2712593	1505178	823580	57758	-	1435	1552580	222296	7956361	7956361	2163
5. BAR	5650171	1904209	1784543	118817	-	-	2048656	1840220	18347116	18347116	44522
6. YNU	6329720	2672106	559777	69488	-	-	6822724	3536844	25012549	25012549	119,902
7. DUS	0784926	1450129	337205	1400490	-	-	5857141	398516	2491127	2491127	1124
8. PIT	8786090	9615826	3084884	277200	1622438	15920	2451224	5197420	25051228	25051228	112
9. HUK	6624907	931253	2524655	170001	-	-	1246270	1902464	11822510	11822510	68,997
10. PKN	9814072	2061675	2207351	301250	71220	-	2566005	4652316	24856173	24856173	24,551
11. BAK	7527259	2201212	9649175	142550	173462	-	1585	2108124	4284220	21961600	150,206
12. OXP	21920885	1155226	2527372	171560	18196	-	1510	2807212	3793200	15215911	112,202

Unit: Dollar.

1989

Table 8.1-3 Collection costs by DPC and 1-7 District offices.

Fiscal year 1989 (2)

District or DPC	Salary Cost	Welfare Cost	Fuel Cost	Equipment Cost (Car, Truck, Van)	Material Cost (Paper, Mail)	Office material Cost (Post, Div, Material)	Repairing of Office	Repairing of Vehicle	Depreciation Cost	Sum of Cost	Amount of Solid waste (Ton)	Collect. Point/ton (Units)
13. NOT	557269	83258	170532	-	-	-	4090	210280	-283228	1275557	1857	678
14. PBR	211040	292014	656959	5769	19780	-	-	312064	1209750	4553706	13343	364
15. LKO	1466455	1767174	280993	41385	53749	3300	-	297823	306568	2825475	8593	318
16. TOR	3094305	371137	578550	84110	-	-	-	1439510	1581912	7358974	45942	162
17. KLS	5762209	154068	1480917	75285	17032	2400	3320	1970991	1621260	9017822	40122	1265
18. BKN	245740	4761	63095	11969	-	-	-	-	107700	485266	3900	111
19. BAP	6889061	425275	795555	81944	-	-	-	335826	945012	8951039	21723	275
20. OKI	2134653	390900	525360	98241	18000	-	-	699592	906444	5307490	24371	218
21. OKT	2507439	574429	1340730	108795	-	-	-	162240	1859264	8732597	4367	400
22. P27	2617226	475221	1151014	128416	-	-	-	216557	1531040	9116323	40334	225
23. RBN	5929415	562982	1005860	100795	-	-	-	194685	1176000	4021914	9117	358
24. TLD	1783229	319660	516744	28188	-	-	-	749487	562776	4013979	8998	446
25. NOC	1099909	35354	288777	562	-	-	-	31179	682908	2412519	1555	209
26. OPC	6371190	1249672	4084459	1345337	-	-	-	14175496	2812084	16498345	24422	398
Total	122189054	31558003	485502224	3761054	2025119	12155	59102	49073166	51898230	208977361	1317675	230

Unit: Baht

Table 8.1-4  
 Repair Cost of the Garbage Truck (1988)

	COMPACTOR	SIDE LOADER	Container	DISTRICT TOTAL
1. PNK	2,083,424.46	33,386.90		2,116,811.36
2. POP	205,966.47	1,513,522.40		1,719,488.87
3. PTW	907,696.59	330,272.31	223,893.15	1,461,862.05
4. SPW	1,486,673.25	396,527.84		1,883,201.09
5. BAR	771,519.80			771,519.80
6. YNW	2,767,032.03	1,487,200.70	1,770,148.22	6,024,380.95
7. DUS	1,213,907.19	1,637,837.56	107,149.83	2,958,894.58
8. PYT	113,245,853.76	227,539.66	412,706.03	113,886,099.45
9. HUK	272,501.38		26,069.95	298,571.33
10. PKN	1,206,660.97	1,667,853.03	650,545.07	3,525,059.07
11. BAK	1,498,784.17	442,288.59	483,867.87	2,424,940.63
12. BKP	598,708.06	466,458.37	309,820.68	1,374,987.11
13. NDJ	2,330.69	6,503.87	35,515.12	44,349.68
14. MBR				000.00
15. LKB	53,110.24	63,089.62	106,325.38	222,525.24
16. TBR	469,116.94			469,116.94
17. KLS	563,800.20	241,173.34	462,543.19	1,267,516.73
18. BKN	375,935.84	241,320.87		617,256.71
19. BKY	130,552.49	197,490.15	65,532.33	393,574.97
20. BKT	425,307.29		554,056.06	979,363.35
21. PSJ	345,475.40	921,988.97		1,267,464.37
22. RBN	269,282.38	297,167.81	201,895.90	768,346.09
23. TLC	219,722.46	57,308.62	213,669.98	490,701.06
				000.00
24. DPC	1,294,339.39	228,295.93	436,026.66	1,958,661.98
Total	130,407,701.45	10,457,226.54	6,059,765.42	146,924,693.41

Table 8.1-5  
Costs and Waste Amounts of Open Dumping and Composting in the Fiscal Year 1988  
 (October '87 - September '88)

B: Baht

	On Nut [1]	Nong Khaem [2]	Ram Intra [3]	Total [4]=(1+2+3)	
<b>1. Open Dumping</b>					
a. Annual Cost	3,462,322 B	3,690,500 B	14,837,064 B	21,989,896 B	(36.3%)
b. Per Ton Cost (a/c)	9 B/t	7 B/t	35 B/t	16 B/t	
c. Annual Waste Amount (t)	378,598 t	562,189 t	423,365 t	1,364,152 t	
d. Daily Average Amount (t/d)	1,037 t/d	1,540 t/d	1,160 t/d	3,737 t/d	
<b>2. Compost Plant</b>					
a. Annual Cost	23,941,169 B	14,649,919 B	-	38,591,088 B	(63.7%)
b. Per Ton Cost (a/c)	253 B/t	298 B/t	-	269 B/t	
c. Annual Waste Amount (t)	94,571 t	49,081 t	-	143,652 t	
d. Daily Average Amount (t/d)	259 t/d	134 t/d	-	394 t/d	
<b>3. Total (1+2)</b>					
a. Annual Cost	27,403,501 B	18,340,419 B	14,837,064 B	60,580,984 B	(100.0%)
b. Per Ton Cost (a/c)	66 B/t	30 B/t	35 B/t	40 B/t	
c. Annual Waste Amount (t)	413,169 t	611,270 t	423,365 t	1,507,804 t	
d. Daily Average Amount (t/d)	1,296 t/d	1,675 t/d	1,160 t/d	4,131 t/d	
	(31.4%)	(40.5%)	(28.1%)	(100.0%)	

Source of Data: DPC

• Depreciation is included in the costs

Duration of Depreciation

- Vehicles = 7 years

- Plants = 15 years

Table 8.1-6

Costs and Waste Amounts of Open Dumping and Composting in the Fiscal Year 1989  
(October '88 - September '89)

B: Baht

	On Nut [1]	Nong Khaem [2]	Ram Intra [3]	Total [4]=(1+2+3)
<b>1. Open Dumping</b>				
a. Annual Cost	462,016 B	4,789,717B	-	5,251,733 B
b. Per Ton Cost (a/c)	7 B/t	9 B/t	-	8 B/t
c. Annual Waste Amount (t)	463,106 t	553,472 t	365,557 t	1,381,135 t
d. Daily Average Amount (t/d)	1,266 t/d	1,516 t/d	1,002 t/d	3,784 t/d
<b>2. Compost Plant</b>				
a. Annual Cost	23,736,567 B	21,288,979 B	-	45,025,546 B
b. Per Ton Cost (a/c)	350 B/t	710 B/t	-	530 B/t
c. Annual Waste Amount (t)	67,770 t	29,995 t	-	977,765 t
d. Daily Average Amount (t/d)	186 t/d	82 t/d	-	268 t/d
<b>3. Total (1+2)</b>				
a. Annual Cost	24,198,583 B	26,078,696 B	-	50,277,279 B
b. Per Ton Cost (a/c)	46 B/t	45 B/t	-	46 B/t
c. Annual Waste Amount (t)	529,876 t	583,467 t	365,557 t	1,478,900 t
d. Daily Average Amount (t/d)	1,451/d	1,599 t/d	1,002t/d	4,052 t/d
e. Waste Amount (%)	35.80%	39.50%	24.70%	100%

Source of Data: DFC

Depreciation is included in the costs

Duration of Depreciation

- vehicles = 7 years

- Plants = 15 years



## **Chapter 9. Interview Sheets and Results Regarding the Pilot Project for the Bell Collection**

This chapter contains the following:

- 1) Interview sheet and results obtained before the Pilot Project (Sheet A)
- 2) Interview sheet and results obtained after the Pilot Project (Sheet B)
- 3) Announcement delivered to citizens before the Pilot Project (Sheet C)

(Summary of results are indicated in hand-writing.)

## INTERVIEW SHEET FOR BELL COLLECTION (Before the Pilot Project)

- 1) Street Name \_\_\_\_\_ (n = 107)
- 2) Does the house have a yard?  
 a. Yes 19 (18%) b. No 88 (82%)
- 3) Gender  
 a. Male 23 (21%) b. Female 84 (79%)
- 4) Interviewee  
 a. Housewife 51 (47%) b. Maid 1 (1%)  
 c. Child 1 (1%) d. Other family member 37 (35%)  
 e. Other (owner of the house) 17 (16%)

### Questions

1. What type of waste receptacles do you use for discharging your waste in your house? (Multiple answers are admitted)
- a. Plastic bag 42 (39%) b. Plastic bin 21 (20%)  
 c. Bamboo basket 32 (30%) d. Petro cans 4 (4%)  
 e. Other (\_\_\_\_\_ ) 8 (7%)
2. Where do you usually keep the above-indicated receptacles?
- a. Inside the house 63 (57%) b. In the yard 0  
 c. Just outside of the house or the gate 33 (31%) d. A vacant lot near the house. 6 (6%)  
 e. Other place (\_\_\_\_\_ ) 4 (4%)
3. Where do you usually put your waste receptacles when a collection vehicle comes?
- a. Usually put waste receptacles inside the premise, and a waste collector comes in and pick them up. 7 (7%)  
 b. Usually put waste receptacles inside the premise, and hand the receptacles to a waste collector by. 24 (22%)  
 c. Usually put waste receptacles just outside of the house so that a waste collector picks the receptacles by himself. 73 (68%)  
 d. Other (\_\_\_\_\_ ) 3 (3%)

Continued

4. How often does the collection vehicle come to your place?
- |                   |          |                   |          |
|-------------------|----------|-------------------|----------|
| a. everyday       | 1 (1%)   | b. 6 times a week | 0        |
| c. 5 times a week | 0        | d. 4 times a week | 3 (3%)   |
| e. 3 times a week | 3 (3%)   | f. twice a week   | 53 (49%) |
| g. once a week    | 26 (43%) | h. no answer      | 1 (1%)   |
5. Does the collection vehicles come to your place on certain fixed days?
- |              |        |       |           |
|--------------|--------|-------|-----------|
| a. Yes       | 2 (2%) | b. No | 103 (98%) |
| c. no answer | 2 (2%) |       |           |
6. Does the collection vehicle come to your place at regular time in a day?
- |              |          |       |          |
|--------------|----------|-------|----------|
| a. Yes       | 16 (15%) | b. No | 88 (82%) |
| c. no answer | 3 (3%)   |       |          |
7. Do you pay the waste collection fee every month? If so, how much?
- |              |                  |          |
|--------------|------------------|----------|
| a. Yes       | _____ Baht/month | 12 (11%) |
| b. No        | 94 (88%)         |          |
| c. no answer | 1 (1%)           |          |
8. Do you pay a tip to a waste collector? If so, how much?
- |              |                   |           |
|--------------|-------------------|-----------|
| a. Yes       | _____ Baht/month. | 100 (93%) |
| b. No        | 5 (5%)            |           |
| c. no answer | 2 (2%)            |           |
9. Are you satisfied with the present waste collection service?
- |                |          |         |
|----------------|----------|---------|
| a. Yes.        | 97 (91%) |         |
| b. No. because | _____    | 10 (9%) |
10. Is there anybody in your house during the daytime?
- |         |          |        |         |
|---------|----------|--------|---------|
| a. Yes. | 97 (91%) | b. No. | 10 (9%) |
|---------|----------|--------|---------|
11. Please give your any opinion or idea concerning the current collection system.

Interviewer's name \_\_\_\_\_

Date \_\_\_\_\_

(Summary of results are indicated in hand-writing)

## INTERVIEW SHEET FOR MUSIC COLLECTION

(After the Pilot Project)

- 1) Street Name \_\_\_\_\_ (n = 124)
- 2) Does the house have a yard?  
 a. Yes 60 (48%) b. No 64 (52%)
- 3) Gender  
 a. Male 26 (21%) b. Female 98 (79%)
- 4) Interviewee  
 a. Housewife 46 (37%) b. Maid 8 (15%)  
 c. Child 41 (33%) d. Other family member 17 (15%)  
 e. Other (\_\_\_\_\_)
- 5) Which is your case;
- a) the garbage truck come close to the interviewee's house (less than 30 m) to pick up garbage receptacles or 99 (80%)
- b) because of the interviewee's soy is too narrow or blind array, there is usually more than 30 m distance between the house and the point nearest to the house where a garbage truck passes. 12 (10%)
- 
- c) no answer 13 (10%)

## Questions

1. Do you know that the garbage collection truck has made sound of music "Ram Wong RAKSAKHAM SAAD"  
 a. Yes 98 (79%) b. No 26 (21%)
2. Did you receive the official letter concerning the Introduction of the Music collection system from Huai Khwang district?  
 a. Yes 50 (40%) b. No 74 (60%)
3. Have you ever heard the announcement from the speaker of garbage collection truck that the music collection system has been introduced?  
 a. Yes 48 (39%) b. No 76 (61%)

4. Do you know what is the music collection system? If you know, please explain briefly.

a. no. answer 10 (8%)  
 a. Yes 23 (57%) b. No 41 (33%)

In case of yes, (interviewer should check the interviewee's answer)

- c. put garbage receptacles just outside the house when we hear the music from the garbage truck. 46 (62%)
- d. bring garbage receptacles up to the collection truck 9 (12%)
- e. Others \_\_\_\_\_ 18 (25%)

5. Are there any changes in your waste discharge manner before and after the music collection was introduced. (If the interviewee's answer is yes, check a. or b. or c.; if no, check d.)

- a. Yes, I cooperate for the garbage collection by putting garbage receptacles just outside the house. 50 (40%)  
 Degree of the cooperation
  - 1. always (100%, almost every time) 30 (24%)
  - 2. usually (more than 75%) 11 (9%)
  - 3. sometimes (25% to 75%) 9 (7%)
  - 4. few (less than 25%) 0

- b. Yes, I cooperate for the garbage collection by bringing garbage receptacles up to the garbage truck. 14 (11%)  
 Degree of cooperation
  - 1. always (100%, almost every time) 8 (6%)
  - 2. usually (more than 75%) 3 (2%)
  - 3. sometimes (25% to 75%) 2 (2%)
  - 4. few (less than 25%) 1 (1%)

c. Yes, Others \_\_\_\_\_ 0

d. No, the situation is not changed; 63 (51%)

- 1) because we have already put garbage receptacles just outside the house before the music collection started. 49 (40%)
- 2) I did not cooperate for the garbage collection for the reason that I did not want to take anything troublesome such as put garbage receptacles outside the house or bring them to the garbage truck. 3 (2%)

- 3) I did not cooperate for the garbage collection for the reason that I pay tip to the collection workers. 0
- 4) I cannot cooperate for the garbage collection for the reason that I use heavy drum can or so, therefore, it is impossible to carry them to the garbage trucks. 7 (6%)
- 5) Others \_\_\_\_\_ 8 (3%)

6) no answer 8 (6%)

6. If you have cooperated for the music collection, will you continue to cooperate the garbage collection?

- a. Yes, as much as possible 64 (52%)
- b. Yes, to some extent. But if possible, I want to stop. 5 (4%)
- c. No, I do not want to.

Reason \_\_\_\_\_

d. Others (no answer) 55 (44%)

7. If you have not yet cooperated for the music collection, are you going to cooperate in the future?

- a. Yes, as much as possible 48 (39%)
- b. Yes, to some extent. If I really have to. 4 (3%)
- c. No, I do not want to. 12 (10%)

Reason \_\_\_\_\_

d. Others 6 (5%)

8. Are you satisfied with the music collection?

- a. Good 25 (69%)
- b. OK (not bad) 17 (12%)
- c. Bad 9 (9%)
- d. no answer 15 (12%)

9. How much are you willing to pay as a garbage collection fee a month?

	(1) to BMA Baht/Month	(2) to Collector Baht/Month	(3)=(1)+(2) Total Baht/Month
a. More than the current fee	_____	_____	_____
b. Same as the current fee	_____	_____	_____
c. Less than the current fee	_____	_____	_____

10. Other comments on the music collection.

example: about music (Is it good sound for you? or the music sound should be changed?)

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## The Introduction of a New Garbage Collection System and Your Cooperation

26 September 1990

Dear Citizens,

BMA is going to introduce a music collection in Huai Khwang District from 1st October 1990. The introduction of the music collection system requires the citizens' cooperation. You are kindly requested to discharge your waste in the manner as explained below:

1. If your house is located on the side of road where a garbage truck can pass,

**Put your garbage receptacles (plastic bag, or plastic bin or bamboo basket) just outside the house when you hear the music coming from the collection truck.**

2. If your house is located in places which are not accessible by the collection truck,

**Bring your garbage up to the collection truck. (Garbage collection crew will not come to your house for garbage collection.)**

With your cooperation, Huai Khwang District will be able to provide garbage collection service twice a week on a regular base for all the planned area. (At present, some area receives collection service once a week.)

If you have any questions, please contact Mrs. Somchitra, Manager of the Cleansing Section, Huai Khwang District, Tel: .....

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Director of Huai Khwang District



**Part III**

**Supporting Information**

**for**

**the Proposed Solid Waste Management System**

## **Chapter 10 Specification for On Nut Incineration Plant**

### **10.1 Specification of Incineration**

A incineration plant is usually constructed as a turn-key project, so that the actual detailed specifications are made by the actual contractors because:

- 1) capacity of main apparatus is determined from mass balance, however, supporting minor equipment and machines will be different between the contractors; and
- 2) some apparatus such as water treatment system, computer system, etc. are different between the contractors, since the contractors develop specific technologies.

From these reasons, it is hard to fix design specifications of the incineration plant. The following specifications shown in this section are a sample of the specifications of the suitable incineration plant for Bangkok waste.

When the BMA contracts with private firms to construct an incineration plant, the following process should be included in the course of tendering:

- 1) The BMA and consultant decide general requirements, necessary volumes of main apparatus and design policy of equipment;
- 2) The BMA and consultant list some firms for tender, and request them to submit their proposed specifications with design documents;
- 3) The BMA and consultant evaluate them and request them revise inadequate items; and
- 4) The BMA and consultant decide the contractor.

To prevent troubles happen after construction, it is important that the BMA has the contractor understand and agree with the general requirement.

#### **10.1.1 General Requirement**

- 1) **Necessity of the Incineration Plant**

The incineration plant aims at reducing volume of the solid waste collected.

- 2) Name of Project  
Construction of On Nut Plant
- 3) Plant Capacity  
200 t/d x 3 units, Total 600 t/d
- 4) Location  
On Nut, Bangkok
- 5) Meteorological Conditions  
Maximum 35°C, Average 28°C, Minimum 20°C  
Rainfall: Average of year 1,500 mm
- 6) Construction Period  
3 years
- 7) Design Criteria

(1) Refuse properties

Following composition and properties shall be basis of design:

	Low	Medium	High
Three components %			
Water	65	59	53
Ash	11	10	10
Combustible	24	31	37
Low heat value (kcal/kg)	750	1,150	1,500

- (2) Capacity of Furnace  
200 t/24 h x 3 Furnace, Total 600 t/d
- (3) Type of Furnace  
Continuous feed type incinerator
- (4) Type of Exhaust Gas Cooling  
Water injection type

(5) Operation of Furnace

- (a) Feed system : Pit and crane type
- (b) Ash removal : Ash extractor
- (c) Draft : Balanced draft

(6) Combustion Conditions

- (a) Flue Gas Temperature at Furnace Exit 700°C - 900°C
- (b) Ignition loss : Less than 7%

(7) Emission Standard

- (a) Dust : 0.15 g/m<sup>3</sup>N
- (b) Sulfur Oxides : 400 ppm
- (c) Nitrogen Oxides : 250 ppm (407 mg/m<sup>3</sup>N)
- (d) Hydrogen Chloride : 125 ppm (200 mg/m<sup>3</sup>N)

(8) Noise Regulation

55 dB (A) on the boundary line of site

8) Responsibility for Defects

- (1) This construction works proceed on a turn key basis which integrates both design and construction, the contractor shall assume all the responsibilities arise from abnormal or malfunctioning of the incineration facilities, despite the basic design and a part of detail design are provided by the BMA.
- (2) Bidder shall in advance conduct a sufficient survey on the waste conditions, designs, and possible problems in the construction works, so as to insure constant and normal incineration of the waste generated in Bangkok.
- (3) Bidders may prepare to amend basic design and a part of detail design from those originally provided by the BMA, if necessary. In such a case, (5) copies each of design/drawing for the amended portion shall be submitted together with technical documents.
- (4) Compliance with specification does not relieve contractor of full responsibility for all of work with proper design and construction and fully suitable for all specified operating conditions.

9) Confliction Requirements

In case of conflicts among the requirements of general technical specification, special technical specification and drawing, the BMA shall determine in the conference with contractor.

10) Guarantee Period

Two years after acceptance by the BMA. During the period, the Contractor should be responsible all defects of the plant except caused by natural disaster, mis-operation of workers and articles of consumptions.

11) Materials

Materials which are used in this construction should be all new and be in conformity with technical standards of

T.I.S., the U.S.A., Japan, Germany, France, U.K., Korea and Taiwan.

12) Inspection

- (1) The contractor shall be responsible for the inspection and test of all materials, and the test shall be conducted in the presence of supervisors (including oversea trips). The cost for the inspection and the test shall be borne by the contractor provided that travelling cost of the BMA's supervisors, and the tests conducted in Thailand shall be borne by the BMA.
- (2) During the contracted period, the supervision shall make maximum 4 times (each time 4 members for 7 days) of trip for inspection of manufacturing of witness to the tests of major equipments which shall be carried out at the contractor's factories abroad.
- (3) Even though construction shall be performed with witness of the supervisor, the revision and supplementary work of defects which is found after inspection and completion shall be done under the full responsibility of the contractors.

13) Test Run and Guarantee

- (1) Test run performance: 90 days
- (2) Within test run performance, pre-final test and final acceptance test must be performed each 3 days.
- (3) During test run, the future operating staff of the BMA shall be trained by qualified engineers of the contractor. The training instruction shall be described in Thai and English.

- (4) Before acceptance for Facilities, all expenses including public services shall be paid by the contractor except transportation of garbage and ash,
- (5) After acceptance, four qualified engineers of the contractor must be in residence one year for training and educating the BMA's staff.

14) Training

- (1) The contractor shall develop an instruction and training program to acquaint the BMA's personnel with their activities in the works.
- (2) The contractor shall make available instructions, training facilities necessary for the effective execution of the instruction program.
- (3) The contractor shall instruct and train the BMA's personnel concerning the operation, maintenance and, if necessary high ranked personnel.
- (4) The contractor shall provide all required notes, manuals and drawings to supplement the operation and maintenance instruction manuals.
- (5) All training manuals shall be described in Thai and English.

15) Value of Guarantee Items

- (1) Refuse Through-put  
200 t/24 h/unit (Low Heat value 750 kcal/kg - 1,500 kcal/kg)
- (2) Flue Gas Temperature at Furnace Exit 700°C - 950°C
- (3) Ignition loss of ash 7%
- (4) Emission Standards

Dust	< 0.15 kg/m <sup>3</sup> N
Sulfur Oxides	< 400 ppm
Hydrogen Chloride	< 200 mg/m <sup>3</sup> N
Nitrogen Oxides	< 400 mg/m <sup>3</sup> N

- (5) Waste Water

Reuse for gas cooling water injection

16) Acceptance

After the BMA's superintendent confirms the completion of construction through all services and satisfied the result of test run, "Acceptance Certificate Notice" shall be issued by the BMA.

17) Preparation and Submission of Bid Documents

- (1) Detailed bid price
- (2) Construction schedule
- (3) Design documents
- (4) Descriptive statement
- (5) The amount of manpower and utilities per year in detail
- (6) Drawings
  - (a) Layout plan including outdoor trunk line
  - (b) Major sectional plan for base layer and special layer of the plant
  - (c) Various floors plan
  - (d) Flow sheets
    - (i) Refuse, air, exhaust gas, ash, dust, control system
    - (ii) City water and supplied water
    - (iii) Waste water
    - (iv) Diesel oil and gas
    - (v) Hot water supply
  - (e) Single phase wiring diagram
  - (f) Sectional plan for major equipments
    - (i) Furnace
    - (ii) Electrostatic precipitator
    - (iii) Gas cooling tower
    - (iv) Stack
  - (g) Perspective drawing of the plant

18) Preparation and Submission of Contractor

- (1) Construction schedule and implementation plan
- (2) Description of designs
- (3) Design calculation sheet
  - (a) Structure and mechanics calculation
  - (b) Predicted air pollution scale of emission gas
  - (c) Mass balance
  - (d) Heat balance
  - (e) Utilities
  - (f) Capacity of main equipment
- (4) Drawings
  - (a) Layout of main equipment

- (b) Various floors plan
- (c) Sectional plan
- (d) Detail drawings of major equipment
- (e) Diagram of plumbing pipes
- (f) Single phase wiring diagram
- (g) Sequence diagram
- (h) Flow sheet
  - (i) Refuse, air, exhaust gas, ash, dust, control system
  - (ii) City water and supplied water
  - (iii) Waste water
  - (iv) Diesel oil and gas
  - (v) Hot water supply
- (i) Detail of building structure and civil work
- (j) Others according to the BMA's request
- (5) Inspection plan
- (6) Test running plan
- (7) Education and training plan
- (8) Construction work management
- (9) Specification of plant
- (10) Others according to the BMA's request

(19) Common descriptions of Mechanical and Electrical Specification

- (1) Capacity of Refuse Pit  
1,800 ton refuse (5,200 m<sup>3</sup>: under platform floor line  
size: app. 40.5 m (L) x 14 m (W) x 9.2 m (D))
- (2) Gratings, passages and stairs to be established suitable for checking and maintenance  
Width of main passage and stair: more than 1.2 m
- (3) Laggings and drainproofing should be carried out as necessary.
- (4) Piping
  - (a) Materials should be suitable for the kind of fluid.
  - (b) Pipe supports to be fixed as necessary.
- (5) Spare parts  
To be supplied enough for two years



## 10.1.2 Technical Specifications for Mechanical and Electrical Part

### 1) Refuse Receiving System

#### (1) Weighing Bridge

- |                   |                              |
|-------------------|------------------------------|
| (a) Quantity      | 2 units                      |
| (b) Type          | Pitless multi load cell type |
| (c) Capacity      | 30 ton                       |
| (d) Platform Size | 3 m x 7.5 m                  |

#### (2) Damping Door

- |              |               |
|--------------|---------------|
| (a) Quantity | 9 units       |
| (b) Size     | 6.5 m x 3.5 m |

#### (3) Refuse Crane

- |                           |                                   |
|---------------------------|-----------------------------------|
| (a) Quantity              | 2 units                           |
| (b) Type                  | Overhead travelling crane         |
| (c) Grab Capacity         | 6 m <sup>3</sup>                  |
| (d) Rated Hoisting Weight | 3.3 ton                           |
| (e) Carrying Capacity     | 8.6 ton                           |
| (f) Hoisting speed        | 60 m/min.                         |
| (g) Traversing Speed      | 40 m/min.                         |
| (h) Travelling Speed      | 50 m/min.                         |
| (i) Opening/Closing Speed | 6.5 sec./11 sec.                  |
| (j) Control System        | Remote and semi-automatic control |

#### (4) Bulky Refuse Shears

- |                         |          |
|-------------------------|----------|
| (a) Quantity            | 1 unit   |
| (b) Capacity            | 5 ton/hr |
| (c) Max. Shearing Force | 150 ton  |
| (d) Size of Filling Bed |          |
| - Length                | 4.0 m    |
| - Width                 | 1.2 m    |

### 2) Incineration System

#### (1) Charging Hopper

- |              |               |
|--------------|---------------|
| (a) Quantity | 3 units       |
| (b) Type     | Vertical Type |

- (c) Volumetric Capacity                      Approx. 18 m<sup>3</sup> including chute
- (2) Stocker  
 Design document: Heat release per unit grate area: Appr. 200 kg/m<sup>2</sup>•h  
 (a) Quantity                                      3 units  
 (b) Type    Step grate type  
 (c) Size  
     - Length                                        14.5 m  
     - width     2.94 m
- (3) Furnace  
 Design document: Heat release per unit space area: Max. 125,000 kcal/m<sup>3</sup>•h  
 (a) Quantity                                      3 units  
 (b) Type    Box type
- (4) Auxiliary Burner  
 (a) Quantity                                      3 units  
 (b) Type    Rotary burner  
 (c) Capacity                                        250 lit/hr•unit  
 (d) Fuel Oil                                         Diesel oil
- (5) Fuel Oil Pump  
 (a) Quantity                                      2 units (One for stand-by)  
 (b) Type    Gear pump  
 (c) Capacity                                        1,200 lit/hr
- (6) Diesel Oil Storage Tank  
 (a) Quantity                                      2 units  
 (b) Type    Cylindrical horizontal type  
 (c) volumetric Capacity                        15 kl/unit
- (7) Hydraulic Unit  
 (a) Quantity                                      3 units
- 3) Flue Gas Cooling System  
 (1) Flue Gas Cooling Tower  
 Design Document: Heat value of Evaporation: less 140,000 kcal/m<sup>3</sup>h at L.H.V.  
 1,500 kcal/kg

- |                                      |                           |  |
|--------------------------------------|---------------------------|--|
| (a)                                  | Quantity                  | 3 units  |
| (b)                                  | Type                      | Water injection type                             |
| (2) Injection Water Pump             |                           |  |
| (a)                                  | Quantity                  | 4 units (One for stand-by)                       |
| (b)                                  | Type                      | Turbine pump                                     |
| (c)                                  | Capacity                  | 14 m <sup>3</sup> /hr                            |
| (d)                                  | Discharge Head            | 230 mAq  |
| (3) Injection Nozzle                 |                           |  |
| (a)                                  | Quantity                  | 14 units/tower                                   |
| (b)                                  | Type                      | Return nozzle                                    |
| (c)                                  | Capacity                  | 1 m <sup>3</sup> /hr•unit                        |
| (4) Injection Water Reservoir        |                           |  |
| (a)                                  | Quantity                  | 1 unit   |
| (b)                                  | Structure                 | Reinforced concrete                              |
| (c)                                  | Capacity                  | 35 m <sup>3</sup>                                |
| 4) Fuel Gas Treatment System         |                           |  |
| (1) Electrostatic Precipitator       |                           |  |
| (a)                                  | Quantity                  | 3 units  |
| (b)                                  | Design Flue Gas Flow      | 60,000 Nm <sup>3</sup> /hr                       |
| (c)                                  | Inlet Dust Content        | 10 g/Nm <sup>3</sup> (Dry)                       |
| (d)                                  | Outlet Dust Content       | 0.15 g/Nm <sup>3</sup> (Dry, O <sub>2</sub> 12%) |
| (e)                                  | Number of Field           | 2  |
| (2) HCl Removal System               |                           |  |
| (a) Design Criteria                  |                           |  |
| (i)                                  | Type                      | Ca(OH) <sub>2</sub> Powder Injection Type        |
| (ii)                                 | Design Flue Gas Flow      | 60,000 Nm <sup>3</sup> /hr•line                  |
| (iii)                                | Design Inlet HCl content  | 600 ppm (Dry, 12% O <sub>2</sub> )               |
| (iv)                                 | Design Outlet HCl Content | 125 ppm (Dry, 12% O <sub>2</sub> )               |
| (b) Ca(OH) <sub>2</sub> Storage Silo |                           |  |
| (i)                                  | Quantity                  | 1 unit   |
| (ii)                                 | Type                      | Vertical cylindrical type                        |
| (iii)                                | Volumetric Capacity       | 52 m <sup>3</sup>                                |

- (c) Ca(OH)<sub>2</sub> Injection Blower
  - (i) Quantity 4 units (One for stand-by)
  - (ii) Type Roots blower
  - (iii) Capacity 810 m<sup>3</sup>/hr
  - (iv) Static Pressure 2,500 mmAq

- (d) Ca(OH)<sub>2</sub> Feeder
  - (i) Quantity 1 unit
  - (ii) Type Table feeder
  - (iii) Capacity 194 kg/hr•line x 3 lines

5) Water Supply System

- (1) Plant Water Transfer Pump
  - (a) Quantity 2 units (One for stand-by)
  - (b) Type Centrifugal pump
  - (c) Capacity 3 m<sup>3</sup>/hr
  - (d) Discharge Head 30 mAq

- (2) Cooling Water Pump
  - (a) Quantity 2 units (One for stand-by)
  - (b) Type Centrifugal pump
  - (c) Capacity 22 m<sup>3</sup>/hr
  - (d) Discharge Head 30 mAq

- (3) Cooling Tower
  - (a) Quantity 1 unit
  - (b) Capacity 22 m<sup>3</sup>/hr
  - (c) Cooling Water Temperature
    - Inlet 37°C
    - Outlet 32°C

- (4) Filter
  - (a) Quantity 1 unit
  - (b) Type Sand filter
  - (c) Capacity 40 m<sup>3</sup>/hr

- (5) Filter Pump
- |                    |                            |
|--------------------|----------------------------|
| (a) Quantity       | 2 units (One for stand-by) |
| (b) Type           | Centrifugal pump           |
| (c) Capacity       | 40 m <sup>3</sup> /hr      |
| (d) Discharge Head | 30 mAq                     |
- (6) Backwash Pump
- |                    |                            |
|--------------------|----------------------------|
| (a) Quantity       | 2 units (One for stand-by) |
| (b) Type           | Centrifugal pump           |
| (c) Capacity       | 170 m <sup>3</sup> /hr     |
| (d) Discharge Head | 30 mAq                     |
- 6) Waste Water Treatment System
- (1) Refuse Bunker Drainage Disposal System
- |              |                           |
|--------------|---------------------------|
| (a) Quantity | 1 lot                     |
| (b) Type     | Evaporation process       |
| (c) Capacity | 500 lit/hr•line x 3 lines |
- (2) Waste Water Treatment System
- |                         |  |
|-------------------------|--|
| (a) Quantity            | 1 lot                                  |
| (b) Process             | Coagulation, sedimentation, filtration |
| (c) Capacity            |  |
| - Organic Waste Water   | 24.4 m <sup>3</sup> /day               |
| - Inorganic Waste Water | 2 m <sup>3</sup> /day                  |
- 7) Waste Heat Utilization
- (1) Hot Water Generator
- |                       |                              |
|-----------------------|------------------------------|
| (a) Quantity          | 3 units                      |
| (b) Type              | Hot air/water heat exchanger |
| (c) Capacity          | 50,000 kcal/hr•unit          |
| (d) Water Temperature |                              |
| - Inlet               | 25°C                         |
| - Outlet              | 60°C                         |
- 8) Air Supply System
- (1) Combustion Air Fan

- |      |                            |                            |
|------|----------------------------|----------------------------|
| (a)  | Quantity                   | 3 units                    |
| (b)  | Type                       | Centrifugal                |
| (c)  | Flow Rate                  | 27,000 Nm <sup>3</sup> /hr |
| (d)  | Total Pressure             | 280 mmAq                   |
| <br> |                            |                            |
| (2)  | Combustion Gas Cooling Fan |                            |
| (a)  | Quantity                   | 3 units                    |
| (b)  | type                       | Centrifugal                |
| (c)  | Flow Rate                  | 13,500 Nm <sup>3</sup> /hr |
| (d)  | Total Pressure             | 200 mmAq                   |
| <br> |                            |                            |
| (3)  | Air Heater                 |                            |
| (a)  | Quantity                   | 3 units                    |
| (b)  | Type                       | Gas/air heater             |
| (c)  | Air Flow Rate              | 18,700 Nm <sup>3</sup> /hr |
| (d)  | Air Temperature            |                            |
|      | - Inlet                    | 20°C                       |
|      | - Outlet                   | 250°C                      |
| <br> |                            |                            |
| (4)  | Induced Draft Fan          |                            |
| (a)  | Quantity                   | 3 units                    |
| (b)  | Type                       | Centrifugal                |
| (c)  | Flow Rate                  | 65,600 Nm <sup>3</sup> /hr |
| (d)  | Total Pressure             | 220 mmAq                   |
| <br> |                            |                            |
| 9)   | Ash Handling System        |                            |
| <br> |                            |                            |
| (1)  | Ash Extractor              |                            |
| (a)  | Quantity                   | 3 units                    |
| (b)  | Capacity                   | 3 ton/hr <sup>o</sup> unit |
| <br> |                            |                            |
| (2)  | Ash Conveyor               |                            |
| (a)  | Quantity                   | 3 units                    |
| (b)  | Type                       | Flight conveyor            |
| (c)  | Capacity                   | 3 ton/hr•unit              |
| <br> |                            |                            |
| (3)  | Ash Crane                  |                            |
| (a)  | Quantity                   | 1 unit                     |
| (b)  | Type                       | Overhead travelling crane  |

- |       |                        |  |
|-------|------------------------|--|
| (c)   | Grab Capacity          | 2 m <sup>3</sup>                             |
| (d)   | Rated Hoisting Weight  | 2 ton  |
| (e)   | Carrying Capacity      | 3.5 ton                                      |
| (f)   | Hoisting Speed         | 20 m/min.                                    |
| (g)   | Travelling speed       | 40 m/min.                                    |
| (h)   | Opening/Closing speed  | 6.5 sec./11 sec.                             |
| <br>  |                        |  |
| (4)   | Flyash Moistener       |  |
| (a)   | Quantity               | 2 units (one for stand-by)                   |
| (b)   | Type                   | Paddle type mixer                            |
| (c)   | Capacity               | 4.5 m <sup>3</sup> /hr•unit                  |
| <br>  |                        |  |
| 10)   | Electrical Equipment   |  |
| <br>  |                        |  |
| (1)   | Power Transformer      |  |
| (a)   | Quantity               | 1 set  |
| (b)   | Type                   | Oil-immersed self-cooling type               |
| (c)   | Rating                 |  |
|       | - Rated voltage        | 24 kV/380 - 229 V                            |
|       | - Rated capacity       | 3,000 kVA                                    |
|       | - Phase and frequency  | 3-ph, 50 Hz                                  |
| <br>  |                        |  |
| (2)   | Switchgear             |  |
| (a)   | Low Voltage Switchgear |  |
| (i)   | Quantity               | 1 set  |
| (ii)  | Type                   | indoor use selfstanding metal-enclosure type |
| (iii) | Nominal voltage        |  |
|       | - Power circuit        | 380 V, A.C. 3-ph                             |
|       | - Lighting circuit     | 380/220 V, A.C. 3-ph, 4-w                    |
|       | - Instrument circuit   | 220 V, A.C. 1-ph                             |
| (b)   | Motor Control Panels   |  |
| (i)   | Quantity               | 1 set  |
| (ii)  | Type                   | Indoor use selfstanding metal-enclosure type |
| (iii) | Nominal voltage        |  |
|       | - Power circuit        | 380 V, A.C. 3-ph                             |
|       | - Control circuit      | 220 V, A.C. 1-ph                             |
| <br>  |                        |  |
| (3)   | Static Capacitors      |  |
| (a)   | Quantity               | 1 set  |

- (b) Type Indoor use oil-immersed self-cooling type,  
Automatic power factor regulation
  - (c) Rating
    - Rated voltage 380 V
    - Rated capacity 200 kVA - 4 sets
    - Phase and frequency 3 ph, 50 Hz
- (4) Emergency Diesel Generator
- (a) Quantity 1 set
  - (b) Type
    - Generator Guarded drip-proof type 3-ph synchronous generator
    - Engine 4 cycle diesel engine
  - (c) Rating
    - Rated output 200 kVA (160 kW)
    - Rated voltage 380 V
    - Phase and frequency 3 ph, 50 Hz
    - speed 1,500 rpm
- (5) Motors
- (a) Quantity 1 set
  - (b) Type Totally-closed fan-cooling type induction motor
  - (c) Rating
    - Rated voltage 380 V
    - Phase and frequency 3 ph, 50 Hz
- (6) Vehicle Control Equipment
- (a) Quantity 1 set
  - (b) Type Indoor use selfstanding metal-enclosure type
  - (c) Rating
    - Control circuit 220 V, A.C. 1-ph
    - Indicating lamp
      - Open, Close - Red
      - Halt - Green

11) Instrumentation

- (1) Instruments
  - (a) Quantity 1 set



- |  |   |
|--|---|
| (b) Type   | Electronics system and local gauges   |
| <br>   |   |
| (2) Analyzers                                      |   |
| (a) NOx, SO <sub>2</sub> , O <sub>2</sub> Analyzer |   |
| (i) Quantity                                       | 2 sets  |
| (ii) Type  | Outdoor use selfstanding metal-enclosure type   |
| (iii) Method                                       | Non electrode reference method  |
| (b) HCl Analyzer                                   |   |
| (i) Quantity                                       | 2 sets  |
| (ii) Type  | Outdoor use selfstanding metal-enclosure type   |
| (iii) Method                                       | Ion electrode reference method  |
| <br>   |   |
| (3) Instrumentation Panel                          |   |
| (a) Quantity                                       | 1 set   |
| (b) Type   | Indoor use selfstanding metal-enclosure type  |
| (c) Components                                     | Semigraphic<br>Annunciators<br>Instruments<br>Command switches<br>CCTV monitors<br>Relays   |
| <br>   |   |
| (4) CCTV System                                    |   |
| (a) Quantity                                       | 1 set   |
| (b) Type   | Electronics system  |
| (c) Service and location                           |   |
| - Camera   | A. Furnace - 3 sets<br>B. Hopper - 3 sets<br>C. Reception hall - 2 sets   |
| - Monitor  | Color 15" with video selector for camera A,<br>B - 3 sets (Central control room)<br>color 15" with video selector for camera B,<br>C - 2 sets (Refuse crane control room) |
| <br>   |   |
| 12) Auxiliary Equipment                            |   |
| (1) Service Air Compressor                         |   |

- |                            |                          |
|----------------------------|--------------------------|
| (a) Quantity               | 1 unit                   |
| (b) Type                   | Reciprocating compressor |
| (c) Air Delivery Flow Rate | 3.2 Nm <sup>3</sup> /hr  |
| (d) Operating Presser      | 7 kg/cm <sup>2</sup> G   |
- (2) Process Flow showing Board
- |          |        |
|----------|--------|
| Quantity | 1 unit |
|----------|--------|
- (3) Others
- |                           |         |
|---------------------------|---------|
| Portable Submersible Pump | 2 units |
| Vacuum Cleaner            | 3 units |
| VTR                       | 1 unit  |

### 10.1.3 Technical Specifications for Civil and Building Works

#### 1) Civil Work

- (1) Ramp Way
- |               |                                   |
|---------------|-----------------------------------|
| (a) Traffic   | One way system                    |
| (b) Structure | Filling and elevated track system |
| (c) Pavement  | Asphalt pavement                  |
| (d) Width     | 5 m                               |
| (e) Slope     | Less than 10%                     |
| (f) Accessory | Guard rail                        |

#### 2) Building Work

- (1) Incinerator Plant Building
- |                           |   |
|---------------------------|---|
| (a) Platform              |   |
| (i) Floor Area            | about 1,063 m <sup>2</sup>              |
| (ii) Transverse Length    | about 19.5 m                            |
| (iii) Longitudinal Length | about 54.5 m                            |
| (iv) Eaves Height         | GL + 14.2 m                             |
|                           | Clear height 5 m                        |
| (v) Foundation            | Reinforced concrete                     |
| (vi) Superstructure       | Reinforced concrete and steel structure |
| (vii) Walls               | Brick wall with plaster and paint       |
| (viii) Roof               | Corrugated galvanized steel sheet       |

- (iv) Entrance/Exit Shutter with electric driven and air curtain included
- (b) Structure above Refuse Bunker
  - (i) Area about 1,199 m<sup>2</sup>
  - (ii) Transverse Length about 22.0 m
  - (iii) Longitudinal Length about 54.5 m
  - (iv) Eaves Height GL + 32.5 m
  - (v) Foundation Reinforced concrete
  - (vi) Refuse Bunker Reinforced concrete
  - (vii) Superstructure Reinforced concrete and steel structure
  - (viii) Walls Brick wall with plaster and paint
  - (iv) Roof Corrugated galvanized sheet
  - (x) Associated Facilities Waste water stage pit, hopper stage, crane operator's cabin and electric room
- (c) Structure above Incinerator/Electrostatic Precipitator
  - (i) Area about 1,674.0 m<sup>2</sup>
  - (ii) Transverse Length about 36.0 m
  - (iii) Longitudinal Length about 46.5 m
  - (iv) Eaves Height GL + 32.7 m
  - (v) Foundation Reinforced concrete
  - (vi) Superstructure Reinforced concrete and steel structure
  - (vii) Walls Brick wall with plaster and paint
  - (viii) Roof Corrugated galvanized steel sheet with natural ventilator
- (d) Induced Draft Fan Room
  - (i) Area about 175.5 m<sup>2</sup>
  - (ii) Transverse Length about 6.5 m
  - (iii) Longitudinal Length about 27.0 m
  - (iv) Room Height about 5.5 m
  - (v) Foundation Reinforced concrete
  - (vi) Superstructure Reinforced concrete
  - (vii) Walls Reinforced concrete
  - (viii) Roof Reinforced concrete
- (e) Ash Bunker
  - (i) Area about 148.5 m<sup>2</sup>
  - (ii) Transverse Length about 4.5 m

- |        |                             |   |
|--------|-----------------------------|---|
| (iii)  | Longitudinal Length         | about 33.0 m  |
| (iv)   | Height of Pit               | 13.0 m  |
| (v)    | Foundation                  | Reinforced concrete   |
| (vi)   | Ash Pit                     | Reinforced concrete   |
| (vii)  | Superstructure              | Reinforced concrete   |
| (viii) | Walls                       | Reinforced concrete   |
| (ix)   | Walls                       | Reinforced concrete   |
| <br>   |                             |   |
| (2)    | Office Building             |   |
| (a)    | Floor                       | 3 stories   |
| (b)    | Width                       | about 12.5 m  |
| (c)    | Length                      | about 46.5 m  |
| (d)    | Foundation                  | Reinforced concrete   |
| (e)    | Superstructure              | Reinforced concrete and steel structure   |
| (f)    | Walls                       | Brick wall with plaster and paint   |
| (g)    | Roof                        | Roman tile roofing  |
| <br>   |                             |   |
| (3)    | Refuse Weighing Bridge Room |   |
| (a)    | Area                        | about 80 m <sup>2</sup>   |
| (b)    | Foundation                  | Reinforced concrete   |
| (c)    | Superstructure              | Reinforced concrete and steel structure   |
| (d)    | Walls                       | Reinforced concrete   |
| (e)    | Roof                        | Roman tile roofing  |
| <br>   |                             |   |
| (4)    | Stack                       |   |
| (a)    | Type                        | Self standing circular shape with internal lining                               |
| (b)    | Structure                   | External stack - Reinforced Concrete<br>Internal stack - 3 sets of Steel Stacks |
| (c)    | Height                      | 60 m  |

### 3) Plumbing

#### (1) Plumbing

##### (a) Water Supply System

Living water is city public water supplied by gravity system through the receiving tank, riser pump and elevated tank.

##### Description

- |                          |        |
|--------------------------|--------|
| (i) Receiving water tank | 1 each |
| (ii) Elevated water tank | 1 each |
| (iii) Riser pump         | 2 each |
| (iv) Piping work         | 1 LS   |

##### (b) Hot Water Supply System

Hot water is supplied utilizing waste heat of the incineration plant.

##### Description

- |                            |                                   |
|----------------------------|-----------------------------------|
| (i) Hot water storage tank | 1 each (including heat exchanger) |
| (ii) Expansion tank        | 1 each                            |
| (iii) circulation pump     | 2 each                            |
| (iv) Piping work           | 1 LS                              |

##### (c) Drainage System

Domestic waste water is led to the waste water treatment system of the incineration plant work. However, the sewerage water is treated with a septic tank.

##### Description

- |                        |        |
|------------------------|--------|
| (i) Sewage septic tank | 1 each |
| (ii) Piping work       | 1 LS   |

##### (d) Sanitary Fixtures

Suitable sanitary fixtures such as water closets, urinals, wash basins, service sinks, mirrors are provided.

(e) Gas System (LOG)

The gas used in this facilities is LPG, supplied from LPG cylinders located outside.

(f) Fire Fighting System

Indoor hydrants and portable fire extinguishers are provided in accordance with local code.

Description

- (i) Indoor hydrant system
  - 1 Fire water pump 1 each
  - 2 Indoor hydrant 1 LS
  - 3 Piping work 1 LS
- (ii) Portable fire extinguisher 1 LS

(2) Air Conditioning and Ventilation System

(a) Air Conditioning System

Air conditioning system consists of air conditioning equipment, piping, automatic control work. The air conditioning system is of individual package air conditioning system.

(i) Design Conditions

Outdoor : CB 36.1°C, RH 55%  
Indoor : DB 26.0°C, RH 55%

(ii) Area of Air Conditioning

Central control room, crane operator room, analysis room, measurement room, office, conference room, rest rooms, chief room.

(b) Ventilation System

Ventilation system is provided for the rooms where heat or vapor are generated by mechanical or electrical equipment.

(3) Electrical work

(a) Power and Feeder System

This system is power supply system for building facilities such as plumbing system, air conditioning system, ventilation system and lighting system, etc.

- (i) Power panel 1 LS
- (ii) Lighting panel 1 LS
- (iii) Wiring work 1 LS

(b) Lighting System

This system consists of general lighting, emergency lighting, inducement lighting and receptacles.

- (i) Lighting fixtures 1 LS
- (ii) Receptacles 1 LS
- (iii) Wiring apparatus 1 LS
- (iv) Wiring work 1 LS

(c) Telephone System

- (i) Automatic telephone exchanger 1 set
- (ii) Extension telephone 30 each
- (iii) Wiring works 1 LS

(d) Loud Speaker System

- (i) Amplifier and accessories 1 set
- (ii) Speakers 1 LS
- (iii) Wiring work 1 LS

(e) Lighting system

(f) Fire Alarm System

Fire alarm system is provided in accordance with local fire service code.

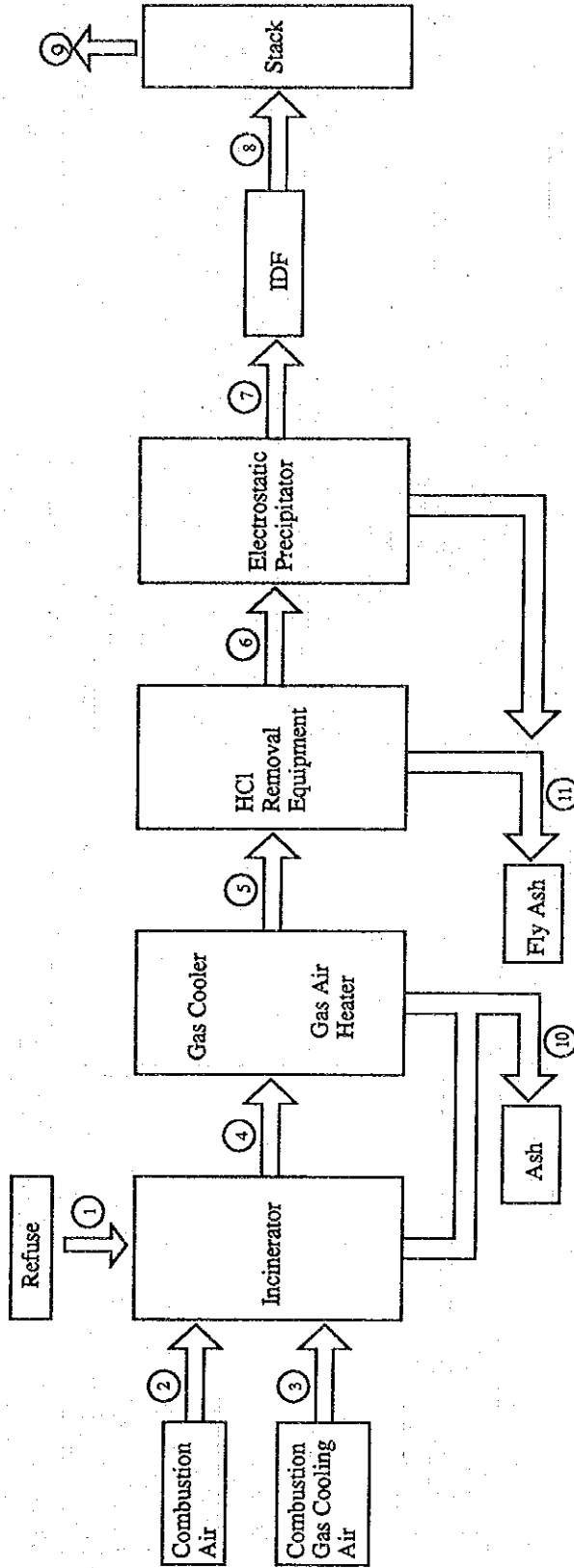
- (i) Fire alarm panel 1 each
- (ii) Detectors 1 LS



## 10.2 Design Calculation

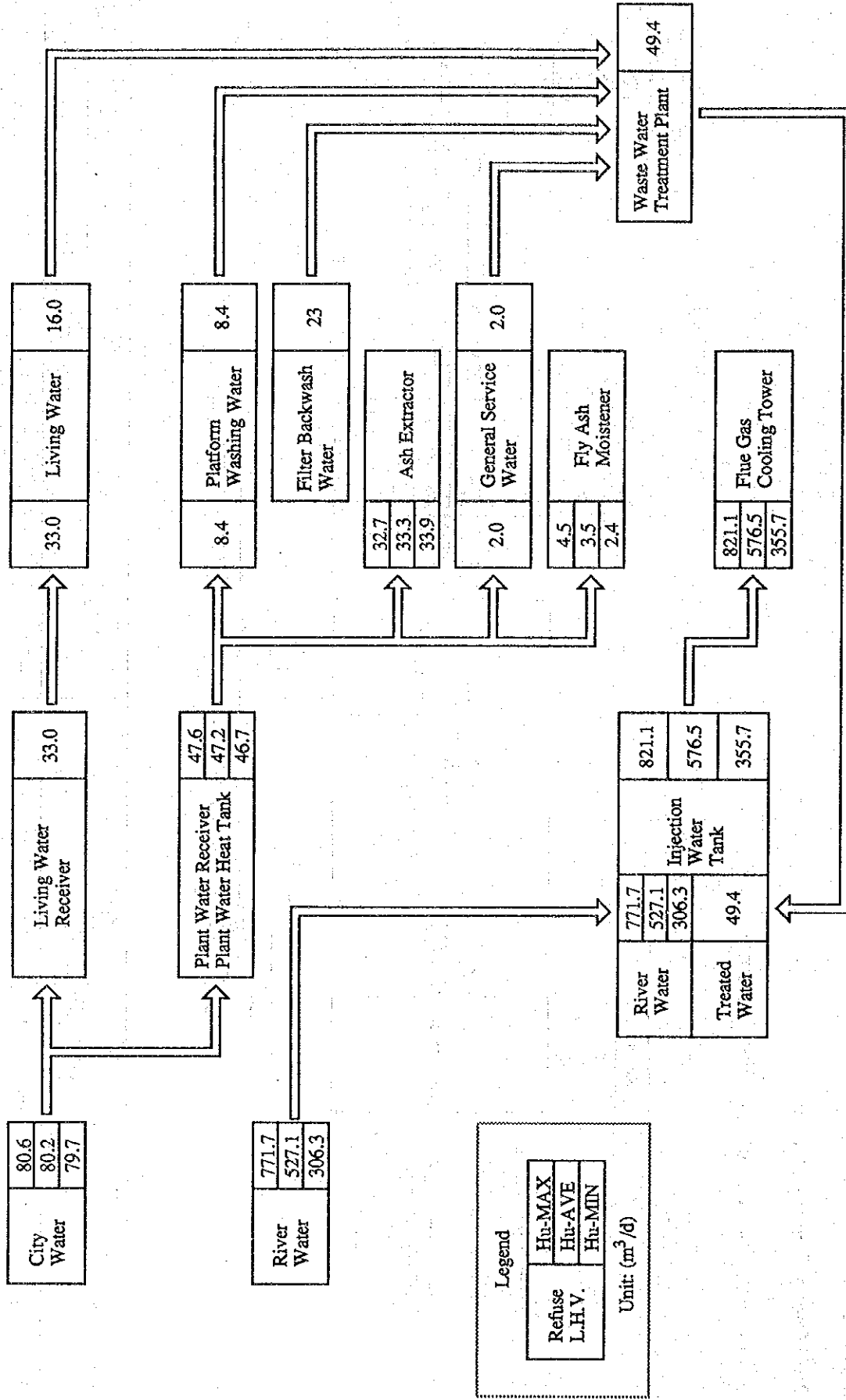
### 10.2.1 Material Balance Diagram

#### 1) Refuse, Air, Flue Gas and Ash (For One Line)

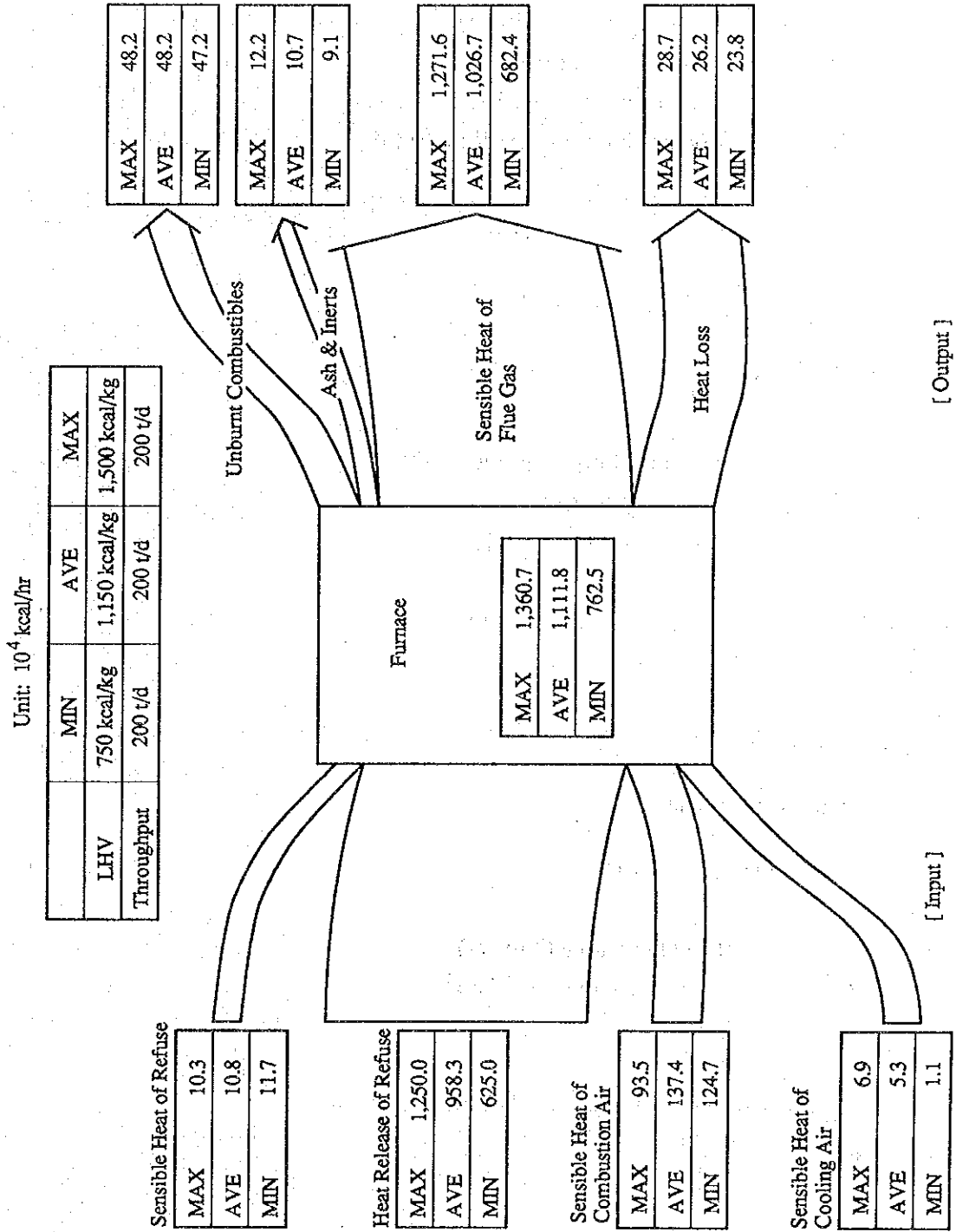


Refuse L.H.V. kcal/kg	①		②		③		④		⑤		⑥		⑦		⑧		⑨		⑩		⑪	
	kg/h	Nm <sup>3</sup> /h	°C	Nm <sup>3</sup> /h	°C	Nm <sup>3</sup> /h	°C	Nm <sup>3</sup> /h	°C	Nm <sup>3</sup> /h	°C	Nm <sup>3</sup> /h	°C	Nm <sup>3</sup> /h	°C	Nm <sup>3</sup> /h	°C	Nm <sup>3</sup> /h	°C	kg/h	kg/h	kg/h
1,500	8,333.3	23,950	125	11,220	20	43,250	850	56,220	280	57,030	275	57,030	265	57,030	265	57,030	260	57,030	260	860	860	250
1,150	8,333.3	20,610	215	8,320	20	36,100	800	46,060	280	46,870	275	46,870	265	46,870	265	46,870	260	46,870	260	880	880	190
750	8,333.3	13,110	250	1,900	20	25,260	750	31,400	280	32,210	275	32,210	265	32,210	265	32,210	260	32,210	260	910	910	130

2) Water Supply (3 lines)



### 10.2.2 Heat Balance Diagram (For One Line)



### 10.2.3 Heat Release per Unit Space Area

$$af = \frac{L \times H_U + Q_A}{V_F}$$

- af : Heat Release (kcal/m<sup>3</sup>•hr)  
L : Throughput (kg/hr)  
H<sub>U</sub> : Refuse L.H.V. (kcal/kg)  
Q<sub>A</sub> : Combustion Air Sensible Heat (kcal/hr)  
V<sub>F</sub> : Combustion Chamber Volume (m<sup>3</sup>)

$$af = \frac{8,333.3 \times 1,500 + 935,000}{241.9} = 55,540 \text{ kcal/m}^3\cdot\text{hr}$$

### 10.2.4 Grate Burning Rate

$$\gamma_C = \frac{L}{A}$$

- $\gamma_C$  : Grate Burning Rate (kg/m<sup>2</sup>•hr)  
L : Throughput (kg/h)  
A : Grate Area (m<sup>2</sup>)

$$\gamma_C = \frac{8,333.3}{46.4} = 180.6 \text{ kg/m}^2\cdot\text{hr}$$

### 10.2.5 Capacity Computation

#### 1) Induced Draft Fan

$$Q = Q_0 \times (1 + \alpha)$$

- Q : Rated Flow Rate (Nm<sup>3</sup>/hr)  
Q<sub>0</sub> : Necessary Flow Rate (Nm<sup>3</sup>/hr)  
 $\alpha$  : Margin

$$Q = 57,030 \times (1 + 0.15) = 65,584.5 \div 65,600 \text{ Nm}^3/\text{hr}$$

2) Combustion Air Fan

$$Q = Q_0 \times (1 + \alpha)$$

- Q : Rated Flow Rate (Nm<sup>3</sup>/hr)  
Q<sub>0</sub> : Necessary Flow Rate (Nm<sup>3</sup>/hr)  
α : Margin

$$Q = 23,950 \times (1 + 0.1) = 26,345 \approx 27,000 \text{ Nm}^3/\text{hr}$$

3) Injection Nozzle

$$N = \frac{W}{Q} \times (1 + \alpha)$$

- N : Quantity of Nozzle (unit/line)  
W : Necessary Injection Water (m<sup>3</sup>/hr•line)  
Q : Capacity of Nozzle (m<sup>3</sup>/hr•unit)  
α : Margin

$$N = \frac{11.4}{1.0} \times (1 + 0.2) = 13.68 \approx 14 \text{ units/line}$$

4) Ash Extractor

$$Q = Q_0 \times \frac{100}{100 - F} \times \alpha$$

- Q : Rated Capacity (t/hr)  
Q<sub>0</sub> : Ash Production (t/hr, dry)  
F : Water Content of Ash (%)  
α : Margin

$$Q = 0.91 \times \frac{100}{100 - 15} = 2.14 \approx 3 \text{ t/hr}$$

5) Electrostatic Precipitator

$$Q = Q_0 \times (1 + d)$$

Q : Rated Flow Rate(Nm<sup>3</sup>/hr)

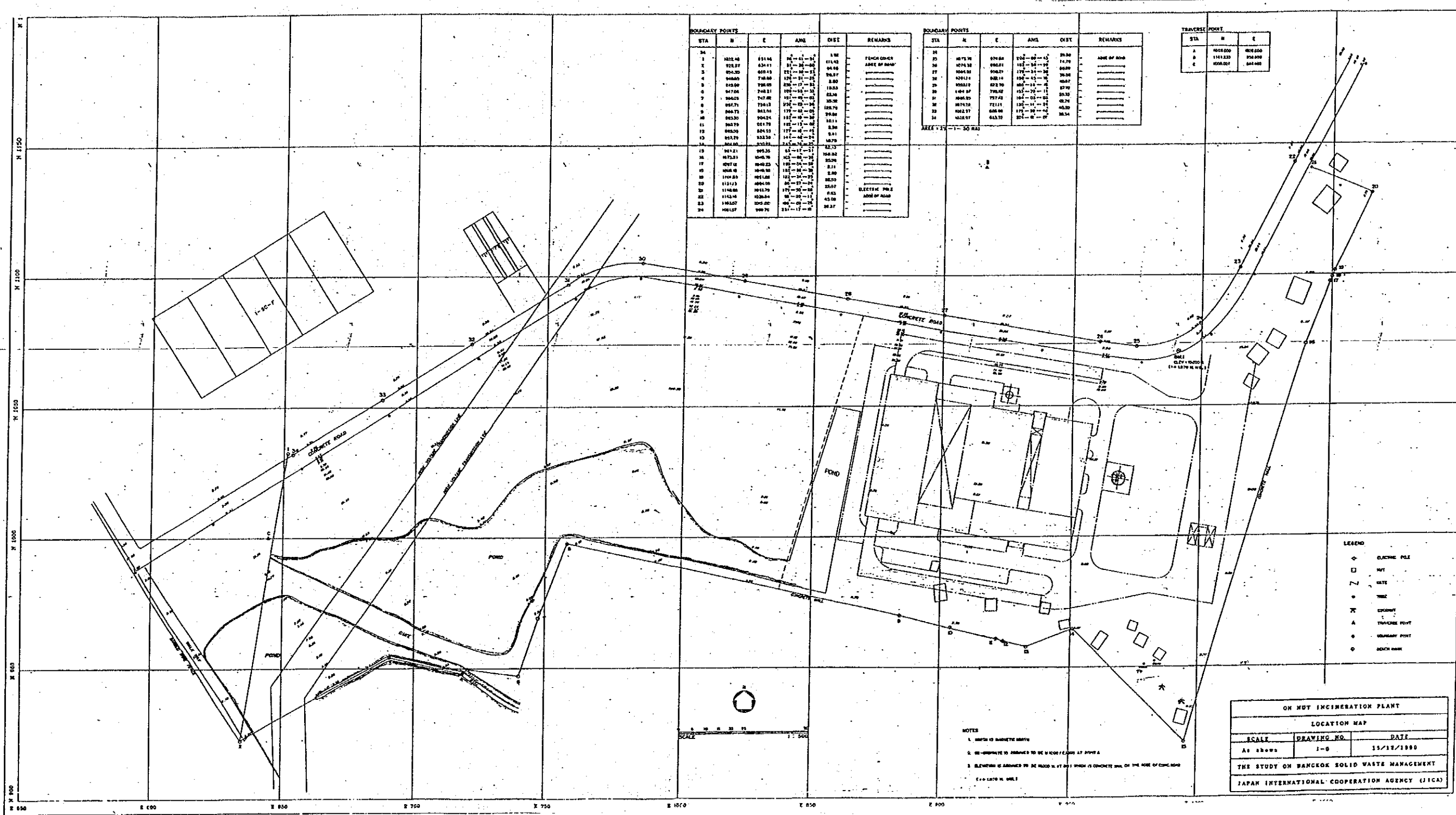
Q<sub>0</sub> : Necessary Flow Rate (Nm<sup>3</sup>/hr)

a : Margin

$$Q = 57,030 \times (1 + 0.05) = 59,881.5 \div 60,000 \text{ Nm}^3/\text{hr}$$

### 10.3 Drawing List

No.	Name
I-0	LOCATION MAP
I-1	SITE LAYOUT
I-2	EQUIPMENT LAYOUT PLAN (FL + 0.0m)
I-3	EQUIPMENT LAYOUT PLAN (FL + 5.5m)
I-4	EQUIPMENT LAYOUT PLAN (FL + 11.0m)
I-5	EQUIPMENT LAYOUT PLAN (FL + 19.0m)
I-6	ELEVATION
I-7	EQUIPMENT LAYOUT SECTION
I-8	SINGLE LINE DIAGRAM
I-9	REFUSE, AIR, FLUE GAS, AND ASH FLOW SHEET
I-10	WATER SUPPLY & DRAINAGE SYSTEM FLOW SHEET



BOUNDARY POINTS					
STA	N	E	ANG	DIST	REMARKS
34					
1	832.48	831.44	96-41-32	1.88	FENCE CORNER
2	828.27	826.11	91-34-00	41.42	EDGE OF ROAD
3	824.20	820.19	87-14-53	64.80	
4	820.00	816.00	82-31-25	96.37	
5	816.00	812.00	77-17-35	130.50	
6	812.00	808.00	72-00-00	160.00	
7	808.00	804.00	66-45-00	185.00	
8	804.00	800.00	61-00-00	205.00	
9	800.00	796.00	55-45-00	220.00	
10	796.00	792.00	50-00-00	230.00	
11	792.00	788.00	44-45-00	235.00	
12	788.00	784.00	39-00-00	235.00	
13	784.00	780.00	33-45-00	230.00	
14	780.00	776.00	28-00-00	220.00	
15	776.00	772.00	22-45-00	205.00	
16	772.00	768.00	17-00-00	185.00	
17	768.00	764.00	11-45-00	160.00	
18	764.00	760.00	6-00-00	130.00	
19	760.00	756.00	0-45-00	95.00	
20	756.00	752.00	4-45-00	55.00	
21	752.00	748.00	9-00-00	10.00	
22	748.00	744.00	13-45-00	45.00	EDGE OF ROAD
23	744.00	740.00	18-00-00	90.00	
24	740.00	736.00	22-45-00	135.00	

BOUNDARY POINTS					
STA	N	E	ANG	DIST	REMARKS
25	736.00	732.00	27-00-00	180.00	
26	732.00	728.00	31-45-00	174.70	EDGE OF ROAD
27	728.00	724.00	36-00-00	165.00	
28	724.00	720.00	40-00-00	150.00	
29	720.00	716.00	44-00-00	130.00	
30	716.00	712.00	48-00-00	100.00	
31	712.00	708.00	52-00-00	60.00	
32	708.00	704.00	56-00-00	15.00	
33	704.00	700.00	60-00-00	45.00	
34	700.00	696.00	64-00-00	90.00	

TRAVERSE POINT		
STA	N	E
A	808.000	808.000
B	1141.230	738.800
C	808.000	808.000

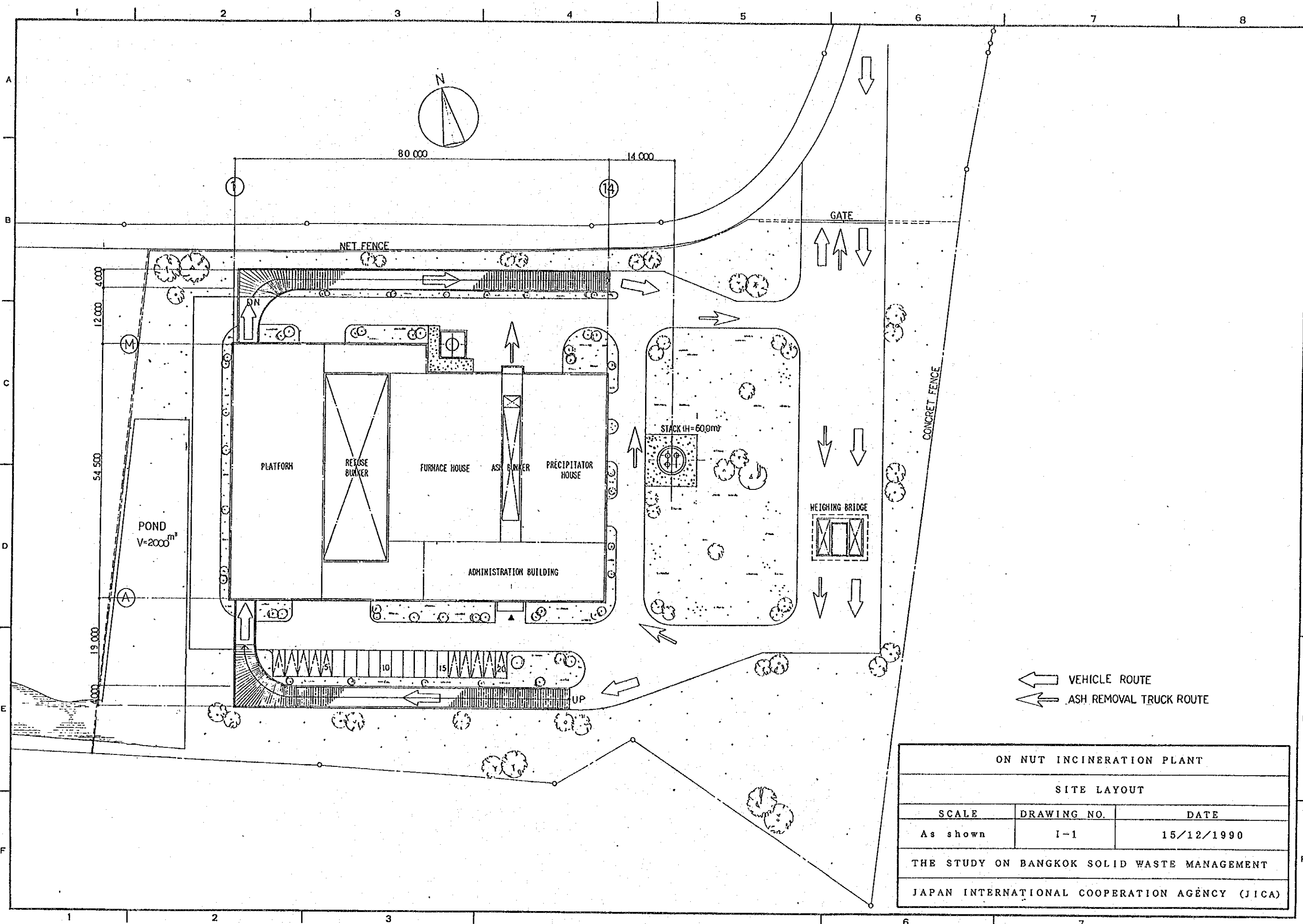
- LEGEND
- ◊ ELECTRIC PILE
  - HUT
  - ▭ WASTE
  - TREE
  - ⊗ EXISTING
  - △ TRAVERSE POINT
  - BOUNDARY POINT
  - CHECK MARK

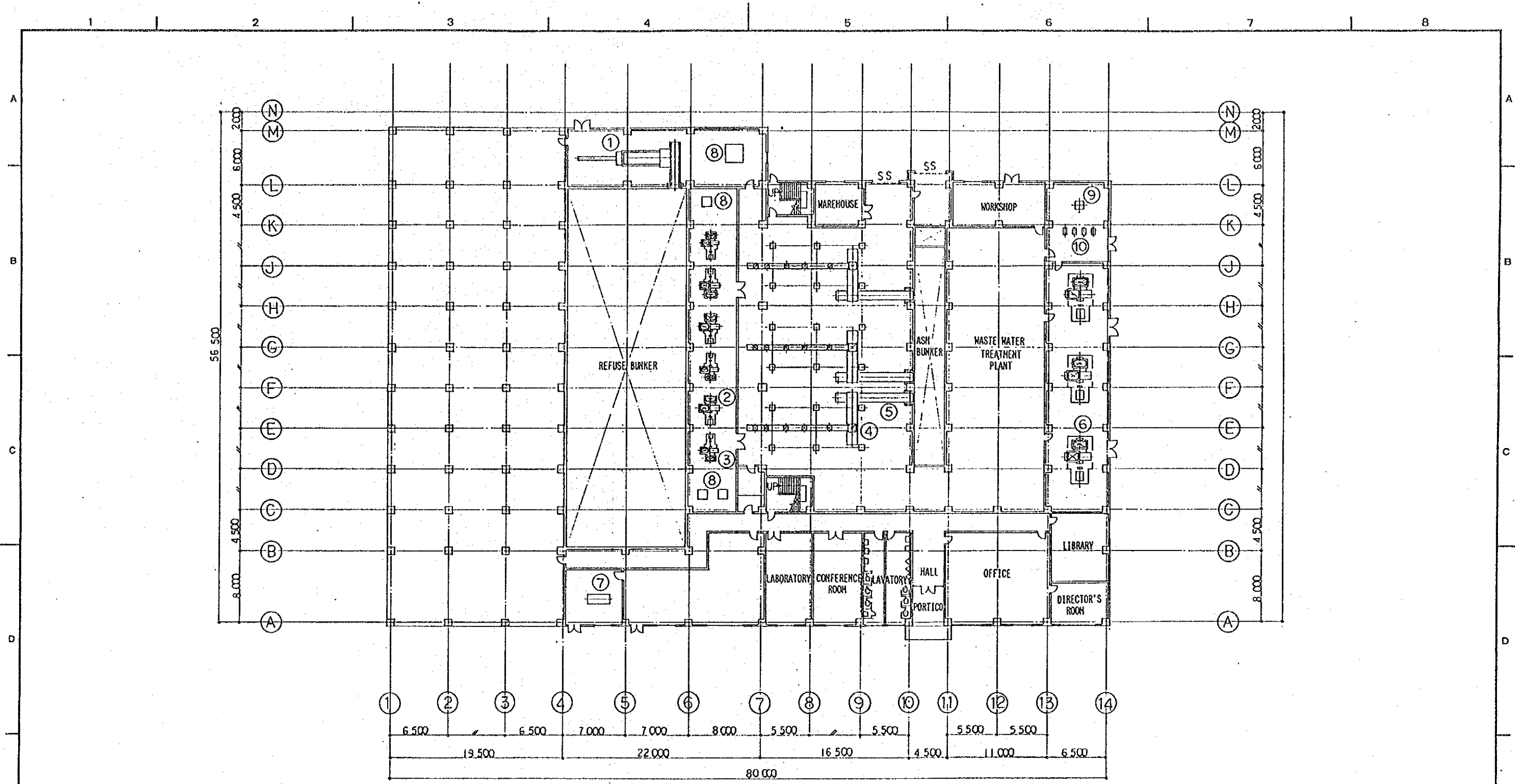
NOTES

1. NORTH IS MAGNETIC NORTH
2. ALL DIMENSIONS IS SHOWN TO BE IN METERS UNLESS OTHERWISE STATED
3. DIMENSIONS IS SHOWN TO BE IN METERS UNLESS OTHERWISE STATED

ON MSW INCINERATION PLANT		
LOCATION MAP		
SCALE	DRAWING NO.	DATE
As shown	1-0	12/12/1990
THE STUDY ON BANGKOK SOLID WASTE MANAGEMENT		
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)		

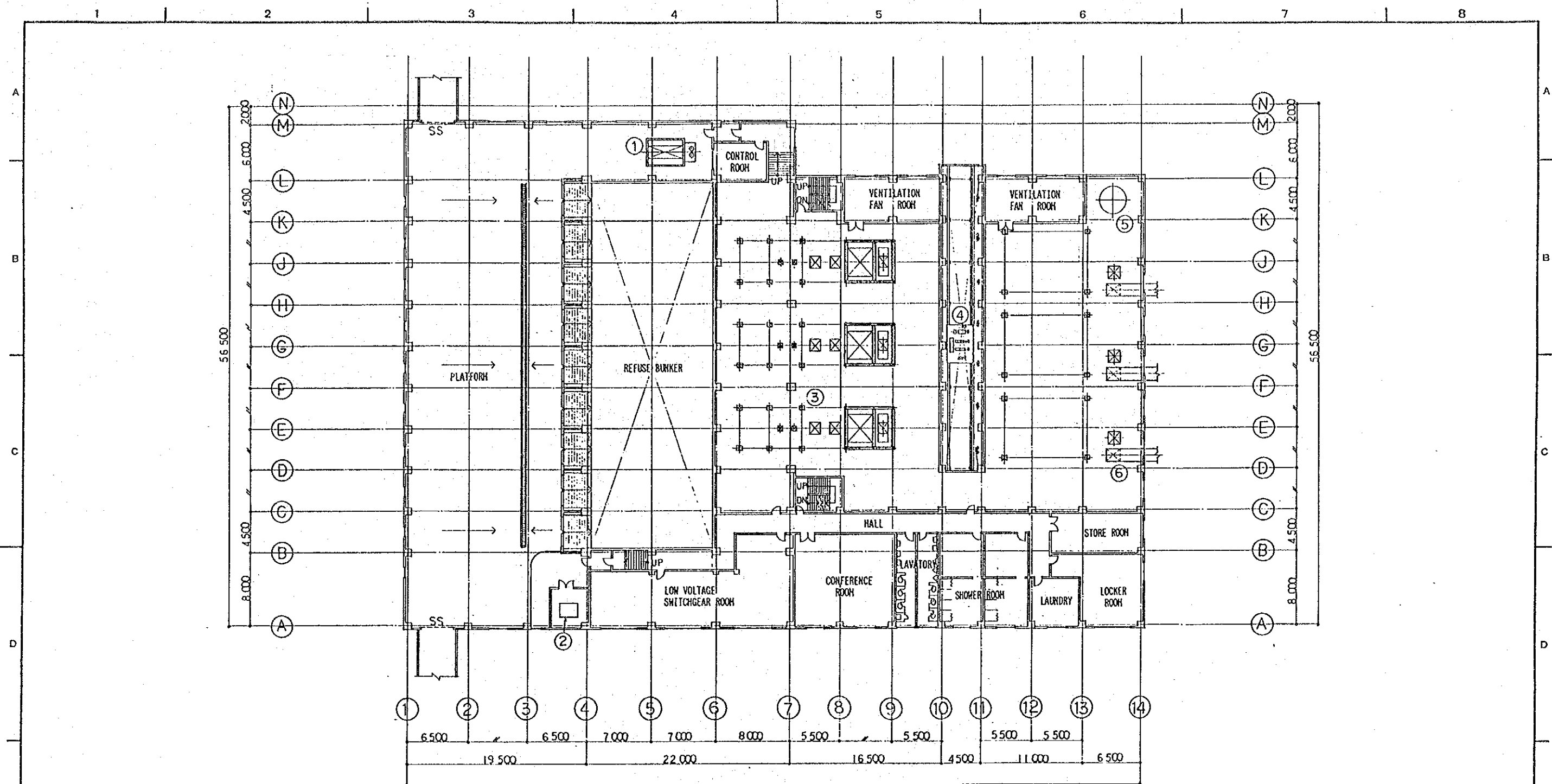






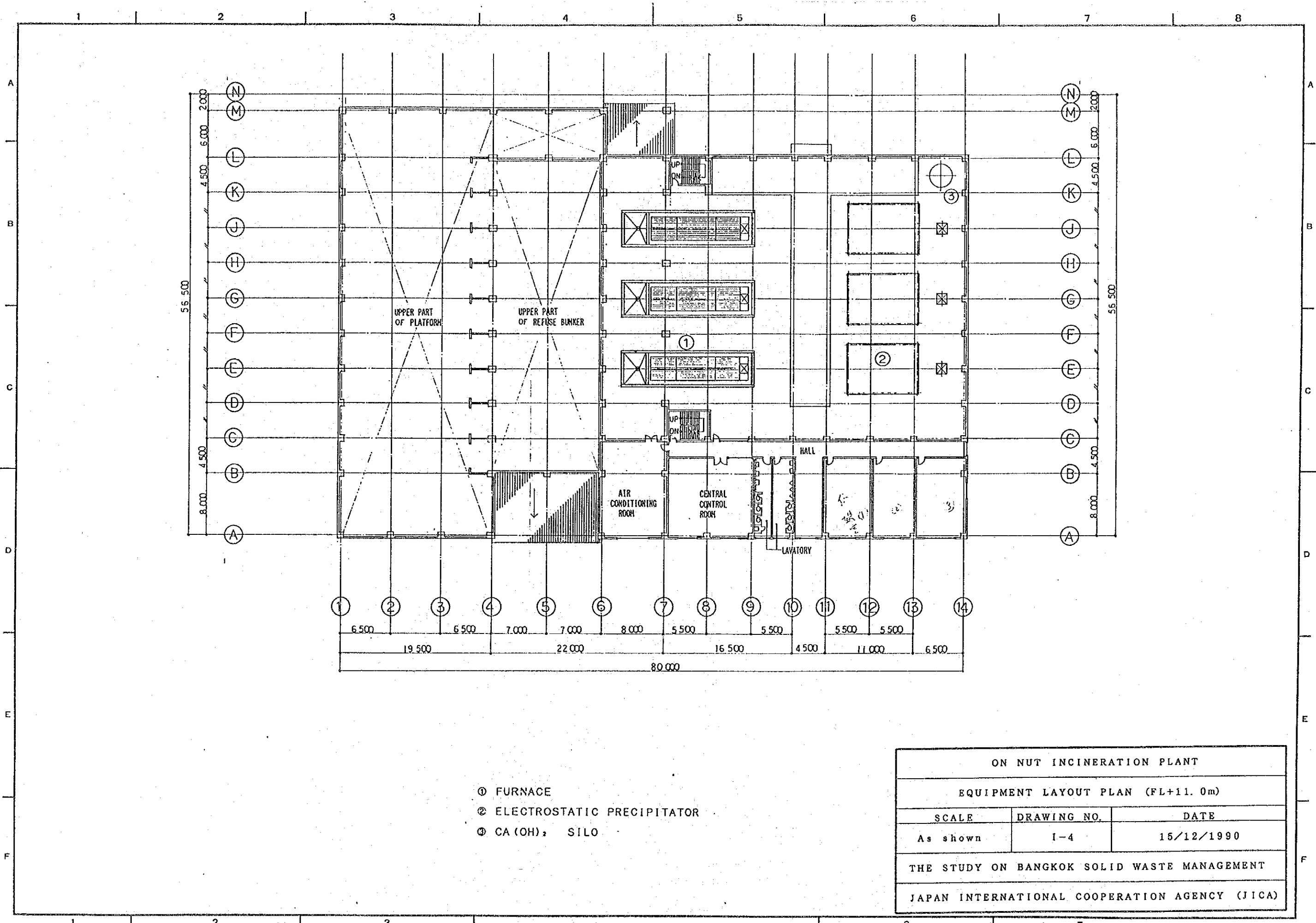
- ① REFUSE SHEARS
- ② COMBUSTION AIR FAN
- ③ COMBUSTION GAS COOLING FAN
- ④ ASH EXTRACTOR
- ⑤ ASH CONVEYOR
- ⑥ INDUCED DRAFT FAN
- ⑦ EMERGENCY DIESEL GENERATOR
- ⑧ HYDRAULIC UNIT
- ⑨ TABLE FEEDER
- ⑩ CA(OH)<sub>2</sub> INJECTION BLOWER

ON NUT INCINERATION PLANT		
EQUIPMENT LAYOUT PLAN (FL+0.0m)		
SCALE	DRAWING NO.	DATE
As shown	I-2	15/12/1990
THE STUDY ON BANGKOK SOLID WASTE MANAGEMENT		
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)		



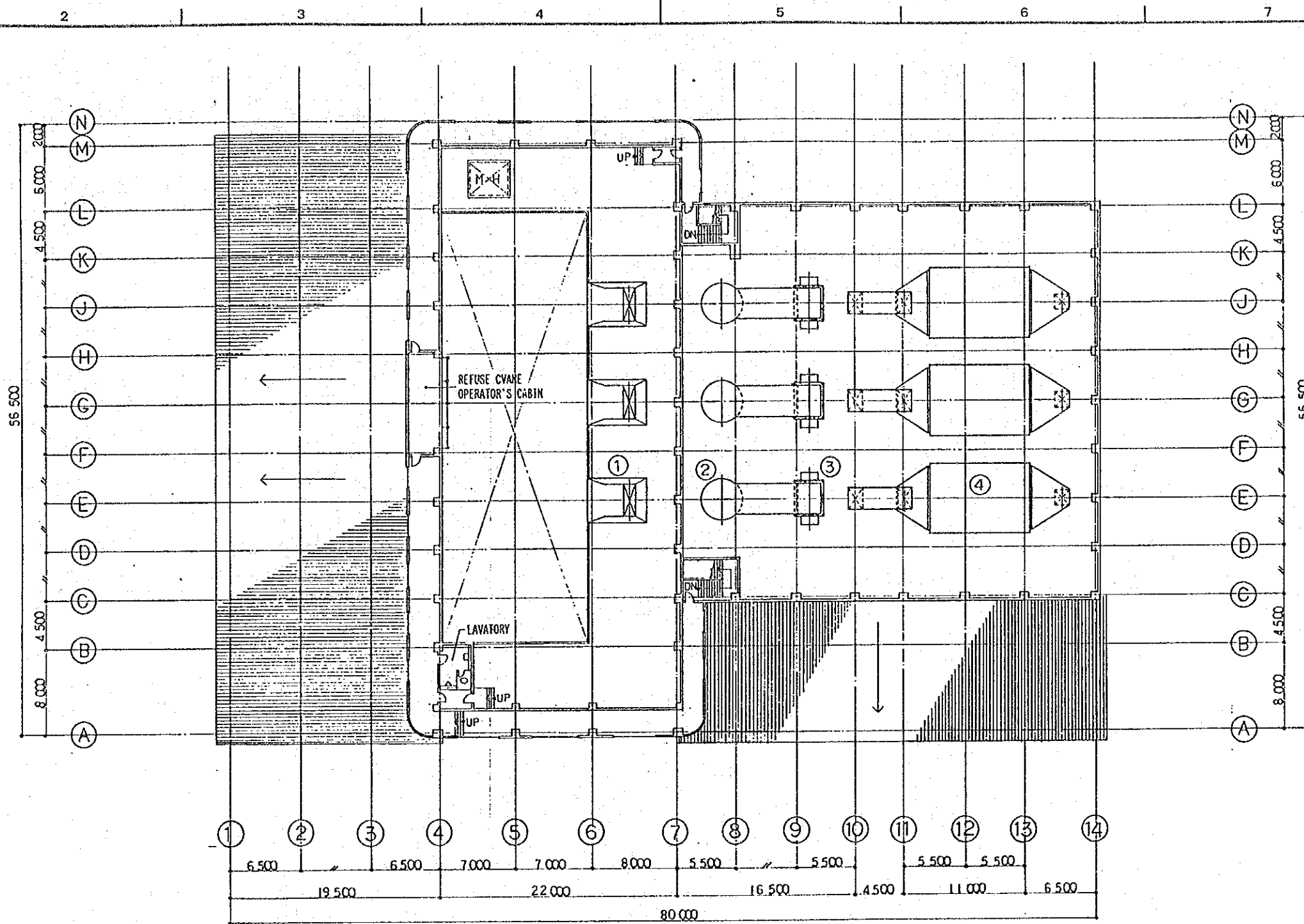
- ① BULKY REFUSE SHEARS
- ② HYDRAULIC UNIT
- ③ FURNACE
- ④ ASH CRANE
- ⑤ CA(OH)<sub>2</sub> STORAGE SILO
- ⑥ FLUE GAS DUCT

ON NUT INCINERATION PLANT		
EQUIPMENT LAYOUT PLAN (FL+5.5m)		
SCALE	DRAWING NO.	DATE
As shown	I-3	15/12/1990
THE STUDY ON BANGKOK SOLID WASTE MANAGEMENT		
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)		



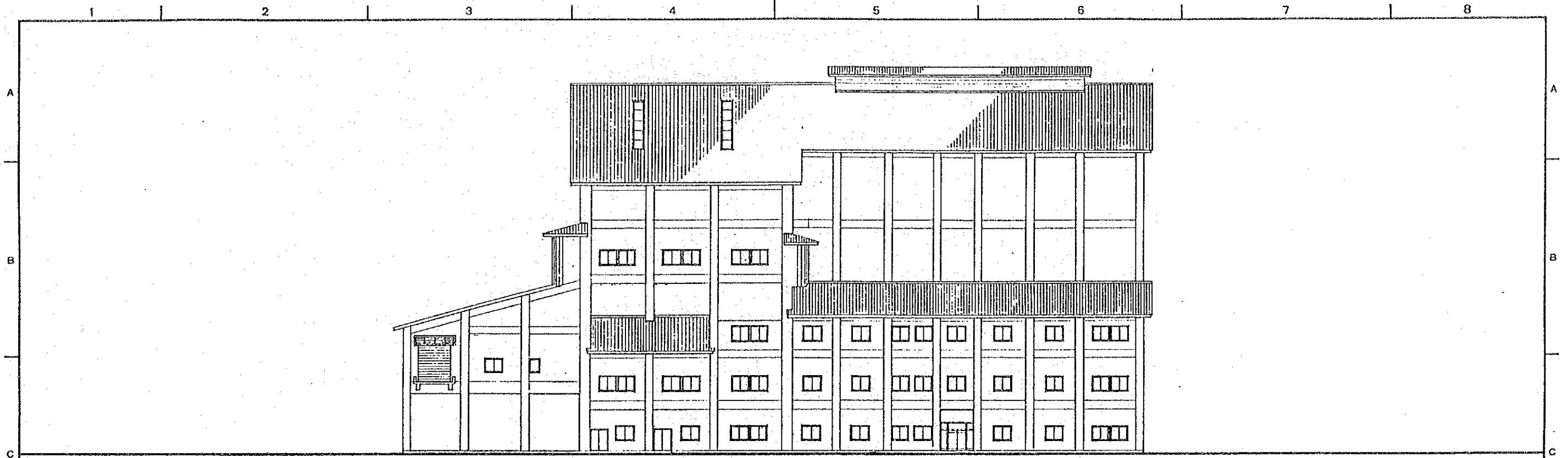
- ① FURNACE
- ② ELECTROSTATIC PRECIPITATOR
- ③ CA(OH): SILO

ON NUT INCINERATION PLANT		
EQUIPMENT LAYOUT PLAN (FL+11.0m)		
SCALE	DRAWING NO.	DATE
As shown	I-4	15/12/1990
THE STUDY ON BANGKOK SOLID WASTE MANAGEMENT		
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)		



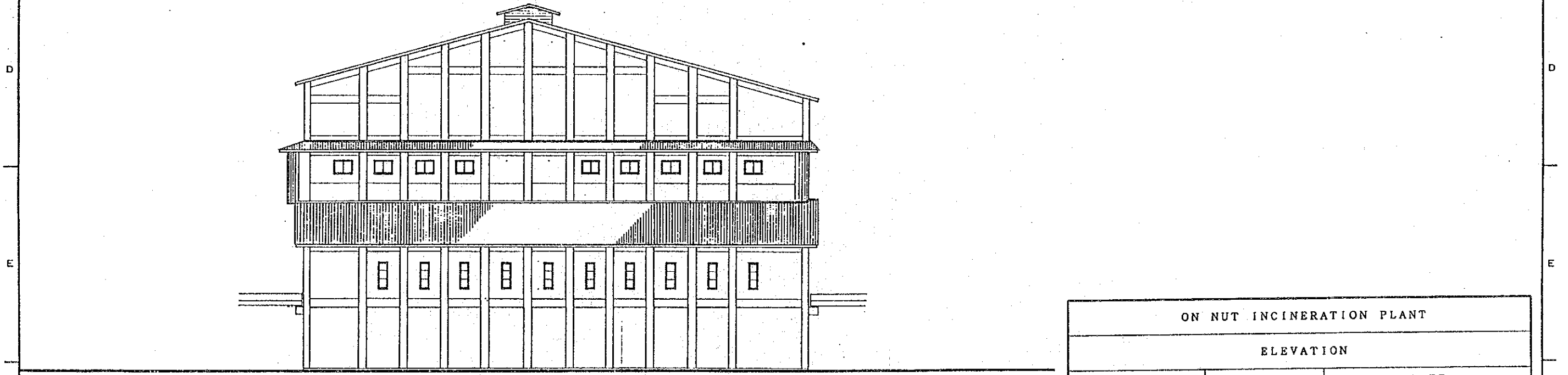
- ① CHARGING HOPPER
- ② GAS COOLER
- ③ GAS AIR HEATER
- ④ ELECTROSTATIC PRECIPITATOR

ON NUT INCINERATION PLANT		
EQUIPMENT LAYOUT PLAN (FL+19.0m)		
SCALE	DRAWING NO.	DATE
As shown	I-5	15/12/1990
THE STUDY ON BANGKOK SOLID WASTE MANAGEMENT		
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)		



① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩ ⑪ ⑫ ⑬ ⑭

**SOUTH ELEVATION**



N M L K J H G F E D C B A

**WEST ELEVATION**

ON NUT INCINERATION PLANT		
ELEVATION		
SCALE	DRAWING NO.	DATE
As shown	I-6	15/12/1990
THE STUDY ON BANGKOK SOLID WASTE MANAGEMENT		
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)		