

TABLE 1-1 INDUSTRIAL EFFLUENT STANDARDS

Items	Units	Standard values	Remarks
300 (5 days, at 20°C)	mg/l	20-60	Fishery canning Max. 100 Starch Industry Centrifugal Max. 60 Sedimentation Max. 100 Noodle Industry Max. 100 Tanning Industry Max. 100 Pulp Industry Max. 100 Frozen food Industry Max. 100
Suspended solids (SS)	mg/l	Depend on dilution ratios of wastewater and receiving water	Ratio 1/8 to 1/150 Max. 30 1/151 to 1/300 Max. 60 1/301 to 1/500 Max. 150
Dissolved solids (DS)	mg/l	Max. 2,000 or under; office's consideration; but not more than 5,000	If salinity of receiving water is higher than 2,000 mg/l, DS in the effluent should not be higher than 5,000 mg/l of the DS in the receiving water
pH	-	5-9	
Permanganate value	mg/l	Max. 50	
Sulfide as H ₂ S	mg/l	Max. 1.0	
Cyanide as KCN	mg/l	Max. 0.2	
Tar	mg/l	none	
Oil & Grease	mg/l	Max. 5.0	Refinery & Lubricant oil Industry Max. 15.0
Formaldehyde	mg/l	Max. 1.0	
Phenol & Cresol	mg/l	Max. 1.0	
Free Chlorine	mg/l	Max. 1.0	
Insecticides	mg/l	none	
Radioactivity	Bq./l	none	
Heavy metals			
Zinc (Zn)	mg/l	Max. 5.0	Zinc Industry Max. 3.0
Chromium (Cr)	mg/l	Max. 0.5	Zinc Industry Max. 0.2
Arsenic (As)	mg/l	Max. 0.25	
Copper (Cu)	mg/l	Max. 1.0	
Mercury (Hg)	mg/l	Max. 0.005	Zinc Industry Max. 0.002
Calcium (Ca)	mg/l	Max. 0.03	Zinc Industry Max. 0.1
Barium (Ba)	mg/l	Max. 1.0	
Selenium (Se)	mg/l	Max. 0.02	
Lead (Pb)	mg/l	Max. 0.2	
Nickel (Ni)	mg/l	Max. 0.2	Zinc Industry Max. 0.2
Manganese (Mn)	mg/l	Max. 5.0	
Silver (Ag)	mg/l		Zinc Industry Max. 0.02

Penalty: A license for operation of factory who does not comply with this notification shall be punished by fine not exceeding ten thousand Baht.

Source: (1) Notification of the Ministry of Industry No. 12 B.E. 2525 (1982) issued under the Factory Act B.E. 2521 (1978) published in the Royal Government Gazette, Vol. 99, Part 33, dated March 5, B.E. 2525 (1982)

(2) Notification of the Ministry of Industry No. 10 B.E. 2521 (1978) issued under the Factory Act B.E. 2521 (1978) published in the Royal Government Gazette, Vol. 95, Part 32, dated November 28, B.E. 2521 (1978)

TABLE 1-2 INDUSTRIAL WATER POLLUTION CONTROL REGULATIONS (I)

1. Industrial plants which shall require machine operators/supervisors of water pollution control systems with qualifications specified in Table 1.3.3

1. An industrial plant discharging wastewater at higher than 40 cubic meters/hour (with the exception of cooling water), or having the BOD load of influent at higher than 100 kilogram/day.

2. An industrial plant using heavy metals in the production process discharging wastewater at higher than 30 cubic meter/day, and having the content of heavy metals in the discharge water at the following values:

- (a) Zinc at higher than 25,000 milligrams/day
- (b) Chromium at higher than 25,000 milligrams/day
- (c) Arsenic at higher than 12,500 milligrams/day
- (d) Copper at higher than 50,000 milligrams/day
- (e) Mercury at higher than 250 milligrams/day
- (f) Cadmium at higher than 1,500 milligrams/day
- (g) Barium at higher than 50,000 milligrams/day
- (h) Selenium at higher than 1,000 milligrams/day
- (i) Lead at higher than 10,000 milligrams/day
- (j) Manganese at higher than 250,000 milligrams/day

3. An industrial plant dealing with iron and steel:

- (a) Using sintering furnaces or acids or other substances which may be polluting the environment in the production process, with production capacity of higher than 100 tons/day.
- (b) Using steel melters with the total capacity of 5 tons/batch.

4. An industrial plant producing petrochemicals from the raw materials obtained as by-products of the Oil refinery in the production process at higher than 100 tons/day.

5. An industrial plant of any size separating or processing the natural gas.

6. An industrial plant producing chlor-alkali, using sodium chloride (NaCl) as raw material in the production of soda ash (Na₂CO₃), caustic soda (NaOH), hydrochloric acid (HCl), chlorine (Cl₂) and bleaching (NaOCl) each or several combined at higher than 100 tons/day.

7. An industrial plant of any size producing cement.

8. An industrial plant engaged in ore smelting or production of metals at higher than 50 tons/day.

9. An industrial plant producing paper pulp at higher than 50 tons/day.

10. An industrial plant of any size engaged in crude oil refinery.

TABLE 1-3 INDUSTRIAL WATER POLLUTION CONTROL REGULATIONS (II)

Qualification requirements of supervisors and machine operators of water pollution control systems.

1. The supervisors are holders of bachelor degree in engineering, or science in chemistry, or other branches or study with experiences in the field of environment, and who has been approved by the Industrial Factory Department. In the case of an engineering consulting firm, it must be operated by person(s) having the qualifications mentioned above.
 2. The machine operators must be graduates of the secondary education, lower level, with the certification from the persons as mentioned in (1).
 3. The persons stated in (1) and (2) must register themselves with the Industrial Works Department, and comply with the regulations and procedures as prescribed by the Industrial Works Department.
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TABLE 1-4 INDUSTRIAL WATER POLLUTION CONTROL REGULATIONS (III)

Monitoring Reporting Requirements

1. Factories mentioned in Table 3.3.2 must arrange to make Poisonous Matter Analysis Reports and submit them to the Industrial Factories Department every 3 months on the form and according to the procedures prescribed by the industrial factories Department. The analysis of the qualities of poisonous matter must be performed by a government analysis laboratory or a private analysis laboratory approved by the Industrial Factories Department in accordance with the regulations and procedures prescribed by the Industrial Factories Department.
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Penalty: a licensee for operating a factory who does not comply with this notification shall be punished by fine not exceeding ten thousand baht.

Source: Notification of the Ministry of Industry No. 13 O.E. 2525 (1982), as amended in No. 22 S.E. 2528 (1985), issued under the Factory Act B.E. 2512 (1969), published in the Royal Government Gazette, Vol. 59 Part 39, dated June 29, B.E. 2525 (1982).

3.2.2 Domestic Effluent Guidelines

Table 1-5 presents domestic effluent guidelines for different community groups classified according to population size, while Table 1-6 shows the guidelines for wastewater analysis.

3.2.3 Building Effluent Standards

Table 1-7 presents the proposed effluent standards for different building types of various size classifications.

3.2.4 Waste Dumping Into Public Water Bodies

Navigation in Thai Water Act BE 2456 (1913), Article 119, as amended under the Announcement of the Revolutionary Party No. 50, dated January 19 BE 2515 (1972) stipulates that "it is forbidden to dump rocks, gravels, silt, soil, mud, detritus, solid wastes, sewage, oil and chemicals in public water courses such as rivers, canals, swamps, reservoirs, and lakes used for navigation or for other utilization".

4. System of water rate and charge for sewerage treatment, way of calculation, way of collection, collection ratio.

At present, only Tambon Patong Municipality and the city of Pattaya have collected wastewater treatment fee. Table 1-8 shows the rate of wastewater treatment fee in the city of Pattaya.

TABLE 1-5

DOMESTIC EFFLUENT GUIDELINES

Parameters	Units	Domestic Effluent Classification for Community Group (persons)			
		A (>2500)	B (501-2500)	C (101-500)	D (<1010)
1. BOD (10°C at 5 days)*	mg/dm ³	10	30	60	90
2. Solids					
2.1 SS	mg/dm ³	30	40	50	60
2.2 Settleable S.	mg/dm ³	0.5	0.5	0.5	0.5
2.3 TDS ***	mg/dm ³	+500	+500	+500	+500
3. Sulfide	mg/dm ³	1.0	1.0	3.0	4.0
4. Free residual Chlorine ****	mg/dm ³	0.3	0.3	-	-
5. Nitrogen					
5.1 TN	mg/dm ³	-	-	40	40
5.2 ORG-N	mg/dm ³	10	10	15	15
5.3 NH ₃ -N	mg/dm ³	-	-	25	25
5.4 NO ₃ -N	mg/dm ³	-	-	-	-
6. pH	mg/dm ³	5-9	5-9	5-9	5-9
7. Oil & Grease	mg/dm ³	10	10	10	10
8. Faecal coliform	MPN/100cm ³	-	-	-	-
9. Phosphate	mg/dm ³	-	-	-	-

Remarks: A, B, C, D size of community with more than 2500, between 501-2500, between 101-500 and less than 1010 persons respectively.

* Settled BOD (30 min)

** more than TDS of used water

*** Maximum allowances under epidemic condition only

Source: Proposed by the Sub-Committee on Domestic Effluent under the Environmental Committee on Water (May 17 SE 1527 (1984)) and approved by the National Environment Board (Jan. 31 SE 1528 (1985))

TABLE 1-6 WATER QUALITY ANALYSIS GUIDELINES

Parameters	Methods of Analysis
1. BOD (20°C at 5 days)	- Azide Modification; 20°C; 5 days.
2. Solids	
2.1 Suspended solids	- Non-filterable residue through glassfiber filter discs
2.2 Settleable solids	- 60 min-settled in 1,000 cc Imhoff cone
2.3 Total dissolved solids	- Filtrate from 2.1 and evaporate at 103-105°C 1hr.
3. Sulfide	- Titration for total sulfide
4. Free residual	- Orthotolidine Azenide
5. Nitrogen	
5.1 TKN	- Kjeldahl
5.2 ORG-N	- Kjeldahl after NH ₃ -N separation
5.3 NH ₃ -N	- Nesslerization after distillation
5.4 NO ₃ -N	
6. pH	- Electrometric pH meter
7. Oil & Grease	- Soxhlet extraction

Method of Analysis: Standards Methods for the Examination of Water and wastewater set by American Public Health Association, American Waterworks Association and Water Pollution Control Federation

Source : Proposed by the Sub-Committee on Domestic Effluent under the Environmental Committee on Water (May 27, S.E 2527 (1984), and approved by the National Environment Board (Jan. 31, S.E 2528 (1985))

TABLE 1-7 PROPOSED BUILDING EFFLUENT STANDARDS

Building type	Size	Min. Requirs.	Remarks
1. Government offices State enterprises International agencies, Bank, Office buildings (except those specified otherwise in this Table)	2,000-10,000 m ² 10,000-55,000 m ² >55,000 m ²	C B A	working area only (excluding central service area)
2. Condominium	< 100 units 101-500 units >500 units	C B A	all sizes
3. Hotels	60-200 rooms >200 rooms	B A	
4. Hospitals	10-30 beds > 30 beds	B A	
5. Massage parlors (or equivalent)	>5,000 m ²	B	
6. Fresh-food markets	500-1,000 m ² 1,001-1,200m ² 1,501-2,500m ² >2,500m ²	D C B A	
7. Housing estate	<20 households 20-100 households 100-500 households >500 households	D C B A	all sizes
8. Food service operations	50-100 m ² 101-500 m ² 501-2,500 m ² > 2,500 m ²	D C B A	dining area
9. Department Stores	5,000-25,000 m ² > 25,000 m ²	B A	
10. Schools, Universities Colleges, Institute	5,000-25,000 m ² > 25,000 m ²	B A	
11. Dormitories	10-50 rooms 51-250 rooms > 250 rooms	D C B	
12. Fishing Piers	> 300 m ²	B	- loading, unloading - sorting Area - excluding nitrogen parameter

Remarks : Concentration of all parameters are the same as those stated in Table 3.3.5 Domestic Effluent Guidelines
 Source : Proposed by the sub-committee on Domestic Effluent (Apr. 10, B.E 2512 (1989) under consideration of the Environment Committee in laws

Table 1-8 Rate of sewage charge and license fee for sewer connection

No.	Type	Sewage Charge (baht/year)		License fee (baht/unit)		Unit
		Wastewater	Pre-treated wastewater	Wastewater	Pre-treated wastewater	
	A.					
1.	Hotel	672.00	67.20	50.00	50.00	Room
2.	Condominium	360.00	36.00	50.00	50.00	Room
3.	Resturant	36.00	3.60	2.00	2.00	Service area(sq.m)
4.	Commercial Building	6.00	0.60	2.00	2.00	
5.	Residential Building	3.60	0.36	2.00	2.00	
6.	Governmental Building	-	-	-	-	
	B					
1.	Small size Factory (Food processing)	40	26	40	26	Kilogram Product/ day

5. Ratio of user's payment for construction of water and wastewater project

There is no direct tax or fee collection for construction of water and wastewater project. All budgets come from the central government.

6. Present Condition of Application of polluters pay principle which is regulated in the Law of Environment of Thailand.

6.1 Current Situation

There is still no application of polluters pay principle; however, BMA is studying to begin to collect treatment fee in Bangkok area after BMA's major treatment facilities completing their construction. If BMA succeeds in establishing fee collection system, the system will be an example to other local authorities around the countries to follow. The program is not only set up a systematic fee collection, it also has to make people in the service area understand the necessity of charging fee and cooperate with BMA or other local authorities.

6.2 Laws on Collection of service fee

The institutes which has powers and duties to manage the services of wastewater treatment are able to collect their service fees from the users within their own boundaries in accordance with the laws involving their own institutes, such as, Bangkok Metropolitan under the Bangkok Metropolitan Administration Act of B.E.2528, Municipalities, Sanitary Districts and Provincial Administrative Organizations within the nearby provinces under the Municipality Act of B.E.2496, the Sanitary District Act of B.E.2495, and the

Provincial Administration Act of B.E.2498, respectively, Metropolitan Waterworks Authority under the Metropolitan Waterworks Authority Act of B.E. 2510, Provincial Waterworks Authority under the Provincial Waterworks Authority Act of B.E.2522, Industrial Estate Authority of Thailand under the Industrial Estate Authority of Thailand Act of B.E.2522, and other government agencies involved.

It is noted that under the National Environment Control and Promotion Act of B.E.2535, the National Environment Board with suggestion from the Pollution Control Committee is entitled to determine the service fee rates of wastewater treatment charged from the users in each area. The said Board should issue such service fee rate as soonest as possible in order that the institutes mentioned hereinabove will comply with.

7. Present condition of private sector's participation for sewage treatment.

7.1 Choices of private sector to participate for sewage treatment

Present condition opens to private sector to participate in the sewage treatment process in many ways and at different stages from studying, designing, constructing and operating. Governmental agencies often give contracts to consulting firm to conduct studies and design works. All constructions of sewage treatment projects are performed by private contractors. In addition, there are many turn key projects for private company to bid especially of BMA projects. For operation of sewage treatment plants, it is likely to give

concessions to private companies. BMA is studying in fee collection system and preparing to contract operation of sewage treatment to private sector.

7.2 Laws Involving Investment and Operation in Wastewater Treatment Services

7.2.1 Investment and Operation by the Government Sectors

Under the laws involved, BMA, the Municipalities, Sanitary Districts and, Provincial Administrative Organizations in the nearby provinces are able to invest and operate wastewater treatment system within their own boundaries. Besides they also have power to invest and operate wastewater treatment system outside their own boundaries. Apart from above, BMA and the Municipalities in the nearby provinces are still entitled to jointly invest and operate the said system in form of "Sahakarn" which has never been established before. For example, BMA may invest and operate such system with one or more Municipalities, Sanitary Districts and Provincial Administrative Organizations in the nearby provinces, and/or Industrial Estate Authority of Thailand, Metropolitan Waterworks Authority, Provincial Waterworks Authority and other government agencies or state enterprises in the form of "Sahakarn" as juristic person (which different from government body) by issuing the Royal Decree (not passing to the Parliament). The researcher is of opinion that BMA is completely ready in budget and manpower to invest and operate the wastewater treatment system with other government agencies and state enterprises involved.

7.2.2 Investment by the Government Sectors and Operation by the Private Sectors

The government sectors which are ready in budget to invest the wastewater treatment system, but are not ready in manpower to operate and maintain such system, should permit the private sectors to involve in their operation on their behalf. There are three (3) forms of private sector involvement as follows; (a) franchise of licensing or concession the private sectors which obtain license or concession will pay an agreed royalty fee to the government sectors involved; (b) contracting-out the government sectors will pay an agreed remuneration to the private sectors, (c) joint venture company establishment the government sectors and the private sectors jointly share investment in the limited company but government sectors must hold shares more than fifty percent (50%) of the total registered capital. Under the laws involved, BMA, the Municipalities, Sanitary Districts and Provincial Administrative Organizations in the nearby provinces can allow the private sectors to operate in their wastewater treatment system in such forms, but they still are responsible for the said operation by the private sectors.

7.2.3 Investment and Operation by the Private Sectors

The government sectors involved can permit the private sectors to invest and operate the wastewater treatment system on their behalf in the boundaries of BMA and nearby

provinces in the form of licensing, franchise or concession as mentioned above. However, the researcher opines that it is very hard to find some private sectors to invest and operate in this form because of high cost and expenses of construction, operation and maintenance for the wastewater treatment system.

7.2.4 Investment and Operation by the Government Sectors and Private Sectors

The form of joint venture company establishment can be applied for this investment and operation as written above. However, it is not easy to find the private sectors to invest and operate by this form because the shareholding and management structure of the said company which are not beneficial to them.

It is noted that the institutes of persons who invest and/or operate the wastewater treatment system for commercial aspects should have absolute power to penalize any user who violates the laws by not making payment of the service fees as same as Metropolitan Waterworks Authority or Provincial Waterworks Authority, such as, cutting a wastewater pipe, etc. However, some laws involved will be amended to serve the said purposes.

SECTORAL SURVEY#2 : EXISTING SEWAGE TREATMENT FACILITIES
(WHOLE AREA THAILAND)

1. The number of sewage treatment plants and staffs, treatment methods, running cost, capacity of the plant, quality of treated water.

Area	No.of staffs	Treatment Method	Capacity CU.M/Day	Running cost (MB /year)	Effluent BOD mg/l
1.Nakhon Ratchasima Municipality	7	SP	32,000	5.00	25-30
2.Khon Kaen Municipality	10	SP	25,000	3.60	25-30
3.Phanutnikhom Municipality	4	SP	2,000	0.50	30
4.Hua Hin Municipality	5	RBC	8,000	4.00	10
5.Patong Municipality	5	OD	5,300	3.50	3.5-10
6.Pattaya City - Jomtien area	-	AS(with Band Aerators)	20,000	-	-
- Pattaya North-South	10	RBC	13,000	8.00	5-10
7.Nakhon Phatom Municipality	-	SP	35,000	-	-
8.BMA - Sapraya area	-	AS	30,000	-	3-5
- Huay Kwang	-	AS	3,000	-	5

* SP = Stabilization Pond

AS = Activated Sludge

OD = Oxidation Ditch

RBC = Rotating Biological Contactors

2. Progress of construction of main sewer

Area	Type of sewers		% of construction
	Diameter	length(m.)	
1. Saen-Suk Municipality			
1.1 Contract #1	1.00x1.00	222	100
	1.20x1.20	115	
1.2 Contract #2	1.00	475	90
	1.20x1.00	707	
	1.20x1.20	375	
	1.20x1.50	215	
	1.50x1.50	427	
	1.80x1.50	282	
	2.20x1.80	801	
	3.00x2.00	401	
	3.00x2.20	1096	
	3.50x2.50	1306	
	OXIDATION DITCH CAPACITY = 9,000 m ³ /d		
1.3 Contract #3	0.60	30	30
	1.00	229	
	1.20	688	
	1.20x1.20	365	
	1.50x1.20	1252	
	1.80x1.20	745	
	2.00x1.20	29	
	1.80x1.50	195	
	2.00x1.50	150	
	3.00x1.50	538	
	1.80x1.80	970	
	2-2.20x1.80	150	
	2-2.20x2.00	777	
	2.50x2.50	1038	
	OXIDATION DITCH CAPACITY = 14,000 m ³ /d		

Area	Type of sewers		% of construction
	Diameter	length(m.)	
2. Sriracha Municipality			
2.1 Contract #1	0.60	1198	100
	0.80	1070	
	1.00	2152	
	1.20	363	
	3.00x2.00	525	
	3.00x2.50	1352	
2.2 Contract #2	EXTENDED AERATION ACTIVATED SLUDGE CAPACITY = 24,000 m ³ /d		Signed contract
3. Laem Chabung Municipality			
3.1 Contract #1	0.40	41	100
	0.60	3028	
	0.80	2590	
	1.00	2997	
	1.20	3092	
	1.00x1.00	312	
	1.20x1.20	868	
	1.50x1.50	37	
	1.80x1.50	142	
	1.90x1.90	276	
	2.50x1.50	39	
	2.70x1.50	154	
3.2 Contract #2	0.60	2292	
	0.80	2417	
	1.00	2520	
	1.20	2171	
	1.00x1.00	946	
	1.20x1.20	1172	
	1.40x1.40	750	
	1.50x1.50	696	
	1.90x1.50	750	

Area	Type of sewers		% of construction
	Diameter	length(m.)	
3. Laem Chabung Municipality	2.20x1.50	310	100
	3.50x1.50	125	
	3.3 Contract #3	OXIDATION DITCH CAPACITY = 25,000 m ³ /d (Civil works)	
	3.4 Contract #4	OXIDATION DITCH (equipment installation)	
4. Chiang Mai Municipality	(western side)		25
4.1 Contract #1	0.40	1419	
	0.60	6522	
	0.80	7381	
	1.00	3595	
	1.20x1.20	4257	
	1.20x1.50	566	
	1.50x1.50	1658	
	2.00x2.00	524	
	AERATED LAGOON CAPACITY = 55,000 m ³ /d		
4.2 Contract #2	0.40	1419	
	0.60	6315	
	0.80	7599	
	1.00	3595	
	1.20x1.00	4257	
	1.20x1.50	566	
	1.50x1.50	1658	
	2.00x2.00	524	
		Signed contract	

Area	Type of sewers		% of construction
	Diameter	length(m.)	
5. Chantha Buri Municipality			
5.1 Contract #1	0.60	2830	20
	0.80	3024	
	1.00	1725	
	1.00x1.00	993	
	1.20x1.20	636	
	1.50x1.80	92	
	3.00x1.80	594	
5.2 Contract #2	0.40	193	
	0.60	2726	
	1.00	492	
	1.20	1038	
	1.50	2030	
STABILIZATION POND			
CAPACITY = 17,000 m ³ /d			
6. Angthong Municipality			
	0.30	952	65
	0.40	549	
	0.60	2592	
	0.80	3741	
	1.00	1317	
	1.20	231	
	1.20x1.20	419	
	1.00x1.50	152	
	1.40x1.40	98	
AERATED LAGOON			
CAPACITY = 8,200 m ³ /d			
7. Ubon Ratchathani Municipality			
7.1 Contract #1	0.60	5620	25
	0.80	4242	
	1.00	1662	
	1.20	1534	

Area	Type of sewers		% of construction
	Diameter	length(m.)	
7.2 Contract #2	1.00x1.00	342	Signed contract
	1.20x1.20	766	
	1.50x1.20	1126	
	1.80x1.20	870	
	3.00x1.20	45	
	2.00x2.00	217	
	0.60	1553	
	0.80	1028	
	1.00	1715	
	1.20	937	
	1.20x1.20	653	
	1.50x1.20	242	
	1.50x1.50	564	
	1.80x1.50	521	
	1.80x1.80	855	
	2.00x1.80	225	
	2.00x2.00	448	
	2.50x2.50	502	
	AERATED LAGOON CAPACITY = 22,000 m ³ /d		

Area	of Construction
<u>BMA</u> Rattanakosin Area Yannava Area	10 Signed Contract

3. Number of engineers and technicians of each field who are in charge of sewage treatment

Patong : 1 Civil Engineer , 1 Electrician
Pattaya : 1 Sanitary Engineer, 2 Technicians
Hua Hin : 2 Technicians
Others : no engineer, only low educated workers

4. Usage of treated sewage

Treated sewage of some projects is currently used for watering plants in public area of their communities.

5. Country of origin concerning main equipment and treatment technology.

Pumps : Sweden, Finland, Germany, U.S.A.
Screens : France, U.S.A.
Tide check Valves : U.S.A.
Aerators : U.S.A.

SECTORAL SURVEY#3 : PLAN OF SEWERAGE WATER TREATMENT FACILITIES

1. Construction Plan of sewer network and sewage treatment plants.

1.1 Construction plan of sewer network and sewage treatment plant by PWD.

Public Work Department (PWD) has established a sewerage works plan which will be conducted in the National Economic and Social plan No.7 and No.8. Under this sewerage plan, seventy-two municipalities or sanitary district areas will be covered. An implementing period will take 10 years which is from 1991 to 2000. Budget for study, design and construction is 29, 295 million baht. At the end of the National Economic and Social plan No.7 (1996), study and design works of the seventy two areas will complete and, among those seventy-two areas, eighteen areas will finish with their construction. In the year of 2000, all seventy-two areas will finish with their construction. Details of construction and budgeting plan for the seventy two areas are shown in table 3-1

1.2 Construction plan of sewer network and sewage treatment plant by BMA

At present, BMA plans to solve Bangkok's water pollution with 5 sewage works projects. The projects are Si Phraya, Rattanakosin, Yanawa, Central treatment (1st stage), and Nong Khaem-Pasricharean Lard Burana. For Si Phraya Project, its wastewater treatment plant is completed and in operation. BMA is constructing the project's collection network to fully cover its target area. For Rattanakosin project, its wastewater treatment plant is nearly completed. This section provides details of the other three projects as follows:

Table 3-1

The development and budget plan of municipal wastewater project (72 Areas) by P70

Unit : Million bath

Project Area	Activities	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1 Muang Nakhon Prathon Municipality	Construction	12	50	140	50						
2 Muang Pattaya	Construction	34	150	300	451	483	360	174			
3 Muang San Suk Municipality	Feasibility Study										
	Detail Design										
	Construction	3.1	56.3	175	215	241	125				
4 Muang Phuket Municipality	Feasibility Study										
	Detail Design		10	9							
	Construction			70	160	160					
5 Muang Chiang Mai Municipality	Feasibility Study										
	Detail Design		15	5	5						
	Construction			100	200	200	150				
6 Muang Nonthaburi and Municipality and Pak Kret Sanitary District	Feasibility Study		18								
	Detail Design			15	15						
	Construction				200	200	200	272	272		
Subtotal budget for Project 1-6		5,295.70	19.1	299.3	811	1296	1284	835	446	272	0

The development and budget plan of municipal wastewater project (72 Areas) by PND (Cont'd)

Unit : Million bath

Project Area	Activities	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
7 Muang Pathwa Thani Municipality	Feasibility Study		6								
	Detail Design			10							
	Construction				80	80	80				
8 Muang Sawut Sakhon Municipality	Feasibility Study		10								
	Detail Design			15							
	Construction				100	100	100				
9 Muang Ayuttaya Municipality	Feasibility Study		8								
	Detail Design			12							
	Construction				100	100	110				
10 Tambol Hua Hin Municipality	Feasibility Study		7.5								
	Detail Design			10							
	Construction				96	96	96				
11 Tambol Cha An Municipality	Feasibility Study		7.5								
	Detail Design			10							
	Construction				96	96	96				
12 Muang Saton Nakhon	Feasibility Study										
	Detail Design			2	8						
	Construction			32	74	60					
Subtotal budget for Project 7-12		1,698.00	0	73	139	532	472	482	0	0	0

The development and budget plan of municipal wastewater project (72 Areas) by PFD (Cont'd)

Unit : Million bath

Project Area	Activities	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
13 Sabui Island	Feasibility Study		7.5								
	Detail Design			11.5							
	Construction				84	84	84	84			
14 Western Phuket Island coast	Feasibility Study		10.5								
	Detail Design			6	9						
	Construction				84	84	84	84			
15 Ban Pae Sanitary District	Feasibility Study		7.5								
	Detail Design			10							
	Construction				72	120	120				
16 Muang Kanchanaburi Municipality	Feasibility Study		8								
	Detail Design			12							
	Construction				84	120	156				
17 Muang Surat Thani Municipality	Feasibility Study		2	7							
	Detail Design				15						
	Construction					91	91	91			
18 Muang Phitsanulok Municipality	Feasibility Study		2	6.6							
	Detail Design				15						
	Construction					91	91	91			
Subtotal budget for Project 13-18		2,019.60	0	37.5	53.1	363	590	626	350	0	0

The development and budget plan of municipal wastewater project (72 Areas) by PWD (Cont'd)

Unit : Million bath

Project Area	Activities	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	
19 Muang Ratchaburi	Feasibility Study		2	6								
	Detail Design				15							
	Construction					91	91	91				
20 Muang Rayong Municipality	Feasibility Study											
	Detail Design			5	13.3							
	Construction					96	96	96				
21 Eastern Saut Prakharn Province (Muang Municipality around Sanitary district)	Feasibility Study		20									
	Detail Design			15	15							
	Construction				200	200	200	200	200			
22 Western Saut Prakharn (Province Muang Municipality and Pra Padang Sanitary District)	Feasibility Study			15								
	Detail Design											
	Construction				20	120	120	120	120	120		
23 Muang Suphanburi Municipality	Feasibility Study		2	6								
	Detail Design				15							
	Construction					104	104	104				
24 Muang Trang Municipality	Feasibility Study											
	Detail Design			5	10.5							
	Construction					96	96	96				
Subtotal budget for Project 19-24		3,125.80	0	34	65.8	457	707	707	615	420	120	0

The development and budget plan of municipal wastewater project (72 Areas) by PWD (Cont'ed)

Unit : Million bath

Project Area	Activities	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
25 Muang Buri Ruim Municipality	Feasibility Study		2	3.4							
	Detail Design				15						
	Construction					78	78	78			
26 Muang chainat Municipality	Feasibility Study		6								
	Detail Design			8							
	Construction				75	90					
27 Muang Angthong Municipality	Feasibility Study		5								
	Detail Design		7								
	Construction			30	90	60					
28 Tambol Pa Noz Municipality	Feasibility Study			6							
	Detail Design				8						
	Construction					75	75				
29 Muang Had Yai Municipality	Feasibility Study										
	Detail Design			10	10						
	Construction				120	240	240	240			
30 Muang Chonburi Municipality	Feasibility Study										
	Detail Design			5.4	8.8						
	Construction					120	120	180			
Subtotal budget for Project 25-30		2,085	0	20	64.8	326.8	663	513	498	0	0

The development and budget plan of municipal wastewater project (72 Areas) by PWD (Cont'd)

Unit : Million Bath

Project Area	Activities	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
31 Tambol Sri Racha Municipality	Feasibility Study										
	Detail Design										
	Construction			50	130	90	55				
32 Muang Ubon Ratcha Thani Municipality	Feasibility Study										
	Detail Design										
	Construction			40	135	144	121				
33 Muang Song Khla Municipality	Feasibility Study										
	Detail Design			6.5	11						
	Construction					112	112	112			
34 Muang Chanthaburi Municipality	Feasibility Study										
	Detail Design										
	Construction			40	130	90	100				
35 Muang Singburi Municipality	Feasibility Study			6							
	Detail Design				8						
	Construction					75	75				
36 Muang Chiang Rai Municipality	Feasibility Study										
	Detail Design			6.5	13.2						
	Construction					96	96	96			
Subtotal budget for Project 31-36		1,950.20	0	0	149	427.2	607	559	208	0	0

The development and budget plan of municipal wastewater project (72 Areas) by PSD (Cont'd)

Unit : Million bath

Project Area	Activities	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
37 Muang Chechoengsao Municipality	Feasibility Study			3.3	3.5						
	Detail Design					1.5					
	Construction						96	96	96		
38 Muang Saraburi Municipality	Feasibility Study										
	Detail Design			6.5	9.9						
	Construction					104	104	104			
39 Muang Pa Yao Municipality	Feasibility Study										
	Detail Design			6.5	11						
	Construction					78	78	78			
40 Muang Bang Bua Thong Municipality	Feasibility Study										
	Detail Design			6.5	9.8						
	Construction					130	130	130			
41 Muang Chumpon Municipality	Feasibility Study			5.5	7.7						
	Detail Design				15						
	Construction					104	104	104			
42 Muang Lampon Municipality	Feasibility Study			3.3	5.5						
	Detail Design				12						
	Construction					78	104	104			
Subtotal budget for Project 37-42		1,929.50	0	0	31.6	74.4	495.5	616	616	96	0

The development and budget plan of municipal wastewater project (12 Areas) by PTO (Cont'd)

Unit : Million bath

Project Area	Activities	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	
43 Muang Pattani Municipality	Feasibility Study											
	Detail Design			6.5	11							
	Construction					104	104	104				
44 Muang Udon Thani Municipality	Feasibility Study											
	Detail Design				3	9						
	Construction					104	104	104				
45 Muang Nakhon Sawan Municipality	Feasibility Study											
	Detail Design				15							
	Construction					100	100	100	70			
46 Muang Kalasin Municipality	Feasibility Study				2	6						
	Detail Design						15					
	Construction							90	90	90		
47 Muang Krabi Municipality	Feasibility Study											
	Detail Design			4		11						
	Construction					65	65	65				
48 Muang Phangnga Municipality	Feasibility Study				2	6						
	Detail Design						15					
	Construction							45	113	113		
Subtotal budget for Project 43-48		1,835.50	0	0	10.5	33	405	403	508	273	203	0

The development and budget plan of municipal wastewater project (72 Areas) by PTO (Cont'd)

Unit : Million bath

Project Area	Activities	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	
49 Muang Lamphang Municipality	Feasibility Study				2	6.5						
	Detail Design						15					
	Construction							120	120	120		
50 Tambol Varin Chamrab Municipality	Feasibility Study				2	6						
	Detail Design						15					
	Construction							90	90	90		
51 Muang Phetchaburi Municipality	Feasibility Study				2	6.5						
	Detail Design						15					
	Construction							120	120	120		
52 Muang Maha Sarakhan Municipality	Feasibility Study				2	6						
	Detail Design						15					
	Construction							105	105	105		
53 Muang Prachuap Khiri Khan Municipality	Feasibility Study											
	Detail Design											
	Construction				72	96	96					
54 Muang Makbon Si Thammarat Municipality	Feasibility Study				2	6						
	Detail Design						15					
	Construction							105	105	150		
Subtotal budget for Project 49-54		2,045.00	0	0	0	82	127	171	540	540	585	0

The development and budget plan of municipal wastewater project (72 Areas) by PWD (Cont'd)

Unit : Million bath

Project Area	Activities	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	
55 Muang Surin Municipality	Feasibility Study				2	6						
	Detail Design						15					
	Construction							120	120	120		
56 Muang Sena Municipality	Feasibility Study											
	Detail Design				8							
	Construction					91	91	91				
57 Taabol Rang Sit Municipality	Feasibility Study											
	Detail Design				25							
	Construction					130	195	195	195			
58 Muang Samut Songkhro Municipality	Feasibility Study				7							
	Detail Design					2						
	Construction						112	112	112			
59 Muang Prachin Buri Municipality	Feasibility Study					8						
	Detail Design						10					
	Construction							90	90	90		
60 Muang Nakhon Nayok Municipality	Feasibility Study					8						
	Detail Design						10					
	Construction							90	90	90		
Subtotal budget for Project 55-60		2,332.00	0	0	0	42	252	433	698	607	300	0

The development and budget plan of municipal wastewater project (72 Areas) by FWD (Cont'd)

Unit : Million bath

Project Area	Activities	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	
61 Muang Sukho Thai Municipality	Feasibility Study					18						
	Detail Design						24					
	Construction							150	150	188	188	
62 Muang Yala Municipality	Feasibility Study					10						
	Detail Design						15					
	Construction							105	105	105	105	
63 Muang Lopburi Municipality	Feasibility Study					9						
	Detail Design						12					
	Construction							112.5	112.5	112.5		
64 Muang Loei Municipality	Feasibility Study					9						
	Detail Design						12					
	Construction							113	113	113		
65 Muang Uttaradit Municipality	Feasibility Study					9						
	Detail Design						12					
	Construction							113	113	113		
66 Muang Yasothon Municipality	Feasibility Study						9					
	Detail Design							12				
	Construction								96	128	128	
Subtotal budget for Project 61-66		2,610.50	0	0	0	0	55	84	604.5	688.5	758	420.5

The development and budget plan of municipal wastewater project (72 Areas) by PRO (Cont'd)

Unit : Million bath

Project Area	Activities	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
67 :Wuang Tak :Municipality	:Feasibility Study:						9				
	:Detail Design							12			
	:Construction								96	128	128
68 :Wuang Kauphaeng Phet :Municipality	:Feasibility Study:						9				
	:Detail Design							12			
	:Construction								96	128	128
69 :Wuang Phetchabun :Municipality	:Feasibility Study:						9				
	:Detail Design							12			
	:Construction								96	128	128
70 :Wuang Roi Et :Municipality	:Feasibility Study:						9				
	:Detail Design							12			
	:Construction								96	128	128
71 :Wuang Narathivat :Municipality	:Feasibility Study:						9				
	:Detail Design							12			
	:Construction								96	128	128
72 :Wuang Nan :Municipality	:Feasibility Study:						10				
	:Detail Design							15			
	:Construction								160	160	160
Subtotal budget for Project 67-72 :		2,370.00	0	0	0	0	55	75	640	800	800

1.2.1 Yanawa Sewage Works Project

Service Area	:	28.5 km ² covers Yanawa district, Sathorn district, Bangrak district and Bangkorlaam district.
Population served	:	480,000 persons
Treatment capacity	:	2000,000 m ³ /day
Contract type	:	Turn key
Implementing period	:	4 years (1994-1997)
Treatment plant location	:	Pak Klong Chong Non-Che
Treatment plant area	:	32,000 m ²
Budget	:	4,712 million baht
Financing	:	75% BMA 25% Governmental Subsidy
Budgetary plan	:	See Table 3-2

1.2.2 Central Treatment Stage 1

Service area	:	37 km ² covers the districts of Pom Prab, Sampanthawong, Patunwan, Ratchathewee and a part of the district of Phra Nakorn, Dusit, Phrayatal, and Huay Khwang
Population served	:	485,000 persons
Treatment capacity	:	350,000 m ³ /day (180,000 m ³ /day at Lumpini plant and 170,000 m ³ /day at 2 nd BMA office)
Contract type	:	Turn key
Implementing period	:	5 years (1993-1997)
Treatment plant Location	:	1 At Lumpini Park with the area of 64,000 m ² 2 At 2 nd BMA office with the area of 22,400 m ²

Budget : 7,700 million baht
 Financing : 75% BMA
 25% Governmental Subsidy
 Budgetary Plan : See Table 3-3

1.2.3 Nong Khaem - Pasichareon - Ratburana Project

Service area : 86 km² covers the district of
 Nong Khaem, Pasichareon and Ratburana
 Population served : 697,000 persons
 Treatment capacity : 222,000 m³/day
 Contract type : Turn key
 Implementing period : 6 years (1995-2000)
 Budget : 7,094 million baht
 Financing : 75% BMA
 25% Governmental Subsidy
 Budgetary plan : See Table 3-4

Table 3-2

Budgetary Plan of Yanawa Sewage Works Project

Unit : Million bath

Fiscal Year	1994	1995	1996	1997	Total
Source of Budget					
Governmental Subsidy	90	1,296	818	1,321	3,534
BMA	33	432	273	440	1,178
Total	132	1,728	1,091	1,761	4,712

Table 3-3

Budgetary Plan of Central Treatment Stage I

Unit : Million bath

Fiscal Year Source of Budget	1993	1994	1995	1996	1997	Tabal
Governmental Subsidy	1,392.3	1,392.3	1,617.3	810.6	562.5	5,775.0
BMA	464.1	464.1	539.1	270.2	187.5	1,925.0
Total	1,856.4	1,856.4	2,156.4	1,080.8	750.0	7,700.0

Table 3-4

Budgetary Plan of Nong Khaem - Pasichareon- Ratburana Project

Unit : Million bath

Fiscal Year Source of Budget	1995	1996	1997	1998	1999	2000	Tabal
Governmental Subsidy	15	250	1,487	1,487	1,487	596	5,321
BMA	5	84	495	495	495	198	1,773
Total	20	334	1,982	1,982	1,982	794	7,094

SECTORAL SURVEY#4 : TRAINING AND RESEARCH INSTITUTIONS CONCERNING SEWERAGE
TREATMENT AND RELATED FIELDS

Several organizations provide sewerage treatment training and seminar. However, most researches in sewerage treatment are conducted by University's graduate school projects. Some governmental agencies receive technical supports from other countries (ie. Japan, Germany) to do mini research projects. The names of organizations which involve in training or researching are listed below.

1. Training and research institutions concerning sewerage treatment and related fields.

1.1 Governmental offices

- 1) The Department of Public Works, Ministry of Interior
- 2) The Department of Industrial Works, Ministry of Industry
- 3) The Department of Health, Ministry of Public Health
- 4) The Department of Pollution Control, Ministry Science, Technology and Environment
- 5) The Department of Drainage and Sewerage, Bangkok Metropolitan Administrative.

1.2 Universities

- 1) Environmental Engineering Department, Kasesart University
- 2) Environmental Engineering Department, Khon Kaen University
- 3) Environmental Engineering Department, Chiang Mai University
- 4) Environmental Engineering Department, Chulalongkorn University
- 5) Environmental Engineering Department, King Mongkut's Institute of Technology

- 6) Environmental Engineering Department, Asian Institute of Technology
- 7) Public Health Department, Prince of Songkhla University
- 8) Public Health Department, Mahidol University

1.3 Engineering Institutes

1. The Engineering Institute of Thailand
2. The Environmental Engineers Association of Thailand
3. The Thai Environment Institute
4. Chula Environmental Research Institute
5. Chula Unisearch, Chulalongkorn University
6. Princess Chulaporn Environmental Research Institute

1.4 Consultants

1. Thamco International Services
2. Pal Consultants
3. Progress Technology Consultants
4. Macro Consultants
5. Water and Environmental Consultants
6. Pro En Consultants
7. San E 68 Consulting Engineers
8. SIS Engineering Consultants

2. Examples of Training or Seminar programs provided by governmental agencies, Universities and engineering institutes are shown here.

Environmental Promotion Department

Course : Wastewater treatment technology

Curriculum:

1. Present situation and problems of water pollution
2. Laws relevant to water pollution control
3. Wastewater treatment processes in Thailand and uses of treated wastewater
4. Municipal wastewater treatment plants (operation and maintenance)
5. Industrial wastewater treatment plants (operation and maintenance)
6. Agricultural wastewater treatment plants (operation and maintenance)
7. Equipments, collection, preservation, and analysis of wastewater.
8. Case study of wastewater treatment plant in Japan
9. Field trip

Duration : 5 days

Cost : 1,200 baht/person

Technical Training Institute

Course : Sanitary and environment works for engineer

Curriculum :

1. Basic knowledge in sanitary system
2. Water treatment
3. Basis science of water and wastewater
4. Air and noise pollution
5. Hydrology
6. Hydraulics
7. City and town drainage system
8. Building's sanitary system
9. Solid waste management
10. Municipal wastewater treatment
11. Cost estimation
12. Buddhist philosophy and Meditation

Duration : 19 days

Cost : 4,375 baht/person

Appendix 1

Notification of Ministry of Industry No. 12 (B.E. 2525)

Effluent Standards in Effect From 13, 1982

Industrial Works Department

(1) pH	Between 5.0 and 9.0
(2) Permanganate Value	60 mg/l
(3) Dissolved solids :	
3.1 Discharge into watercourses :	2,000 mg/l or more but not exceeding 5,000 mg/l, depending upon discharging point
3.2 Discharge into sea or estuaries (Salinity higher than 2,000 mg/l)	5,000 mg/l higher than dissolved solids content in sea or estuary waters.
(4) Sulfide as H ₂ S	1.0 mg/l
(5) Cyanide as HCN	0.2 mg/l
(6) Heavy metals :	
6.1 Zinc	5.0 mg/l
6.2 Chromium	0.5 mg/l
6.3 Arsenic	0.25 mg/l
6.4 Copper	1.0 mg/l
6.5 Mercury	0.005 "
6.6 Cadmium	0.03 "
6.7 Barium	1.0 "
6.8 Selenium	0.02 "
6.9 Lead	0.2 "
6.10 Nickel	0.2 "
6.11 Manganese	5.0 "
(7) Tar	Nil
(8) Oil & Grease	5.0 mg/l (Except for crude oil refinery and lubricant blending plant; less than 15 mg/l)
(9) Formaldehyde	1.0 mg/l
(10) Phenols & Cresols	1.0 "
(11) Free chlorine	1.0 "
(12) Insecticides and radioactive substances	Nil
(13) Suspended solids	30 mg/l or more depending on dilution ratio as shown below

<u>Dilution Ratio</u>	<u>Allowable Suspended solids</u>
8 - 150	30 mg/l
151 - 300	60 "
301 - 500	150 "
(14) BOD, 5 days, 20°C	20 mg/l or more but not exceeding 60 mg/l depending upon discharging point, except for industries as shown below
14.1 Fish canning (category 7 (1))	200 mg/l Until 31 Dec. 1982 100 " As of 1 Jan. 1983
14.2 Tapioca starch : New process (category 9(3))	100 mg/l Until 31 Dec. 1982; thereafter as in (14)
	Old process 200 mg/l Until 31 Dec. 1982 100 " As of 1 Jan. 1983
14.3 Noodle factory, using less than 500 kg. of rice per day (category 10(3))	150 " Until 31 Dec. 1982 100 " As of 1 Jan. 1983
14.4 Tanneries (category 29)	200 " Until 31 Dec. 1982 100 " As of 1 Jan. 1983
14.5 Pulp mills (category 33(1))	150 " Until 31 Dec. 1982 100 " As of 1 Jan. 1983
14.6 Seafood processing (category 92)	200 " Until 31 Dec. 1982 100 " As of 1 Jan. 1983
(15) Temperature	Less than 40°C
(16) Color and Odor	Not objectionable when mixed in receiving water

Tel. 2459907
12 June 1982

Office of Industrial Services and
Waste Treatment
Industrial Works Department

Appendix 2

Notification of Ministry of Industry No. 13 (D.E. 2525)
issued in accordance with the Factory Act D.E. 2512

Subject: Duty of Licensees to operate industrial plants

GOVERNMENT GAZETTE Volume 99 Part 89 dated June 29, 1982: — By virtue of Section 39 (16) of the Factory Act D.E. 2512, the Minister of Industry hereby announces the principles and procedures to be followed by the licensees to operate industrial plants:

1. The following industrial plants must have the supervisors and machine operators to take responsibility of the system of prevention of pollution, whose qualifications are specified in 2.
 - 1.1 An industrial plant discharging waste water at higher than 125 cubic meters/hour (with the exception of cooled water), or having the BOD load of influent at higher than 200 kilogram/day.
 - 1.2 An industrial plant using heavy metals in the production process discharging waste water at higher than 50 cubic meters/day, and having the content of heavy metals in the discharged waste water at the following values:
 - 1.2.1 Zinc at higher than 250,000 milligrams/day
 - 1.2.2 Chromium at higher than 25,000 milligrams/day
 - 1.2.3 Arsenic at higher than 12,500 milligrams/day
 - 1.2.4 Copper at higher than 50,000 milligrams/day
 - 1.2.5 Mercury at higher than 250 milligrams/day
 - 1.2.6 Cadmium at higher than 1,500 milligrams/day
 - 1.2.7 Barium at higher than 50,000 milligrams/day
 - 1.2.8 Selenium at higher than 1,000 milligrams/day
 - 1.2.9 Lead at higher than 10,000 milligrams/day
 - 1.2.10 Nickel at higher than 10,000 milligrams/day
 - 1.2.11 Manganese at higher than 250,000 milligrams/day
 - 1.3 An industrial plant dealing with iron and steel:
 - 1.3.1 Using drying furnace or acids or other substances which may be polluting the environment in the production process, with production capacity of higher than 100 tons/day;

- 1.3.2 Using steel smelters with the total capacity of 5 tons/batch.
- 1.4 An industrial plant producing petrochemicals from the raw materials obtained as by-products of the oil refinery in the production process at higher than 100 tons/day.
- 1.5 An industrial plant of any size separating or processing the natural gas.
- 1.6 An industrial plant producing chlor-alkali, using sodium chloride (NaCl) as raw material in the production of soda ash (Na_2CO_3), caustic soda (NaOH), hydrochloric acid (HCl), chlorine (Cl_2) and bleaching (NaOCl) each or several combined at higher than 100 tons/day.
- 1.7 An industrial plant of any size producing cement.
- 1.8 An industrial plant engaged in ore smelting or production of metals at higher than 50 tons/day.
- 1.9 An industrial plant producing paper pulp at higher than 50 tons/day.
- 1.10 An industrial plant of any size engaged in crude oil refinery.
2. The supervisors, machine operators responsible for the system of prevention of pollution, shall meet the following qualifications:
 - 2.1 The supervisors are holders of bachelor degree in engineering, or science in chemistry or technical chemistry, or other branches of study with experiences in the field of environment, who are approved by the Industrial Works Department. For an engineering consultant firm, it must have the service of qualified persons as indicated earlier.
 - 2.2 The machine operators must be graduates of the secondary education, lower level, with the certification from the persons as mentioned in 2.1.
 - 2.3 The persons stated in 2.1 and 2.2 must register themselves with the Industrial Works Department, and complying with the regulations and procedures as prescribed by the Industrial Work Department.

3. This notification shall be in force on the expiration of ninety days from date of its publication in the Government Gazette.

Given on the 4th day of June B.E. 2525 (1982)

Signed: Major-General Chatichai Choonhavan,
Minister of Industry.

Appendix 3

Notification of Ministry of Industry No. 15 (B.E. 2527)

issue in accordance with the Factory Act B.E. 2512

Subject : Duty of Licensees to operate industrial plants

By virtue of Section 39(16) of the Factory Act B.E. 2512, the Minister of Industry hereby announces the principles and procedures to be followed by the licensees to operate industrial plants

1. The licensees to operate the following industrial plants must take response to do as specified in 2.
 - 1.1 An industrial plant producing pulp at higher than 50 tons/day
 - 1.2 An industrial plant producing chemical except fertilizer as follows :
 - 1.2.1 Chlor-alkali plant, using Sodium Chloride (NaCl) as raw material for the production of Soda Ash (Na_2CO_3), Caustic Soda (NaOH), Hydrochloric Acid (HCl), Chlorine (Cl_2), Sodium Hydrochlorite (NaOCl) and Bleaching Powder each or several combined at higher than 100 tons/day.
 - 1.2.2 An industrial plant producing petrochemicals from the raw materials obtained as by products of the Oil Refinery in the production process at higher than 100 tons/day.
 - 1.3 An industrial plant of any size engaged in crude oil refinery.
 - 1.4 An industrial plant of any size producing cement.
 - 1.5 An industrial plant producing iron and steel, using iron ores or scrap iron as raw material with production capacity higher than 100 tons/day or using melting furnace with the total capacity of 5 tons/batch.
 - 1.6 An industrial plant engaged in iron smelting or production of metals at higher than 50 tons/day.

2. Environmental Impact Assessment (EIA) report must be submitted when asking for extension the operation license every 3 years and the report should have detail as described in 3.
3. EIA report must consists of the following items:
 - 3.1 Project description and site selection
 - 3.2 Existing condition of physical and ecological resources such as air, water, land, transportation system, terrestrial, aquatic, raw material resource etc.
 - 3.3 Environmental impact assessment of the project on existing resources.
 - 3.4 Mitigation for protecting and/or enhancing environmental resources.
 - 3.5 Waste recycling scheme
 - 3.6 Environment monitoring program in the area where expected to impact by the project.

Given on the 27th day of January B.E.2527(1984)

Signed : Ob Hasuratana

Ministry of Industry

Appendix 4

Notification of The Ministry of Industry

No. 22 (B.E. 2528)

Issue in accordance with the Factory Act B.E. 2512
Subject: Duties of a Licensee for Operating a Factory

By virtue of Section 39(16) of the Factory Act B.E. 2512, the Ministry of Industry hereby announces the principles and procedures to be complied by a licensee for operating a factory as follows:

1. Item 1.1 of the Notification of Ministry of Industry No.13 (B.E.2525) dated 4th June B.E.2525 shall be repealed and apply the following causes in place.

"1.1 The factory which generates wastewater at or greater than 60 m³/hr. (except cooling water) or B.O.D. loading of influent at or greater than 100 kgs/day."

2. Item 2.1 of the Notification of Ministry of Industry No.13 (B.E.2525) dated 4th June B.E.2525 shall be repealed and apply the following causes in place.

"2.1 The supervisor must be a university graduate in Engineering or in Science with environmental working experience approved by the Industrial Works Department.

In case of an engineering consultant firm, it must have qualified personnel as above mentioned."

3. Apply the following causes as item 4 of the Notification of Ministry of Industry No.13 (B.E.2525) dated 4th June B.E.2525

"4. The factory as mentioned in item 1.1 to 1.10 must submit an analytical report to the Industrial Works Department every 3 months according to the specified forms and procedures. The pollutant analysis must be carried out by an official laboratory, or a private laboratory certified by the Industrial Works Department, according to the principles and procedures specified by the Industrial Works Department."

This Notification comes into effect after the expiration of ninety days following the date of its publication in the Government Gazette.

Given on the 31st of May B.E.2528
Signed by Mr. Ob Vasurat
Minister of Industry

(Unofficial Translation)

NOTIFICATION OF THE MINISTRY OF INDUSTRY

No. 25 (B.E. 2531 (1988))

Issued under the Factory Act B.E. 2512 (1969)

Re: Duties of Factory Operation Licencees

By virtue of Section 39 (6) and (16) of the Factory Act B.E. 2512 (1969), the Minister of Industry hereby lays down regulations and procedures on the duties of factory operation licencees as follows:

The provisions of No. 20 of the Notification of the Ministry of Industry No. 2 (B.E. 2513 (1970)) dated 24th July 1970 shall be repealed and the following shall be substituted in lieu thereof:

"No. 20. Factory operation licencee shall comply with the following:

(1) There shall be provided a separate receptacle with proper lid as suitable for collecting refuse or waste matters containing poisonous articles or cotton wood, cloths, or yarn waste contaminated with inflammables, and such refuse shall be eliminated specially by a safe method without creating any nuisance.

(2) The factory operation licencee whose factory having refuse or waste matters of the description and properties as stated in any Chapter of the Schedule annexed hereto shall proceed with the elimination of refuse or waste matters as follows:

2.1 No refuse or waste matters shall be taken outside the factory compound, except where a permission is obtained from the Department of Industrial Works to take out such for destruction, elimination, throwing or burial by the method and at the place prescribed by the Department.

2.2 Shall report the particulars concerning type, quantity, description, properties and place of storage of refuse or waste matters and, also the methods for storage, destruction, elimination, throwing, burial, removal and transportation thereof according to the bases and guidelines for compliance and the procedures prescribed by the Department of Industrial Works."

This is effective on and from the day following the date of its publication in the Government Gazette.

Notified this 3rd day of August 1988

PRAMUAN SAPAVASU

Minister of Industry

(Ref. : Government Gazette, Volume 105, Part 153, of 20th September 1988)

Appendix 6

Characteristics and Properties of Waste Materials
Attached to the End of Notification of the Ministry of Industry

Section 1. Characteristics and Properties of Waste Materials

Type	Properties	Method of Testing or Analysis
1.1 Ignitable substance	1.1.1 It is a liquid and has flash point less than 60°C excluding an aqueous solution contains alcohol of less than 24% by volume.	-determined by Pensky-Martens Closed Cup Tester using the test method specified in ASTM D-93-79 or D-93-80 or -determined by Setaflash Closed Cup Tester, using the test method specified in ASTM Standard D-3278-78
	1.1.2 It is not a liquid and is capable of, under standard temperature and pressure, causing fire through friction, absorption of moisture or spontaneous chemical changes and, when ignited, burns so vigorously and persistently that it creates a danger.	
	1.1.3 It is an ignitable compressed gas of any mixture in a container of absolute pressure, of 2.81 kg/cm ² (40 lb/inch ²) at 21°C (70°F) or greater than 7.31 kg/cm ² (104 lb/inch ²) at the temperature higher than 55°C (130°F)	-using the test method specified in ASTM Standard D-323
	1.1.4 It is an oxidizer of any compounds of chlorate, permanganate, inorganic peroxide and nitrate, and rapidly generates oxygen that activates combustion of organic substance.	
1.2 Corrosive substance	1.2.1 It is an aqueous and has pH less than or equal to 2, or equal to or greater than 12.5	-determined by pH meter, using a US EPA test method

1.2.2 It is a liquid and can corrode steel grade SAE 1020 at a rate greater than 6.35 mm (0.250 inch) per year at a test temperature of 55°C (130°F)

-determined by the test method specified in NACE (National Association of Corrosion Engineers) Standard TM 01-69

1.3 Reactive substance

1.3.1 It is unstable and readily undergoes violent changes without detonation

1.3.2 It reacts violently with water

1.3.3 It forms explosive mixtures with water

1.3.4 When mixed with water, it generates toxic gases, vapours or fumes in a sufficient quantity that may be harmful to human health and environment.

1.3.5 It is a cyanide or sulfide compound which, when exposed to pH condition between 2 and 12.5, can generate toxic gases, vapours or fumes in a sufficient quantity that may be harmful to human health and environment.

1.3.6 It is capable of detonation if heated under confinement or readily capable of explosive decomposition at standard temperature and pressure.

1.4 Other toxic substance

It is a solid waste which, using a standard test method, the extract from a representative sample of the waste contains any of the contaminants at a concentration as follows:-

arsenic more than 5 mg/l
cadmium more than 1 mg/l
chromium more than 5 mg/l
lead more than 5 mg/l
mercury more than 0.2 mg/l

Extraction procedure and leaching test must be complied to a standard method specified in the Notification of the Industrial Works Department

Section 2. Off-Specification or Spent Solvents

ITEM NO.	SOLVENTS	CHEMICAL FORMULA
2.1	CHLOROMETHANE OR METHYL CHLORIDE	CH_3Cl
2.2	MONOCHLOROBENZENE OR CHLOROBENZENE	$\text{C}_6\text{H}_5\text{Cl}$
2.3	DICHLOROMETHANE OR METHYLENE CHLORIDE	CH_2Cl_2
2.4	1,2-DICHLOROETHYLENE OR ACETYLENE DICHLORIDE	ClCHCHCl
2.5	TRICHLOROMETHANE OR CHLOROFORM	CHCl_3
2.6	1,1,1-TRICHLOROETHANE OR METHYL CHLOROFORM	CH_3CCl_3
2.7	1,2-TRICHLOROETHANE OR VINYL TRICHLORIDE	$\text{Cl}_2\text{CHCH}_2\text{Cl}$
2.8	1,1,2-TRICHLOROETHYLENE	ClCHCCl_2
2.9	1,1,2,2-TETRACHLOROETHYLENE OR PERCHLOROETHYLENE	Cl_2CCCl_2
2.10	1,1,2,2-TETRACHLOROETHANE OR ACETYLENE TETRACHLORIDE	$\text{Cl}_2\text{CHCHCl}_2$
2.11	ETHYL CHLORIDE	$\text{C}_2\text{H}_5\text{Cl}$
2.12	2-BUTENAL OR CROTONALDEHYDE	$\text{CH}_3\text{CHCHCHO}$
2.13	CARBON DISULFIDE	CS_2
2.14	1-CHLORO-2, -3-EPOXYPROPANE OR EPICHLOROHYDRIN	$\text{CH}_2\text{OCHCH}_2\text{Cl}$
2.15	3,5-DIMETHYLPHENOL OR XYLENOL	$(\text{CH}_3)_2\text{C}_6\text{H}_3\text{OH}$
2.16	HYDROXY BENZENE OR PHENOL	$\text{C}_6\text{H}_5\text{OH}$
2.17	NITROBENZENE OR NITROBENZOL	$\text{C}_6\text{H}_5\text{NO}_2$
2.18	1,1-OXYBIS (2-CHLOROETHANE) OR DICHLOROETHYL ETHER	$\text{O}(\text{CH}_2\text{CH}_2\text{Cl})_2$
2.19	PENTACHLOROETHANE OR PENTALIN	$\text{CHCl}_2\text{CCl}_3$
2.20	METHYL ALCOHOL OR METHANOL	CH_3OH

Section 3. Waste Materials from Specific Industries

No.	Waste material	Categories of Industries As at the end of the Notification of MOI No.1(B.E.2512) & No.7(B.E. 2520) issued in accordance with the Factory Act B.E. 2512
3.1	Brine muds Wastewater treatment sludge	Caustic soda manufacturing according to the category no.42 and no.13(2), using mercury process.
3.2	Discarded or unused toxic substance specified in the Toxic Substance Act B.E.2510	Pesticide manufacturing or packing according to the category no.43
3.3	Wastewater treatment sludge	Paint manufacturing according to the category no.45(1)
3.4	Emission control dust Wastewater treatment sludge	Scrap lead smelting according to the category no.60 and battery manufacturing according to the category no.74(1)
3.5	Off-specification electronic spare parts	Electronic spare parts manufacturing according to the category no.32
3.6	Wastewater treatment sludge Spent solution from cyanide nickel, copper, chromium and zinc plating bath Residue from the bottom of cyanide, nickel, copper, chromium and zinc plating bath	All types of electroplating
3.7	Wastewater treatment sludge	Explosive manufacturing, repair and or modifying according to the category no.99
3.8	Exhaust tubes, off-specification fluorescent tube contaminated with mercury	Fluorescent tube manufacturing according to the category no.74(1)
3.9	Wastewater treatment sludge Emission control dust from manganese pulverizing room.	Dry cell manufacturing according to the category no.74(5)
3.10	Paint residues form paint spraying room	Automobile or trailer assembling according to the category no.77(1) & (2), motorbike, bicycle or tricycle manufacturing according to the category no.78(1) and (2)

- 2.1.4 Sludge or waste materials contaminated with insecticide, pesticide, herbicide, or fungicide Add alkaline solution such as lime, sodium hydroxide (NaOH) to sludge in sufficient quantity for complete detoxification of all contaminants.
-

2.2 The solidified waste must have the following properties:-

- 2.2.1 leaching rate less than 1×10^{-6} cm/sec.
- 2.2.2 compressive strength not less than 14 kg/cm²
- 2.2.3 density not less than 1.04 ton/m³
- 2.2.4 tenacious characteristic, uninflamable and odourless.

2.3 If a licensee for operating a factory in item 1 wants to detoxify or solidify waste materials with other methods than the above mentions, must propose the details with reasons to the Industrial Works Department for approval, case by case.

3. A licensee for operating a factory whose factory located either in Bangkok, Samutprakarn, Patumthani, Nonthaburi, Nakornprathom, Rajburi or Samutsakorn must discharge waste materials in the place and with the methods as follows:

3.1 Location of landfill site

3.1.1 Must be the appropriate geological conditions without mineral deposit, no fractures or hollows in the bedrock and have suitable soil thickness between the landfill base and groundwater, and level of groundwater must be low.

3.1.2 Must not be flood plain, no flood problems and must not be near rivers, canals or natural water resources.

3.1.3 Distant from public, to avoid falling and spilling of waste, traffic problems in transportation and dust and noise pollution in operation.

3.1.4 Must have sufficient capacity for at least 5 year landfilling.

3.2 The design of the landfill site

The landfill site must be prepared as follows:-

3.2.1 Line the floor and side walls of a landfill with impermeable material to prevent leachate of waste from contaminating ground and surface water near by. The liner must strong and thick enough to resist weight and the whole pressure.

It must be the special synthetic material for this purpose. Or a natural barrier such as clay which water permeability must not exceed 1×10^{-7} cm/sec. (0.1 feet/year) or being both materials together.

3.2.2 The floor of a landfill must be above the groundwater level at least 5 feet.

3.2.3 Must have leachate collecting system inside a landfill and a leachate treatment system at landfill site or collect it to treat at other place.

3.2.4 When any cell is closed, finally cover it with impermeable material to prevent cells from percolation of water or other liquid. Recover it with soil and ground cover in order to curtail wind and water erosion and must have a proper drainage system for water and rainfall runoff from the site.

3.2.5 If use clay liner, it must be at least 60 cm thick, and compacted at 30 cm and 60 cm thick. If use other materials as liner or use special process, must be approved by the Industrial Works Department, case by case.

3.2.6 The cover liner must be the same impermeable material and thickness as the floor liner. The soil layer for ground cover must be at least 150 cm thick. Between cover liner and soil layer must be sand layer to provide additional draining system for surface runoff.

3.2.7 Ground cover must be short root plants or having evidence that roots are not longer than 150 cm

3.2.8 Must have a series of observation wells with sizes and numbers approved by the Industrial Works Department to test the characteristics of the near by groundwater and to monitor the landfill condition during operation. The characteristics of groundwater must not exceed the following standard:

Pollutants	Accepted quantity mg/l
arsenic	0.05
cadmium	0.01
chromium	0.05
lead	0.05
mercury	0.001
nickel	0.05
manganese	0.3
copper	1.0
zinc	5.0

3.3 Landfill Operation Process

3.3.1 Record keeping and reporting on landfill

operation are required such as type, quantity and landfilling method including a chart illustrates each cell and its contents. The records must also be readily to be examined at any time by the Industrial Works Department.

3.3.2 Must report the Industrial Works Department immediately if an emergency or accidental leaking of wastes occur, and must cope with the emergency or accident by the method and within the period of time determined by the Industrial Works Department.

3.3.3 If any cells are not used temporarily, must cover it with clay, or soil with ground cover to prevent being blown or washed away, or other impermeable materials and have sufficient drainage system.

3.3.4 Must have precaution if filling the incompatible wastes in the same cell, to avoid mixing or contacting each other which may cause violent chemical reaction.

3.3.5 In case of filling a liquid waste is necessary, must contain it in a corrosive resistant container with an absorbent liner and sealed it completely.

3.4 Monitoring method

3.4.1 Must continuously test the quality of ground water from the observation wells before filling wastes at least 2 times, during operation and after closing, and keep records for comparison. If the analysis of groundwater sample indicates that the characteristics of groundwater exceed the standard, the amendment is immediately required and must report the Industrial Works Department.

3.4.2 Must test the characteristics of collected leachate before discharging, if it is more contaminated than the Effluent Standard according to the Notification of the Ministry of Industry, must treat it till conform to the Standard.

4. The licensee for operating a factory whose factory located in other areas besides the item 3, must dispose the waste material with a method and in a suitable and safe place according to the sanitary landfill techniques and must submit the details of the method and the landfill site to the Industrial Works Department for approval, case by case.

5. The licensee for operating a factory in item 1 must remove or transport the waste material as the following process:-

5.1 A vehicle to remove and transport the waste material must be covered completely, no leaking or spilling.

5.2 Must not remove or transport incompatible wastes in the same vehicle without precautions of chemical reaction.

5.3 Must use an appropriate container of each type of wastes for removal and transportation.

5.4 Must have safety measures and emergency rectification for accident or spilling during removal and transportation.

6. The extraction procedure and the leaching test must be as follows:

6.1 Pulverize and sieve waste sample till sample dimensions range from 0.5 to 5 mm.

6.2 Put 50 gms of sample in item 6.1 in the solution of distilled water and hydrochloric acid, pH 5.8 to 6.3, which solution volume is 10 times (mls) of weight (gms) of waste sample.

6.3 Shake it with agitator for 6 hours with shaking frequency 200 stroke per minute and shaking amplitude of 5 cm.

6.4 Filtrate the solution with the glass fiber paper filter with 1 micron pores.

6.5 Analyse the filtrate using the wastewater analytical standard method.

7. The information of waste disposal:

7.1 The licensee for operating a factory in item 1 must submit the following documents together with the details of the disposal process to the Industrial Works Department:

- Factory map including the disposal and the landfill site
- Operation methods such as storage, transportation and direction, detoxification, discharging or landfilling, including monitoring method and record keeping.

7.2 Must inform the details in item 7.1 to the Industrial Works Department within 90 days after the Notification of the Ministry of Industry No. 25 (B.E.2531) comes into effect when renew the license for operating a factory according to Section 17 or expand the operation of a factory according to Section 21 of the Factory Act B.E.2512

7.3 The above mentioned details must be reported according to the specified forms attached to this Notification.

Given on the 30th of September B.E.2531
Signed by Mr. Pisal Khongsamran
Director General

JICA