No.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF PUBLIC ENTERPRISES (MOPE)
EGYPTIAN ENVIRONMENTAL AFFAIRS AGENCY (EEAA)

STUDY ON INDUSTRIAL WASTE WATER POLLUTION CONTROL IN THE ARAB REPUBLIC OF EGYPT

DELTA STEEL MILL CO.
DESIGN PACKAGE

DECEMBER 2000

CHIYODA-DAMES & MOORE CO., LTD.
CHIYODA CORPORATION

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JR
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Document Title **CONCEPTUAL DESIGN REPORT**

Company Name **DELTA STEEL MILL COMPANY**

Document No. DS - CD - 00 - 01 REV. 0

Project Name THE STUDY ON INDUSTRIAL WASTE WATER POLLUTION CONTROL IN THE ARAB REPUBLIC OF EGYPT

Client JAPAN INTERNATIONAL COOPERATION AGENCY
INDUSTRIAL DEVELOPMENT STUDY DIVISION

Consultant CHIYODA DAMES AND MOORE CO.
CHIYODA CORPORATION

ISSUED DATE 1999. 11. 12

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CONSULTANT

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DATE	11/10'99	11/10'99	Nov. 11 '99

DELTA STEEL MILL CO.

1. General Outline

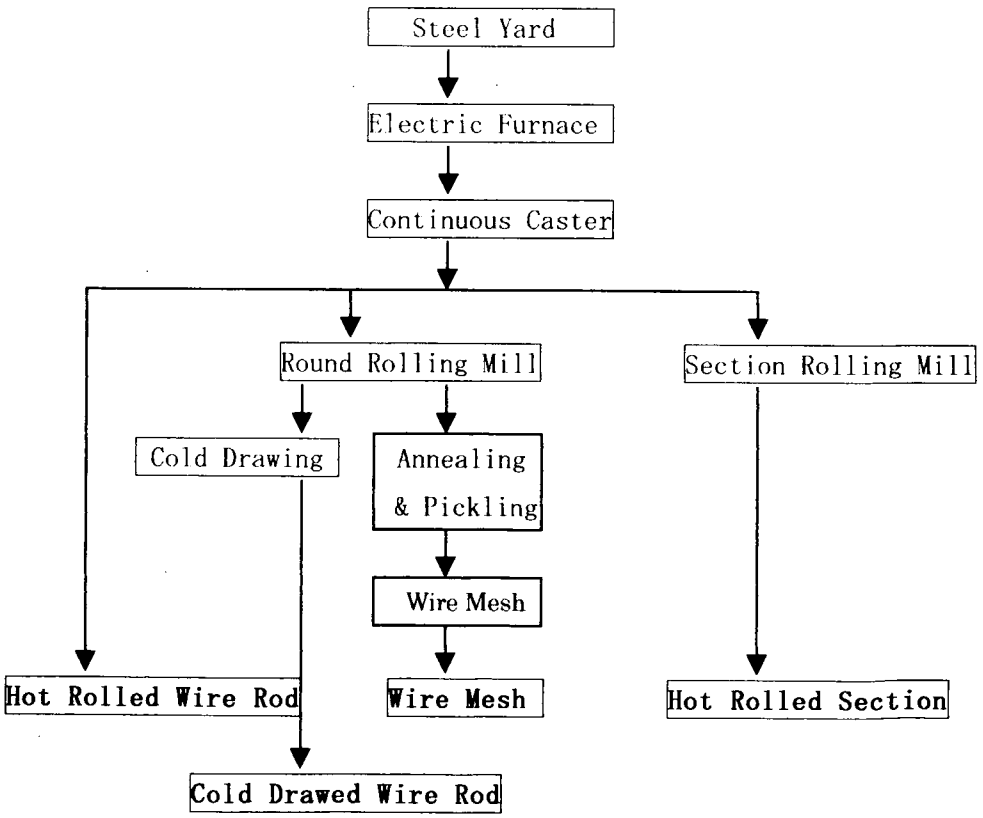
1.1 Factory Profile

(1) Address:	18 Emad EL-Deen St. Cairo
(2) Capital:	35 million L.E.
(3) Total Sales (Revenue):	156 million L.E./Year
(4) Number of Employees:	2,500
(5) Area:	Factory 336,000 m^2
	Structure 120,000 m^2
(6) Operation Hours	: 24 hrs x 330 days x 3 shifts

1.2 Production Process

(1) Production Process

Production process is as follows;



(2) Annual Production(1997)

1) Long Product	: 135,000 Ton/Year
2) Tubes & Pipes	: 2,000 Ton/Year
Total	: 137,000 Ton/Year

2. Waste Water Survey

2.1 Field Survey

(1)Date: Sep.06 – Sep.26, 1999.
(Sampling & Flow Measurement Sep.08 & 09)

(2) Persons in Charge:

1) JICA Study Team	T. Yasukawa (WWT Engineer)
	Y. Hiraiwa (Process Engineer)
2)Delta Steel Mill Co.	Mr. Youssri Ibrahem
	Mr. Asaad Ramsis Saleh
3)TIMS	Mr.Samiel Hammad Hassen,and others

2.2 Questionnaire

The answer sheets of questionnaire sent before visit was received at site survey.

2.3 Existing Waste Water Sewer System

Refer to DWG. NO. DS-CD-15-01.

(1) 700 m^3/h water of Nile River branch canal is used for process cooling water and some washing water after own treatment suitably. And city water of 200 m^3/h is used for sanitation/domestic water and cooling tower make-up water. Intake water fee is 50,000LE/year constantly in proportion not to consumption quantity

(2) Waste water is discharged to the Mastorod drainage canal and sanitary waste water is discharged to the public sewage, respectively.
The canal is extremely polluted in the cause of wastewaters from factories in the industrial district.

(3) Major wastewater treating units are Neutralization Unit (for acid pickling waste water) and simple type of Oil Separator. It seemed that operation and maintenance of the treating units is inadequate, for example removal of floated oil in the oil separator.

(4) The cooling water from Electric Arc Furnaces No.5 (625 m^3/h) & No.6 (625 m^3/h) is reused through the cooling tower.

(5) Discharge fee of waste water to the drainage is 0.36 L.E/m^3

(6) Frankly speaking, the production process plants and water, wastewater systems are superannuated and they are not always in suitable maintenance.

(7) The drawings of wastewater pollution improvement plan have been prepared by EGITALEC Co. in Cairo. Major treating unit is 1st, 2nd sedimentation basins with dewatering unit and rapid filtration of approx.10 filters. It is said that estimated cost is approx. 10 million LE.

2.4 Waste Water Sampling, Flow Measurement and Analysis

(1) Based on the result discussion with the Factory and sewer survey at site, 5 sampling points were selected. And sampling/flow measurement method was agreed mutually.

(2) Composite sampling (6 hrs-period x 4 times), flow measurement and wastewater qualities (pH, Turbidity, Electric conductivity, Dissolved Oxygen, Salinity, water temperature) were measured at field every sampling time.

The results of field measurement are shown on Table 1.

(3) Sampling Point: 5 points (Refer to DWG. NO. DS-CD-15-01)

(4) Detail of water qualities was analyzed at TIMS laboratory. (Refer to Table 2).

Table 1-1 Flow rate/Water Quality measured at Site (Sep.8&9,1999)

	① Air Station Outlet					② Mixing of Roll. & Sect. Mill				
Sampling Time	21:20	3:20	9:00	15:00	Av.	20:05	4:05	9:10	3:15	Av.
Flow rate [m^3/h]	103	61	122	124	103	209	473	571	571	447
pH [−]	7.72	7.47	7.20	7.77	7.54	7.10	7.74	7.60	7.60	7.51
Turbidity[unit]	279	6	61	27	93	65	12	20	19	28
EC [μS/cm]	379	330	312	325	340	326	335	321	320	330
DO [mg/L]	6.58	6.76	7.13	7.39	7.97	8.01	8.09	8.03	7.73	7.97
Salinity [%]	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
COD_{Mn}(P) [mg/L]	5	5	5	5	5	5	50	10	5	17.5
W. Temp [℃]	31.2	34.8	32.2	27.1	31.3	27.7	29.9	28.7	27.2	28.4

Note: COD_{Mn}(P) shows the analysis data by Pack Test.

Table 1-2 Flow rate/Water Quality measured at Site (Sep.8&9, 1999)

	③Mixing of Found.Rol.Sect. Mill					④ C.W. of EAFs No.5&6				
Sampling Time	22:20	4:20	9:25	15:25	Av.	22:50	4:50	9:50	15:45	Av.
Flow rate[m^3/h]	272	854	784	1786	922	109	710	69	79	240
pH [−]	7.10	7.74	7.60	7.60	7.61	7.61	7.66	7.70	7.87	7.72
Turbidity[[unit]	9	54	56	13	33	6	8	9	51	19
EC [μS/cm]	321	324	319	322	322	361	329	321	335	340
DO [mg/L]	7.96	8.11	8.08	7.67	7.96	7.33	6.66	7.59	6.96	7.14
Salinity [%]	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
COD_{Mn}(P)[mg/L]	5	10	10	10	8.8	5	5	10	20	10
W. Temp [℃]	27.9	30.0	28.3	27.5	28.4	30.0	31.0	28.9	30.1	30

Table 1-3 Flow rate/Water Quality measured at Site (Sep.8 & 9,1999)

	⑤ End of Pipe (Middle of Pit)					⑥ Intake Water (ref.)			
Sampling Time	23:10	5:10	10:10	16:10	Av.				20:00
Flow rate[m^3/h]	—	—	—	—	600				—
pH [−]	7.61	7.64	7.84	7.80	7.72				7.8
Turbidity[unit]	49	11	13	18	23				
EC [μS/cm]	326	326	336	328	329				
DO [mg/L]	7.81	8.13	8.00	7.28	7.80				
Salinity [%]	0.01	0.01	0.01	0.01	0.01				
COD_{Mn}(P)[mg/L]	5	20	20	50	16.3				10
W. Temp [℃]	28.4	29.6	27.9	27.9	28.5				29

Table 2 Analysis Results of Waste water Quality

Sampling No	①	②	③	④	⑤
Point / Item	Air Station	Mix Roll. & Sect.Mill	Mix.Fo.Ro Sec Mill	CW. EAFs No.5&6	End of Pipe Mid. of Pit
pH [-]	7.54	7.51	7.61	7.72	7.72
SS [mg/L]	22	64	56	18	34
BOD_5 [mg/L]	15	12	10	6	15
CODcr [mg/L]	23.2	50.4	34.9	34.8	29.1
Oil&Grease [mg/L]	2,301	154	35	1	8.9
TDS [mg/L]	220	230	210	210	260
PO_4^{3-} [mg/L]	0.46	0.16	0.18	0.37	0.09
T-N [mg/L]	0.24	0.44	0.26	0.34	0.18
W. Temp [℃]	31.3	28.4	28.4	30	28.5

* Analyzed by TIMS Laboratory.

3. Conceptual Design

3.1 Philosophy of Conceptual design

(1)Conceptual design 1

Conceptual design 1 (CD-1) shows the recommendable wastewater treating system to all wastewaters in the Factory to meet the wastewater disposal regulation to Nile River (Law No.48/1982) and water saving point of view.

But, the drawings prepared Conceptual Design of Waste Water Flow (Block Flow DS-CD-15-02) only.

(2)Conceptual design 2

Conceptual design 2 (CD-2) shows the study of wastewater treating system, in case that the demonstration plant will be applied in the factory by JICA.

Therefore, wastewaters for conceptual design were selected the following points of view:

- Quality: Wastewater should be treated by the treating system consisting of various treating unit processes.
- Quantity: Flow rate(plant capacity) to be treated within limited JICA budget,

  and wastewater are discharged continuously as possible.
- The plants of wastewater source are operated constantly as possible.

3.2 Conceptual Design 1

(1) Recommendable wastewater treating system for Delta Steel Mill Co. is shown on DWG. No. EF-CD-15-02 as Block Flow Diagram.

The system consists of Oil Separator, Clarifier (coagulation/sedimentation) and Sand filter to remove suspended solids and a slice of oil as same as CD-2 (Refer to DWG. No. EF-CD-15-03)

Also, Softener planned by EGITALEC Co. is provided to remove hardness and to reuse for cooling water.

(2) But, to reuse treated water by Softener or to discharge it to the public sewage without Softener should be decided comparing with running cost of Softener and wastewater discharge fee to the public sewage.

3.3 Conceptual Design 2

(1) Design Basis

1) Waste water : Waste water from Air Station

2) Flow rate : Max. 120 m^3/h

3) Water quality :

Table 3 Water Quality

	Oil Separator Inlet	Filter Outlet	Nile Regulation Law of No.48
pH [mg/L]	6~7	7~8	6~9
BOD [mg/L]	20	20	20
COD [mg/L]	30	20	30
SS [mg/L]	200	2	30
Oil & Grease [mg/L]	1,000	2	<5

The treated water qualities shall be meet to discharge waste water regulation "Nile River (Law No.4 of 1994)".

(2) Waste Water Treatment System

Refer to DWG. NO. DS-CD-15-03/04

1)Pre-treatment

(a)Equalization Pond

The pond is provided to equalize quantity and quality by air bubbling.

(b)Oil Separator:

120 m^3/h x API Type Oil Separator, 1 train (made of concrete)

i)Waste water from Air station contains floatable oil to be removed by gravity easily. Oil separator is designed based on API (American Petroleum Institute) manual.

ii)Oil recovery tank should be provided, recovery oil may be used for fuel.

iii)In case that waste water contains much settleable solids, mechanical scraper may be provided.

2) Primary treatment

[Clarifier]

120 m^3/h x Conventional type, 1 set (Carbon steel/epoxy)

- Coagulation/Flocculation unit
- Chemical Injection Facility (drums, mixers, pumps)
- Sedimentation Basin

by coagulants, and flocs settled in the sedimentation basin.

(b) Supernatant of the sedimentation basin may meet to Nile River Regulation.

(c) In order to polish treated water, it is fed to the filters.

(d) Sludge accumulated on the bottom of sedimentation basin is discharged to Dewatering Unit automatically, periodically.

3) Advanced Treatment

[Filter Unit]

(a) Sand Filter

・60 m^3/h x 3 sets (1 set stand-by), carbon steel/epoxy

Filter media Anthracite + sand/gravel

(b) Backwashing unit

Filtered Water Pit, Backwash waste pit,

Backwash pumps, blowers

i)To remove micro flocs in the clarified water, Sand filters are used. Filtered water can be reused as cooling water.

ii)Filters are backwashed with air and filtered water once 18-24hs automatically, periodically by a sequence-timers.

iii) Backwash wastewater is returned to Equalization Pond to treat again.

4) Sludge Dewatering Unit

(a) Sludge Thickener

Gravity separation with sludge collecting rake, carbon steel/epoxy

(b) Centrifuge

Horizontal type, stainless steel

i)Solid content of Clarifier bottom sludge is around 1%wt(10g-SS/L). Therefore, it is thickened in Sludge Thickener by gravity, then dewatered by Centrifuge.

ii)To thicken and dewater effectively, polymers as coagulant are injected to sludge, respectively.

iii)Supernatant of Thickener and separated wastewater by Centrifuge are returned to Equalization Tank to treat again.

5) Local Control Room

(a)The control room (Approx. 6m x 12m, ground floor only) is built at the demonstration plant area.

(b)The room consists of a control panel room and an electricity distribution panel room , rest room for operators, toilet, sink locker, etc..

(c)Chemical storage room is also provided.

6)Electricity

(a) Electricity (380V AC x 3 phase x 50HZ) is received from power sub-station at the corner of Casting Shop through underground buried cable along the road. Cable length is approx. 600m.

(b) Approx. 200kVA electricity is used for power, lighting, control for instrument for wastewater treating unit, and air conditioning in the control room.

(3)Disposal of sludge

Pollutants in wastewater are removed, dewatered cake generates finally at the wastewater treatment plant. Wastewater in the Factory may not contain any harmful materials such as heavy metals and organic chlorine compounds, therefore, dewatered cake can be dumped to the specified place near desert under management.

(4) Location of Demonstration Plant

Location of Demonstration Plant to be constructed was selected preliminarily a southwest part of the Factory by JICA Study Team and the Factory personnel(Refer to DS-CD-12-02 Fig.3).

1) Location: Scrap Yard 50m x 50m

2) Power Supply: Sub-station=Charging Shop
380VAC/50HZ, underground/direct buried

(5) Budgetary Cost Estimation

1) Conditions of Estimation

(a)Major mechanical equipment, electrical equipment, instrument, and valves are purchased out of Egypt (Japan or Europe).

(b)Bulk materials such as pipe and fittings, re-bar, cable are purchased in Egypt.

(c) Large vessels (larger than 3.0m) and tanks is erected at site.
Sand filters made of carbon steel and filter media are purchased from Japan.

(d) Large basins are constructed of reinforced concrete.

(e) Field works are conducted by Egyptian contractors under supervising by Japanese consultants.

(f) Construction at site is proceeded as the standard schedule.

Table 4 Budgetary Cost Estimation

	Yen Portion	LE Portion	
	[x10³Yen]	[LE]	[x10³Yen]
1. Equipment & Material			
(1) Mechanical	101,000		
(2) Elec./Instrument	49,000		
(3) Transportation	29,000		
Sub-Total(1)	179,000		
2.Construction(w/Local Mate)			
(1) Civil/Architecture		1,114,000	
(2) Installation/Piping		812,000	
(3) Elec. /Instrument		660,000	
(4) Commissioning		7,200	
Sub-Total(2)		2,593,200	88,170
3. Indirect Cost			
(1) Contractor Expenses		648,300	22,040
(2)Supervision Expenses			10,000
Sub-Total(3)		648,300	32,040
Total Cost	299,210 [x10³ Yen]		

Note: 1) Exchange Rate 1 LE = 34 Yen

2) Indirect Cost = Direct Cost (Field Portion) x 0.25

3) Excluded Supervision Fee by Japanese consultant

4) Demarcation of Scope of Work between Egyptian and Japanese Sides has not been decided yet.

(6)Standard Schedule :

Standard schedule is shown on Table 5, but it is not so easy schedule.

It is scheduled so as to be passed Egypt custom without any delay.

Table 5 Standard Construction Schedule

Item \ Month	1	3	5	7	9	11	13
Detail Design	*						
1) Procurement		**********					
2) Transportation			**********				
3)Civil Work			**********				
4)Instal./Piping				**********			
5)Elec./Instrument					********		
6)Control Room			*******				
7)Commissioning						**	
Demonstration Operation							*

4. Recommendations of Feasible Improvement for Waste Water Treatment

(1) Improvement of existing Oil Separator/Sedimentation Basins

The floating oil and settled sludge in the existing Oil Separator/Sedimentation Basin should be removed by manual periodically, and recovered oil can be used as fuel.

(2) Suitable routine work

1) Appearance (such as color, clearness, smell, floating matters, etc.) of inlet and outlet water should be checked visually at routine work, and be taken suitable action, if necessary.

2) Sewer ditch should be cleaned by removing accumulated scum and sludge, etc.

(3) Calibration electrode of pH meter

The electrodes of pH meter in Neutralization unit should be calibrated every week, and be always kept in water during plant shut-down too.

(4) Spare Parts and Maintenance

The flow indicators and pressure gages around pumps should be always equipped as design, and be always maintained so as to work normally.

5. Process Survey

(1).General;

This company produces the long products mainly such as "Light Section", "Round/Section Bars", "Hot Rolled/Cold Drawn Wire Rod", Cast Iron Pipe and Fittings, Grinding Media so on, using EAF, CCM, Hot Rolling Mill, Cold Work Facilities and Foundries process.

Designed production capacity 0f rolled material is about 155,000 tons annually in total but current production result (1998) is about 118,000 tons/year (76% of above) due to the market condition.

Application of longitudinal products is for general use of construction materials, and market condition is deteriorating recently, in addition total domestic production capacity has been raised by the establishment of ANSDK (Alexandria National Steel DK) who produced longitudinal products using Direct-Reduction Furnace, EAF, CCM, and Hot Rolling Mill.

But also 3 % of return on sales could be obtained in this company.

(2).Operation and Process;

Latest operational conditions provided by DSM are as follows(!999/7-8 average);

Table 6 Operation Status

Process	Production (ton/month)	Ope. time (hr/month)	Productivity (ton/hr)	Availability (%)	Yield (%)
No.5 EAF(25t)	1,200	624	2.56	75	86
No.6 EAF(25t)	3,000	624	2.56	75	86
B't-CCM	4,055	depend on EAF	depend on EAF	depend on EAF	95
Section Mill	4,000	546	10	80	90
Round Mill	8,000	546	20	70	90

Total yield ; 73.5(%)

Note: No.4 EAF with capacity of 18 ton is stopped due to high operational cost.

Upper stream facilities consist of old EAF(F5/in'72), not so old EAF(F6/in'83) and CCM(in '86). Operation conditions such as monthly production amount and operation time so on are fluctuated due to various reasons.

Hot rolling mill consists of one old large section/round rolling mill and one modernized small round rolling mill. And, productivity of the former mill is half of the latter mill.

Depend on above operation conditions they uses big amount of purchased billets

due to the unbalance of productivity between upper stream(EAF) and down stream(rolling mills). This means, important theme on the production process and facilities to be modernized at upper stream and at down stream is existing.

(3).Equipment;

Regarding facility information, refer to ANNEX-1.

Except one EAF, CCM and small round rolling mill, almost of all facilities are aged and maintenance activity seems not to be adequately, so, leaked oil from rolling mill especially from large section/round rolling mill goes into the wastewater sewer.

Maintenance activity is very important job not only to repair the broken machine but also to get good products quality, productivity, yield, to reduce cobbles and to reduce environmental pollution so on.

In Japan we call it " Productive Maintenance" and it is adopted by many industries. From productive and environmental points of view, adequate maintenance for rolling mill especially for section/round mill is urgent and important theme as well.

From the view point of long term theme, survey and study for modernization of process and equipment by specialists will be recommendable.

(4) Environmental;

There are two serious problems on environmental matter.

One is air pollution by dusty exhaust gas from EAF because their dust collection system doesn't work and dust is discharged into the atmosphere directly.

The other problem is water pollution. Large amount of leakage oil from rolling mill goes into the wastewater sewer, but function of oil and SS separation is inadequate at the simple treating units.

(5) Conclusion;

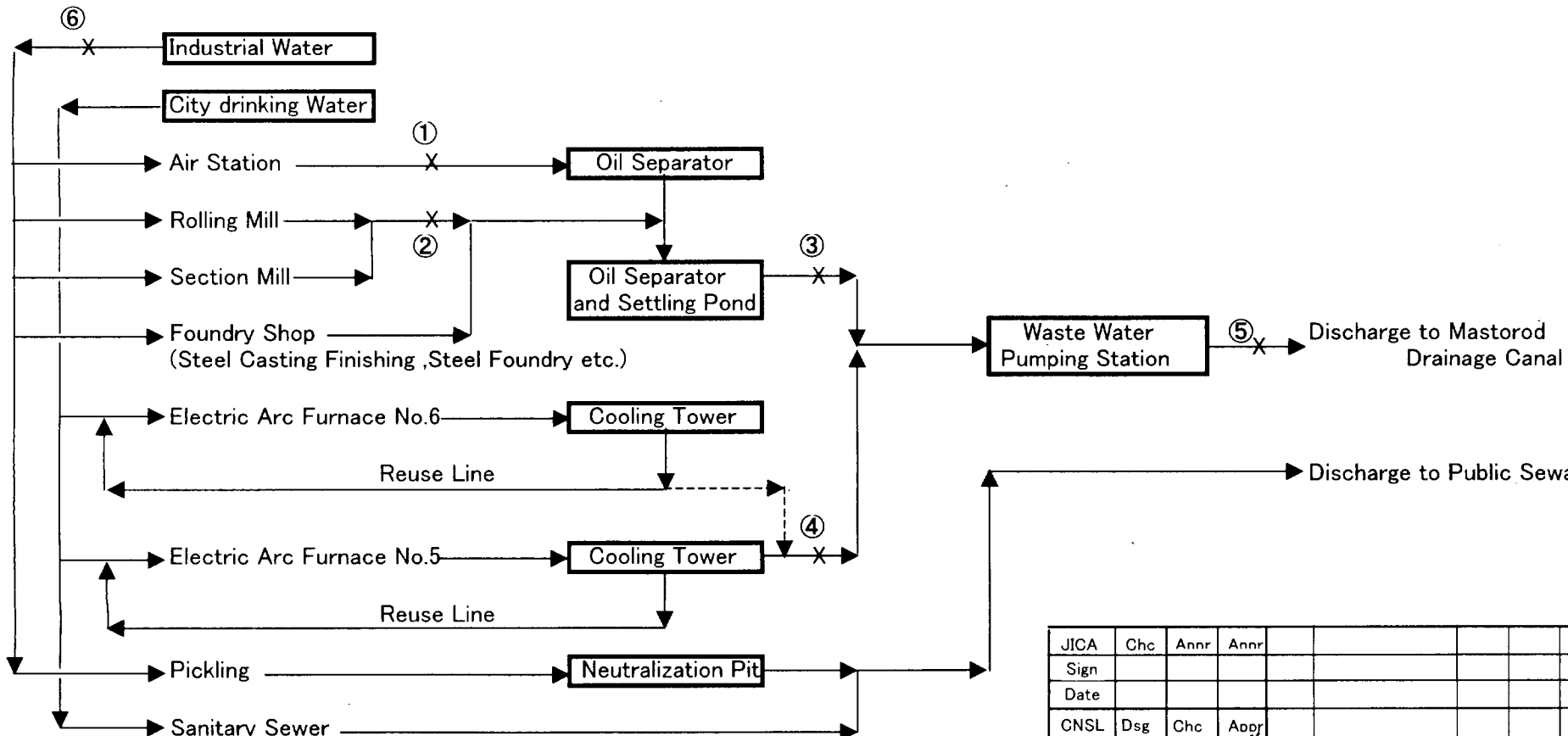
This Factory has the long history and almost of all facilities are old except some area. From the environmental and productive points of view, improvement of maintenance activity and system for production equipment and environmental protection equipment are quite important and urgent matter for pollution prevention and for increase of productivity.

· DRAWING LIST OF CONCEPTUAL DESIGN

[DELTA STEEL MILL CO.]

NO	DRAWING NAME	DWG. NO.	REV.	DATE	NOTE
1	FLOW SHEET				
1)	SCHEMATIC DIAGRAM OF WASTE WATER FLOW	DS-CD-15-01	0	1999.10.13	
2)	CONCEPTUAL DESIGN OF WASTE WATER FLOW	DS-CD-15-02	0	1999.10.13	CD-1 & CD-2
3)	BLOCK FLOW DIAGRAM OF				
	WASTE WATER TREATMENT	DS-CD-15-03	0	1999.10.13	
4)	CONCEPTUAL DESIGN OF				
	WASTE WATER TREATMENT	DS-CD-15-05	0	1999.10.14	
2	PLOT PLAN				
1)	LOCATION OF W.W.T. DEMONSTRATION PLANT	DS-CD-12-01	0	1999.10.13	
2)	PLOT PLAN FOR CONCEPTUAL DESIGN OF				
	W.W.T. DEMONSTRATION PLANT	DS-CD-12-02	0	1999.10.13	

NOTE:

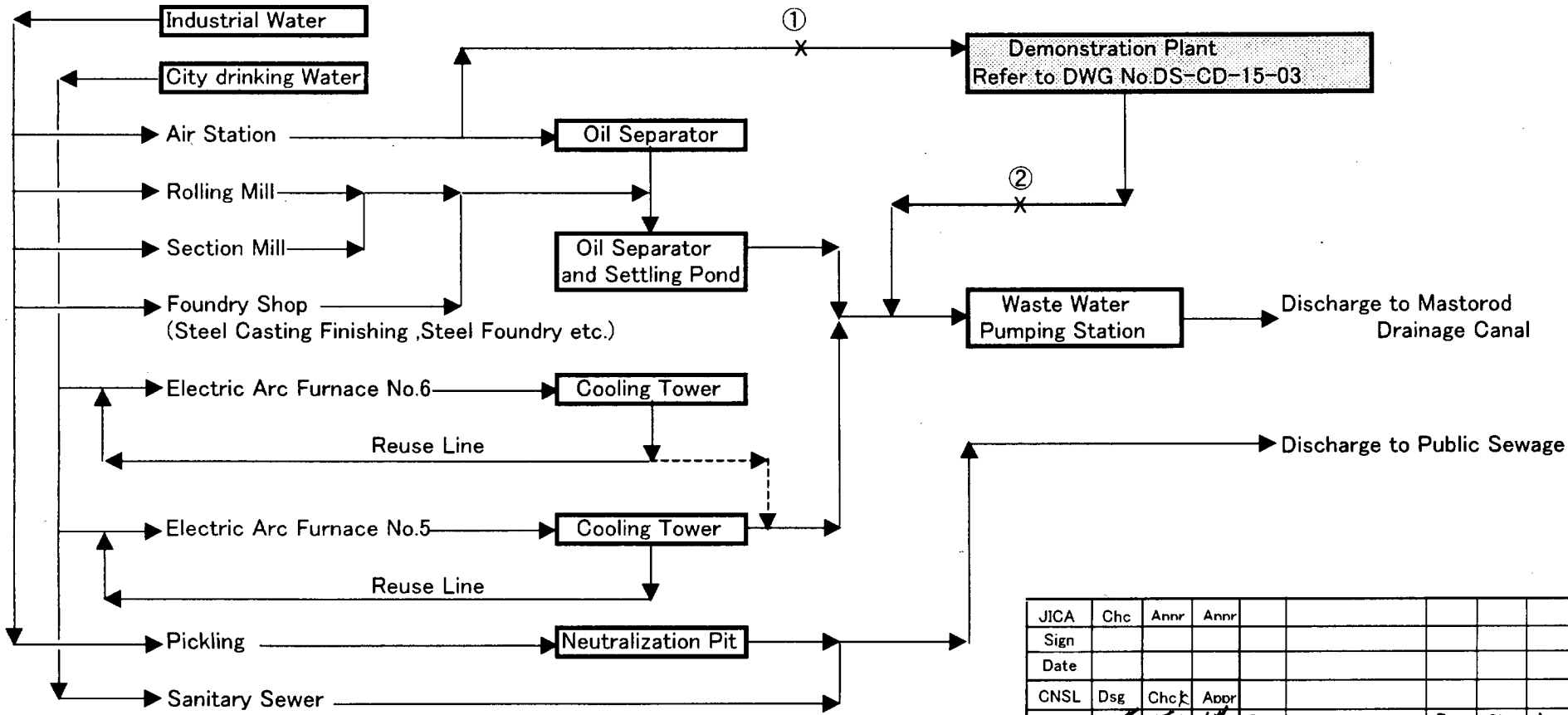


Sampling Point / Analytical Item	Unit	①	②	③	④	⑤	⑥	⑦
Flow Rate	m^3/h	102	448	922	239	600*1		
pH	—	7.54	7.51	7.61	7.72	7.72		
Conductivity	μS/cm	345	326	322	367	329		
Turbidity	NTU	106	28	33	19	23		
Water Temp.	℃	31.3	28.4	28.4	30	28.5		
Salinity	%	0.01	0.01	0.01	0.01	0.01		
COD_{Mn}* 2	mg/L	5	18	9	10	24		

* : Field Measurement(Average)　　* 1 : Data by Factory Personal　　* 2 : Pack Test

JICA	Chc	Annr	Annr						
Sign									
Date									
CNSL	Dsg	Chc	Appr						
Sign				Rev	Descrip	Dsgn	Chc	Appr	Date
Date				REVISION					

CLIENT	JAPAN INTERNATIONAL COOPERATION AGENCY		
CONSULTANT	CHIYODA DAMES & MOORE CO. CHIYODA CORPORATION		
PROJECT	THE STUDY ON INDUSTRIAL WASTE WATER POLLUTION CONTROL IN THE ARAB REPUBLIC OF EGYPT		
TITLE	FOR DELTA STEEL MILL CO. SCHEMATIC DIAGRAM OF WASTE WATER FLOW		
ISSUED	1999. 11. 12	SCALE	NONE
DWG NO	DS-CD-15-01	REV.	0



Sampling Point / Analytical Item	Unit	①	②	③	④	Nile Branch Regulation
Flow Rate	m^3/h	120	120			-
pH	—	6～7	7～8			6～9
Conductivity	$\mu S/cm$	340	350			-
SS	mg/L	200	2			30
Oil & Grease	mg/L	1,000	2			5
BOD	mg/L	20	20			20
COD	mg/L	30	20			30

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Sign										
Date										
CNSL	Dsg	Chck	Appr							
Sign				Rev	Descrip	Dsgn	Chc	Appr	Date	
Date				REVISION						

CLIENT	JAPAN INTERNATIONAL COOPERATION AGENCY		
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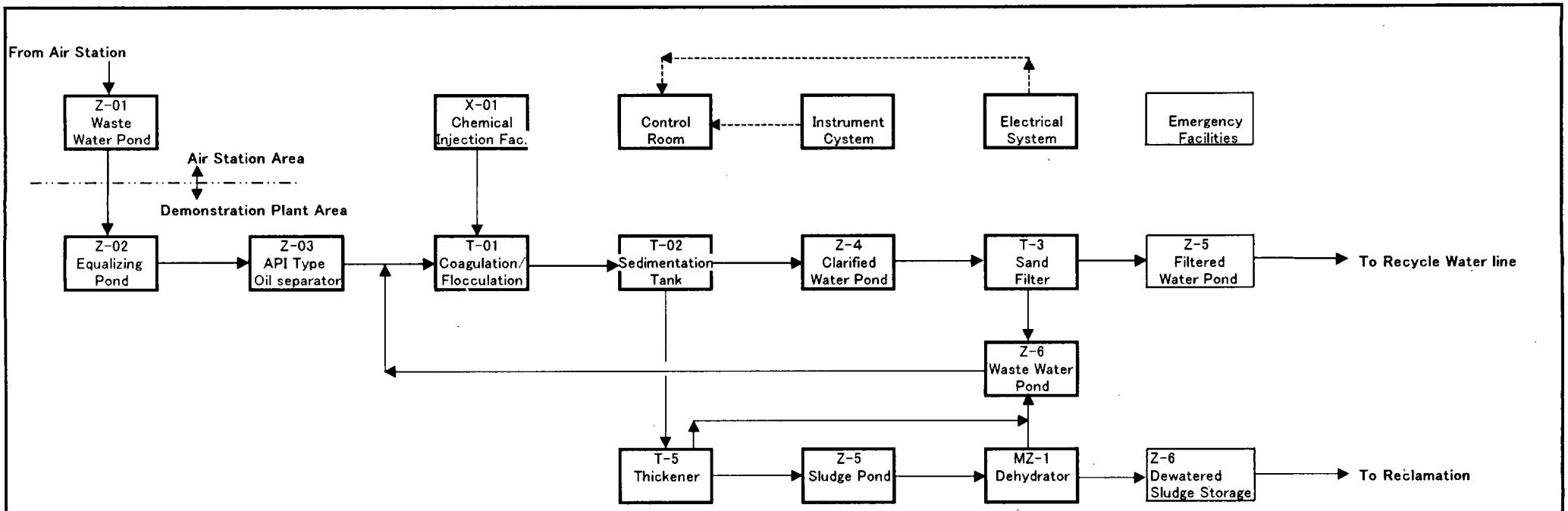
PROJECT	THE STUDY ON INDUSTRIAL WASTE WATER POLLUTION CONTROL IN THE ARAB REPUBLIC OF EGYPT		
TITLE	FOR DELTA STEEL MILL CO. CONCEPTUAL DESIGN (2) FOR WASTE WATER FLOW		
ISSUED	1999. 11. 12	SCALE	NONE
DWG NO	DS-CD-15-02	REV.	0



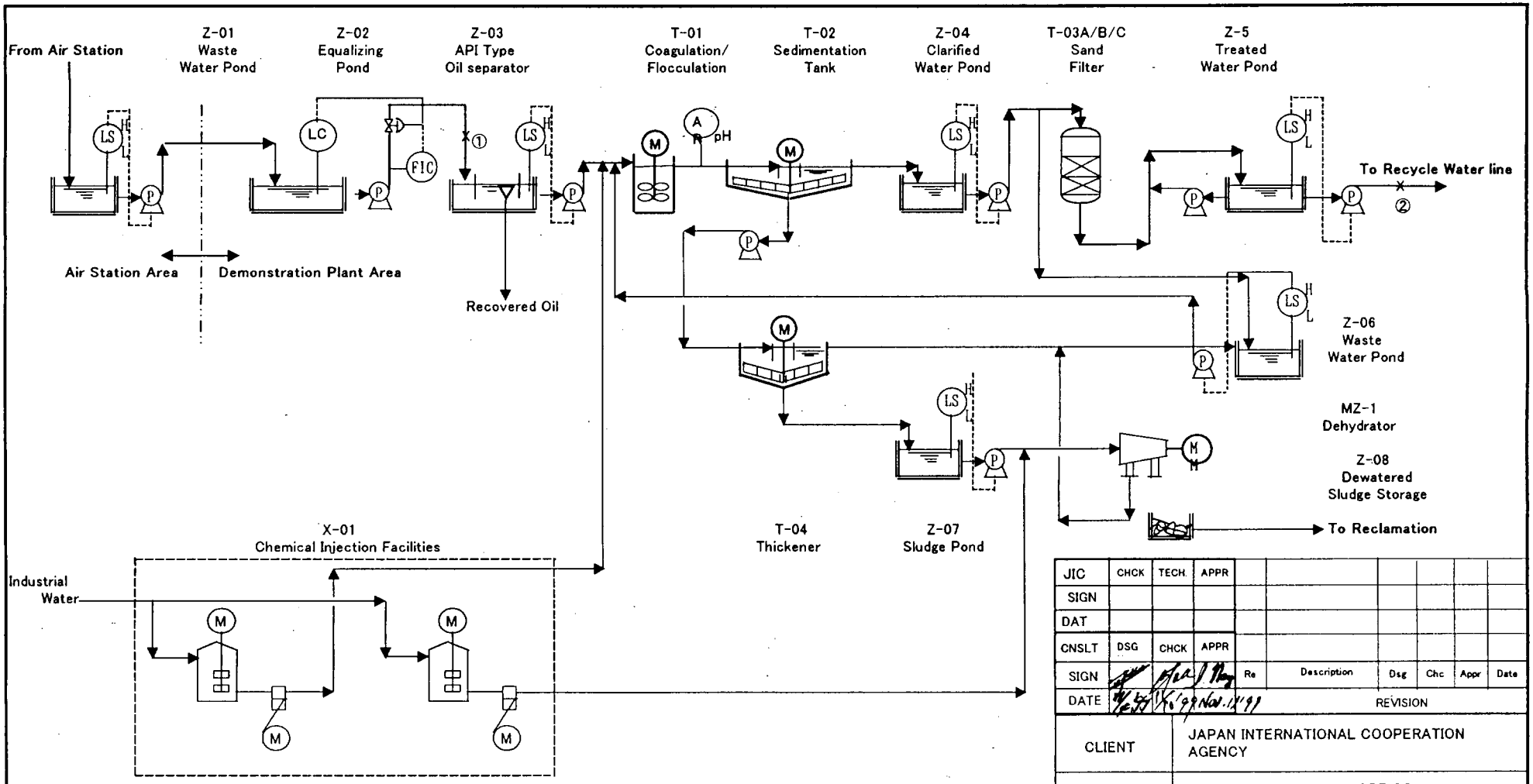
CD-17

Compoment of Facilities

Number	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
Item	Waste Water Pond	Equalizing Pond	API Type Oil Separator	Coagulation/ Flocculation	Sedimentation Tank	Clarified Pond	Biological Treatment	Sand Filter	Filtered Water Pond	Sterlization Tank/Pond
	O	O	O	O	O	O	×	O	O	×
Number	⑪	⑫	⑬	⑭	⑮	⑯	⑰	⑱	⑲	⑳
Item	Thickener	Sludge pond	Backwashed Water Pond	Dehydrator	Dewatered Sludge Stora	Chemical Injection Fac	Emergency Facility	Instrument System	Electrical System	Control Room
	O	O	O	O	O	O	O	O	O	O
Number	21	22	23	24	25	26	27	28	29	30
Item										

JIC	CHCK	TECH.	APPR						
SIGN									
DATE									
CNSLT	DSG	CHCK	APPR						
SIGN				Re	Descripti	Dsgn	Chc	Appr	Dat
DATE	11/6/99	11/6/99	NOV.11'99	REVISION					

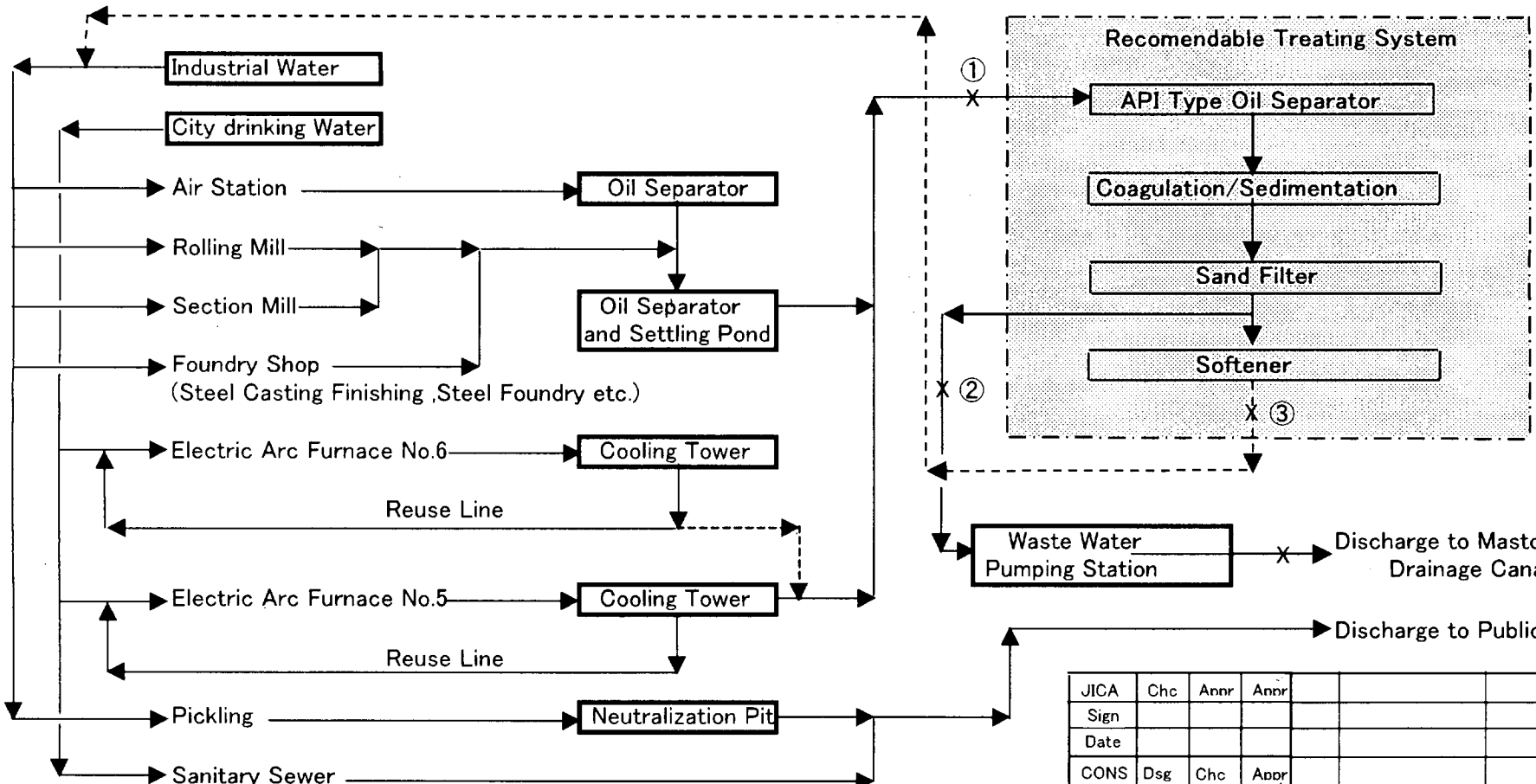
CLIENT	JAPAN INTERNATIONAL COOPERATION AGENCY		
CONSULTAN	CHIYODA DAMES & MOORE CO. CHIYODA CORPORATION		
PROJECT	THE STUDY ON INDUSTRIAL WASTE WATER POLLUTION CONTROL IN THE ARAB REPUBLIC OF EGYPT		
TITLE	FOR DELTA STEEL MILL CO. BLOCK FLOW DIAGRAM OF W.W.T. DEMONSTRATION PLANT		
ISSUED	1999. 11. 12	SCAL	NONE
DWG	DS-CD-15-03	REV.	0



Stream No. / Analytical Item	Unit	①	②	③	④	Nile Branch Regulation
Flow Rate	m^3/h	120	120			-
pH	—	6~7	7~8			6~9
Conductivity	$\mu S/cm$	340	350			-
SS	mg/L	200	2			30
Oil & Grease	mg/L	1,000	2			5
BOD	mg/L	20	20			20
COD	mg/L	30	20			30

JIC	CHCK	TECH.	APPR						
SIGN									
DAT									
CNSLT	DSG	CHCK	APPR						
SIGN				Re	Description	Dsg	Chc	Appr	Date
DATE				REVISION					

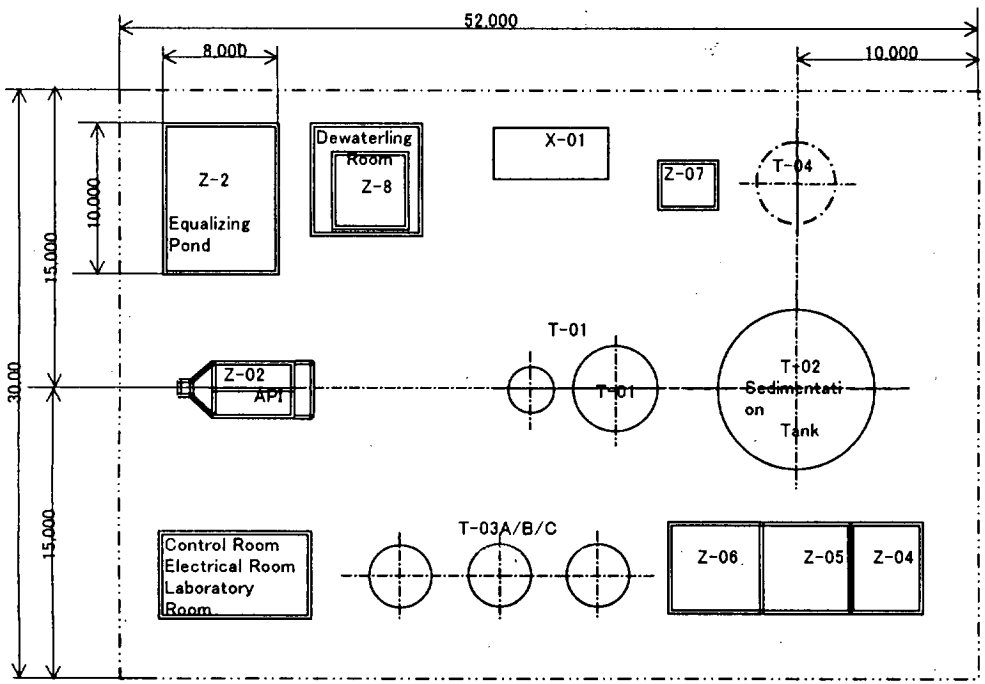
CLIENT	JAPAN INTERNATIONAL COOPERATION AGENCY		
CONSULTAN -	CHIYODA DAMES & MOORE CO. CHIYODA CORPORATION		
PROJECT	THE STUDY ON INDUSTRIAL WASTE WATER POLLUTION CONTROL IN THE ARAB REPUBLIC OF EGYPT		
TITLE	FOR DELTA STEEL MILL CO. PROCESS FLOW DIAGRAM OF W.W.T. DEMONSTRATION PLANT		
ISSUED	1999. 11. 12	SCAL	NONE
DWG NO	DS-CD-15-04	REV.	0



Sampling Point / Analytical Item	Unit	①	②	③	④	Nile Branch Regulation
Flow Rate	m^3/h	120	120	120		-
pH	—	6～7	7～8	7～8		6～9
Conductivity	$\mu S/cm$	340	350	350		-
SS	mg/L	200	5	2		30
Oil & Grease	mg/L	1,000	2	2		5
BOD	mg/L	20	20	20		20
COD	mg/L	30	30	20		30

JICA	Chc	Appr	Appr							
Sign										
Date										
CONS	Dsg	Chc	Appr							
Sign				Rev	Descrip	Dsgn	Chc	Appr	Date	
Date				REVISION						

CLIENT	JAPAN INTERNATIONAL COOPERATION AGENCY		
CONSULTANT	CHIYODA DAMES & MOORE CO. CHIYODA CORPORATION		
PROJECT	THE STUDY ON INDUSTRIAL WASTE WATER POLLUTION CONTROL IN THE ARAB REPUBLIC OF EGYPT		
TITLE	FOR DELTA STEEL MILL CO. CONCEPTUAL DESIGN (1) OF RECOMMENDABLE W.W.T. SYSTEM		
ISSUED	1999. 11. 12	SCALE	NONE
DWG NO	DS-CD-15-05	REV.	0



T-01	Coagulation Tank /Flocculation Tank	2,400$^{\phi}$×3,000^{l}×10 m^{3} & 4,770$^{\phi}$×5,000^{l}×60 m^{3}
T-02	Sedimentation Tank	8,000$^{\phi}$×4,500^{l}×180 m^{3}
T-03A/B/C	Sand Filter	3,200$^{\phi}$×4,000^{l}×32 m^{3}
T-04	Thickener	4,500$^{\phi}$×4,000^{l}×45 m^{3}
Z-01	Waste Water Pond	4,000^{w}×5,000^{l}×2,000^{d}×30 m^{3}
Z-02	Equalizing Pond	8,000^{w}×10,000^{l}×3,500^{d}×24
Z-03	API Type Oil Separator	3,400^{w}×5,600^{l}×1,500^{d}×25 m^{3}
Z-04	Clarified Water Pond	4,000^{w}×5,000^{l}×2,000^{d}×30
Z-05	Treated Water Pond	5,000^{w}×5,000^{l}×3,000^{d}×60
Z-06	Waste Water Pond	5,000^{w}×5,000^{l}×3,000^{d}×60 m^{3}
Z-07	Sludge Pond	2,500^{w}×2,500^{l}×2,500^{d}×10 m^{3}
Z-08	Dewatered Sludge Storage	4,000^{w}×4,000^{l}×2,500^{d}×30 m^{3}
MZ-01	Dehydrator	
X-01	Chemical Injectior	

JIC	CHCK	TECH.	APPR						
SIGN									
DATE									
CNSLT	DSG	CHCK	APPR						
SIGN				Re	Description	Dsg	Chc	Appr	Date
DATE				REVISION					

CLIENT	JAPAN INTERNATIONAL COOPERATION AGENCY
CONSULTANT	CHIYODA DAMES & MOORE CO. CHIYODA CORPORATION
PROJECT	THE STUDY ON INDUSTRIAL WASTE WATER POLLUTION CONTROL IN THE ARAB REPUBLIC OF EGYPT
TITLE	FOR DELTA STEEL MILL CO. PLOT PLAN FOR W. W. T. DEMONSTRATION PLANT
ISSUED	1999. 11. 12
SCAL	1/250
DWG NO	DS-CD-12-02
REV.	0

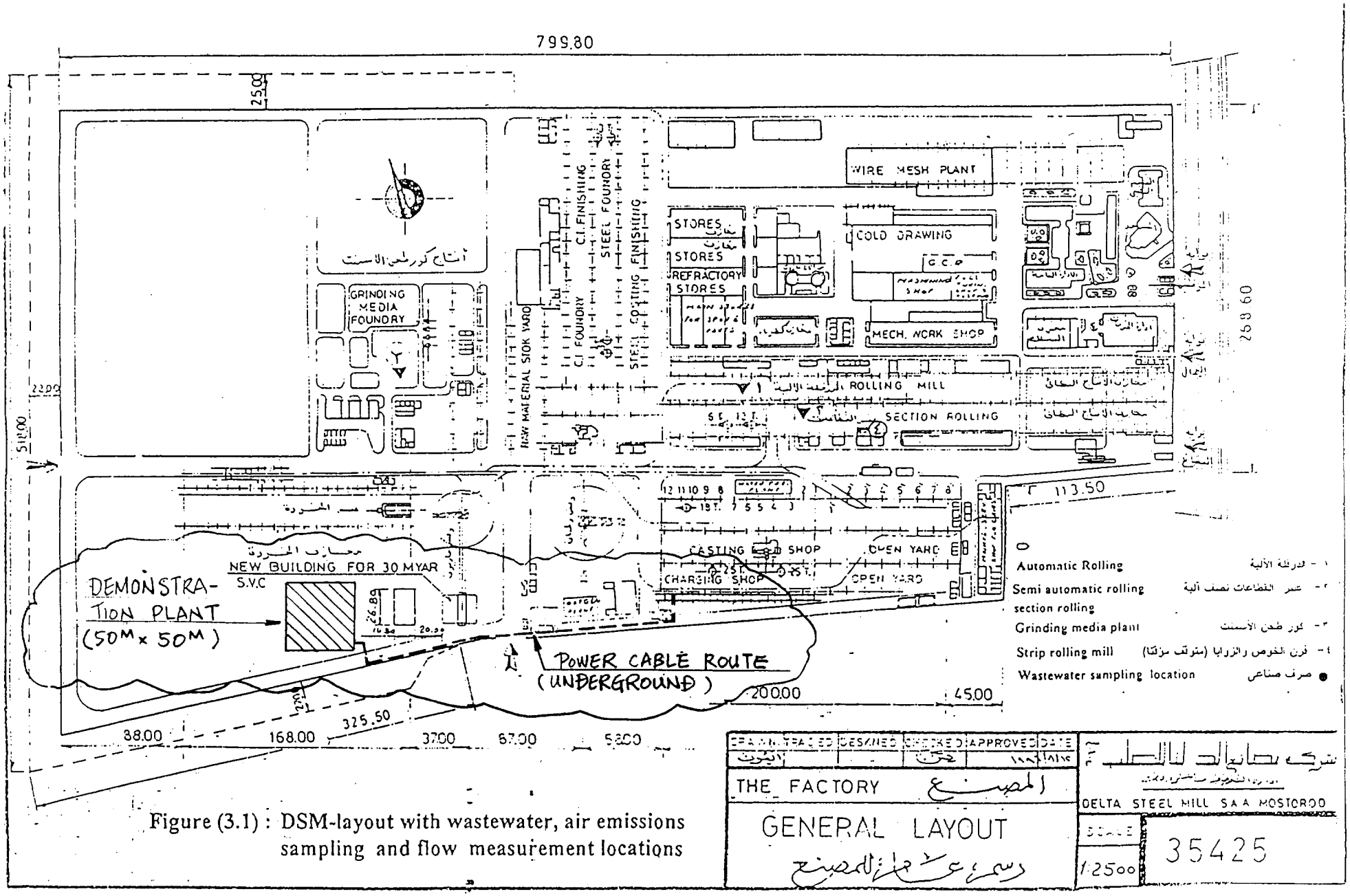


Figure (3.1) : DSM-layout with wastewater, air emissions sampling and flow measurement locations

DSM

Fig 3 : POWER CABLE ROUTE FOR DEMONSTRATION PLANT

Table-1 EQUIPMENT LIST for Delta Steel Mill Co.

CLIENT :Japan International Cooperation Agency

PROJECT :The Study on Industrial Waste Water Plant

PLANT :Demonstration Plant

WASTE W. :Air Station Waste Water

REV	1	2	3	MADE	
BY				CKD	
APVE				APVE	
DATE				DATE	Oct.10,'99

Equipment NO.	Service	No. Req'd	Type of Equipment	Remarks
T-01	Coagulation Tank	1	Vertical Cylindrical Type	Carbon Steel/Epoxy
	/Flocculation Tank		2,400$^{\phi}$×3,000^{H}×10 m^3	Coating
			&4,770$^{\phi}$×5,000^{H}×60 m^3	
T-02	Sedimentation Tank	1	Vertical Cylindrical Type	Carbon Steel/Epoxy
			8,000$^{\phi}$×4,500^{H}×180 m^3	Coating
T-03A/B/C	Sand Filter	3	Vertical Cylindrical Type	Carbon Steel/Epoxy
			3,200$^{\phi}$×4,000^{H}×32 m^3	Coating
T-04	Thickener	1	Vertical Cylindrical Type	Carbon Steel/Epoxy
			4,500$^{\phi}$×4,000^{H}×45 m^3	Coating
Z-01	Waste Water Pond	1	Vertical Rectangular Type	
			4,000^{W}×5,000^{L}×2,000^{H}×30 m^3	
Z-02	Equalizing Pond	1	Vertical Rectangular Type	
			8,000^{W}×10,000^{L}×3,500^{H}×240 m^3	
Z-03	API Type Oil Separator	1	Vertical Rectangular Type	
			3,400^{W}×5,600^{L}×1,500^{H}×25 m^3	
Z-04	Clarified Water Pond	1	Vertical Rectangular Type	
			4,000^{W}×5,000^{L}×2,000^{H}×30 m^3	
Z-05	Treated Water Pond	1	Vertical Square Type	
			5,000^{W}×5,000^{L}×3,000^{H}×60 m^3	
Z-06	Backwashed Waste Water Pond	1	Vertical Square Type	
			5,000^{W}×5,000^{L}×3,000^{H}×60 m^3	
Z-07	Sludge Pond	1	Vertical Square Type	
			2,500^{W}×2,500^{L}×2,500^{H}×10 m^3	

Note:

Table-1 EQUIPMENT LIST for Delta Steel Mill Co.

CLIENT :Japan International Cooperation Agency

PROJECT :The Study on Industrial Waste Water Plant

PLANT :Demonstration Plant

WASTE W. :Air Station Waste Water

REV	1	2	3	MADE	
BY				CKD	
APVE				APVE	
DATE				DATE	007.10.'99

Equipment NO.	Service	No. Req'd	Type of Equipment	Remarks
Z-08	Dewatered Sludge Storage	1	Vertical Square Type	Carbon Steel/Epoxy
			$4,000^{W} \times 4,000^{L} \times 2,500^{H} \times 30\ m^3$	Coating
MZ-01	Dehydrator	1	Centrifuge Type	Stainless Steel
			$1.5\ m^3/h$	
X-01	Chemical Injection	1	Tank, Mixer, Pump for	
	Facilities		Coagulant, Polymer	

Note:

Table-2 INSTRUMENT LIST for Delta Steel Mill Co.

CLIENT :Japan International Cooperation Agency

PROJECT :The Study on Industrial Waste Water Plant

PLANT :Demonstration Plant

WASTE W. :Air Station Waste Water

REV	1	2	3	MADE	
BY				CKD	
APVE				APVE	
DATE				DATE	Oct. 10'99

Instrumen NO.	Service	No. Req'd	Type of Equipment	Remarks
FIC-01	Sedimentation line	1	30 m^3/h~150 m^3/h	
			Flow Indicating controller	
LC-01	Equalizing Pond	1	1,000 mm~1,500 mm	
			Level Controller	
pH-01	Sedimentation line	1	pH 4~10	
			pH Analyzer	
LS-01	Waste Water Pond	1	500 mm~1,000 mm	
			Level Switch	
LS-02	Oil Separator	1	1,000 mm~1,500 mm	
			Level Switch	
LS-03	Clarified Water Pond		1,000 mm~1,500 mm	
			Level Switch	
LS-04	Backwashed Waste Water P.	1	500 mm~2,000 mm	
			Level Switch	
LS-05	Sludge Pond	1	500 mm~2,000 mm	
			Level Switch	
LC-06	Treated Water pond	1	1,000 mm~2,000 mm	
			Level Controller	

Note:

DOCUMENT TYTLE: **STANDARD SKETCH DRAWINGS OF W.W.T. MAJOR EQUIPMENT**

DOCUMENT NO. STD - CD - 20/50-01 REV. 0

PROJECT: THE STUDY ON INDUSTRIAL WASTE WATER POLLUTION CONTROL IN THE ARAB REPUBLIC OF EGYPT

CLIENT: JAPAN INTERNATIONAL COOPERATION AGENCY INDUSTRIAL DEVELOPMENT STUDY DIVISION

CONSULTANT: CHIYODA DAMES AND MOORE CO. CHIYODA CORPORATION

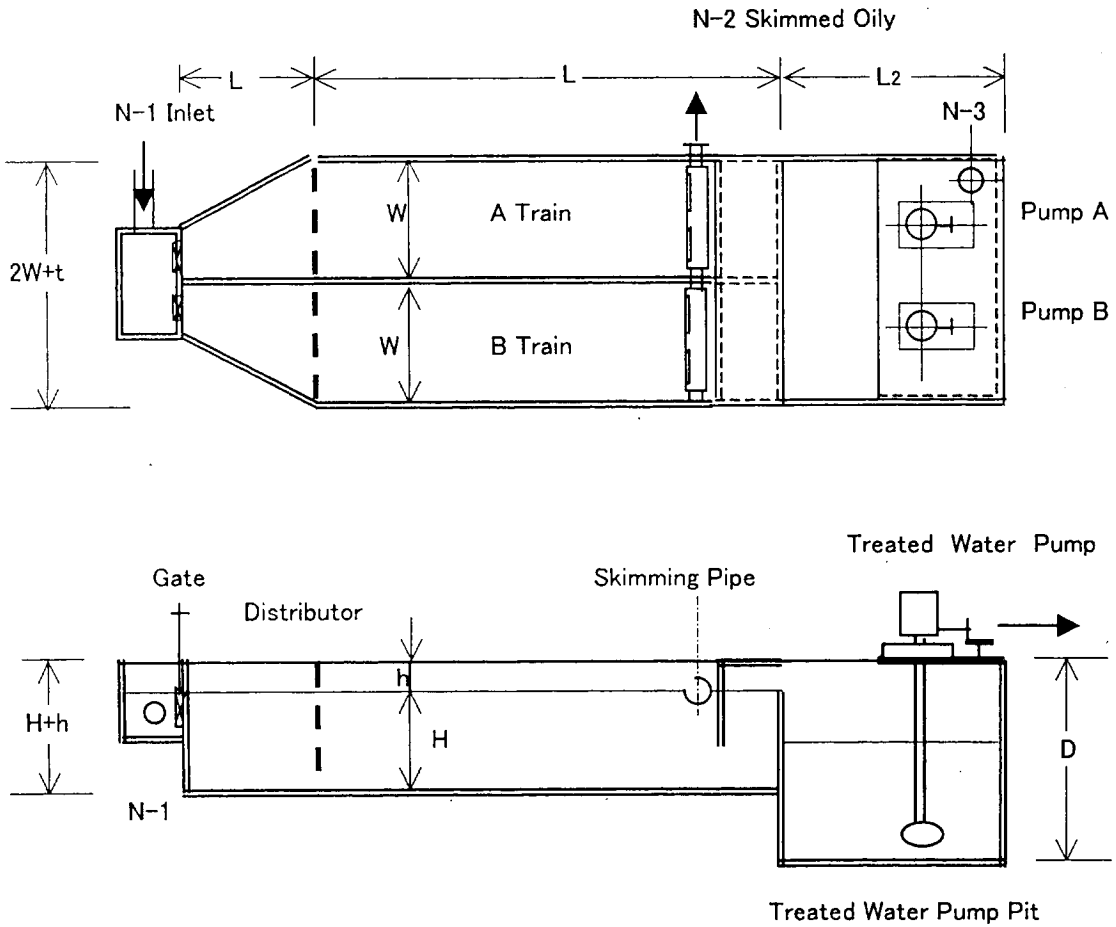
ISSUDED DATE: 1999. 10. 18

JICA

	CHCK'D	TECH.	APPR'D
SIGN			
DATE			

CONSULTANT

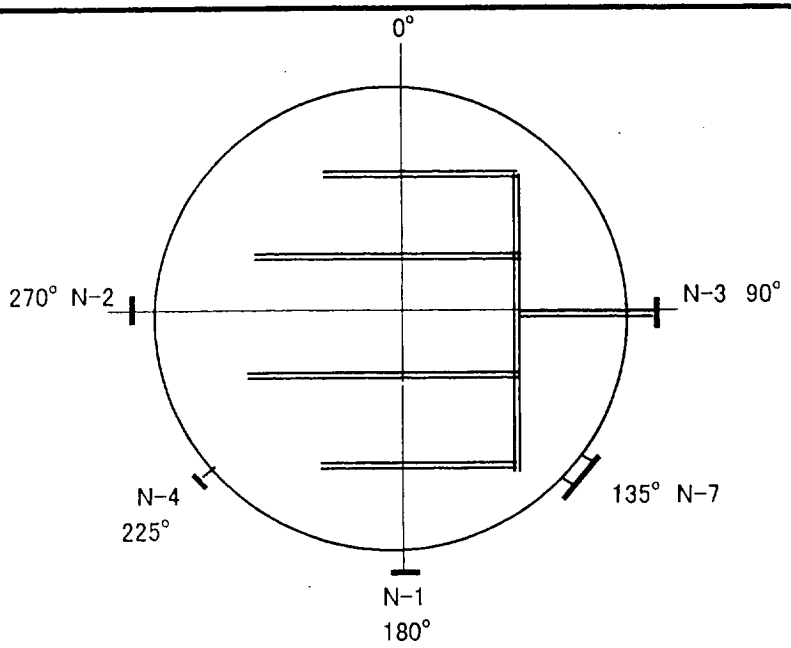
	DSGN	CHCK'D	APPR'D
SIGN			
DATE	Oct.18.'99	Oct.18'99	Nov.11'99

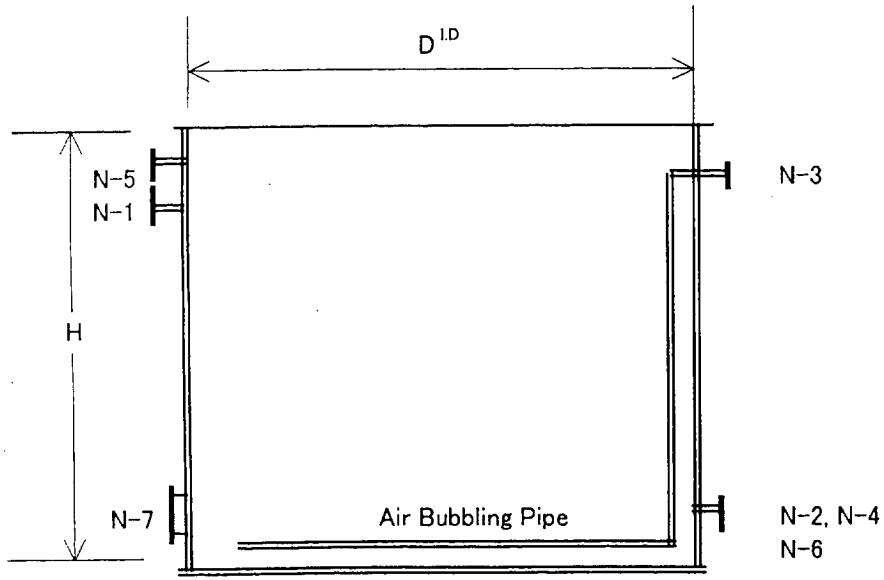


Material: Reinforced Concrete
Accessories: Skimming Pipe
Hand rail, Inside Ladder
Option: Flight Scraper (Surface, Bottom)

Nozzle No	Name	Size	No	Note
N-1	Raw Water inlet		1	
	Water Outlet			
N-2	Skimmed Oily		1	
N-3	Level Instrument		1	

CLIENT	JAPAN INTERNATIONAL COOPERATION AGENCY
TYTLE	FOR: WASTE WATER TREATMENT UNIT STANDARD DRAWING OF _____m^3/h API OIL SEPARATOR (Z-1)
DWG. NO.	STD - CD - 50 - SK01 REV.0

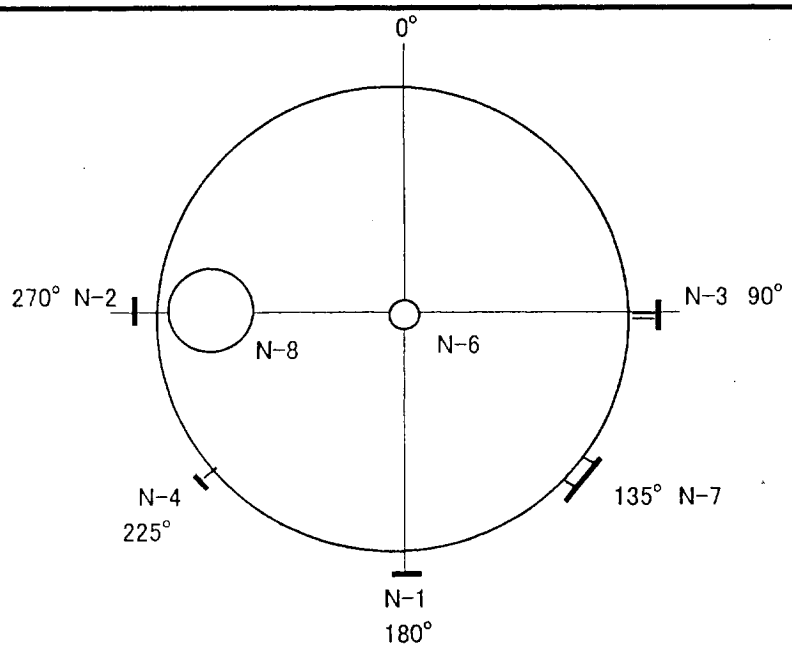




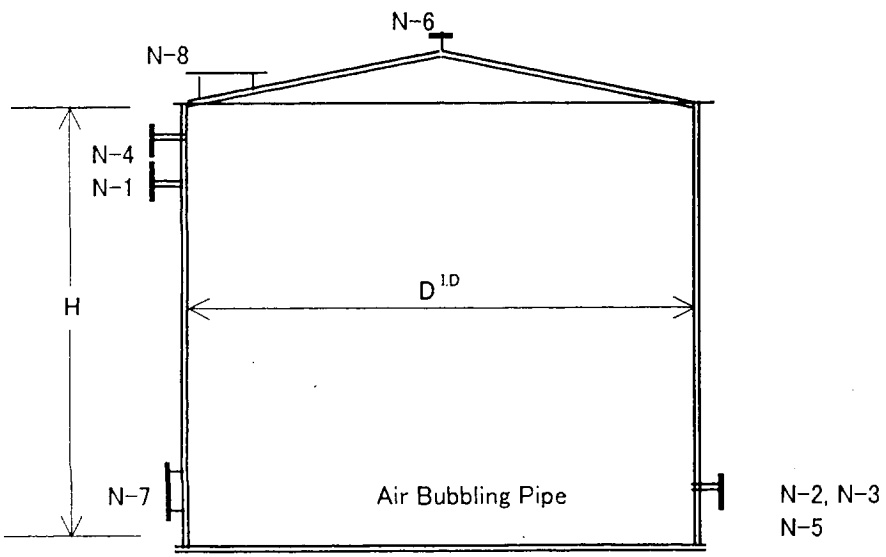
1)Type: Cylindrical Tank
(Open Top Tank)
2)Materials: Carbon Steel
inside Epoxy Coating
3)Accessories: Stairway

Nozzle No	Name	Size	No	Note
N-7	Manhole	500A	1	
N-6	Level Instrument		1	
N-5	Over Flow		1	
N-4	Drain		1	
N-3	Bubbling Air Inlet		1	
N-2	Raw Water Outlet		1	
N-1	Raw Water inlet		1	

CLIENT	JAPAN INTERNATIONAL COOPERATION AGENCY
TYTLE	FOR: WASTE WATER TREATMENT UNIT STANDARD DRAWING OF _____m^3 EQUALIZATION TANK (T-1)
DWG. NO.	STD - CD - 22 - SK01 REV.0

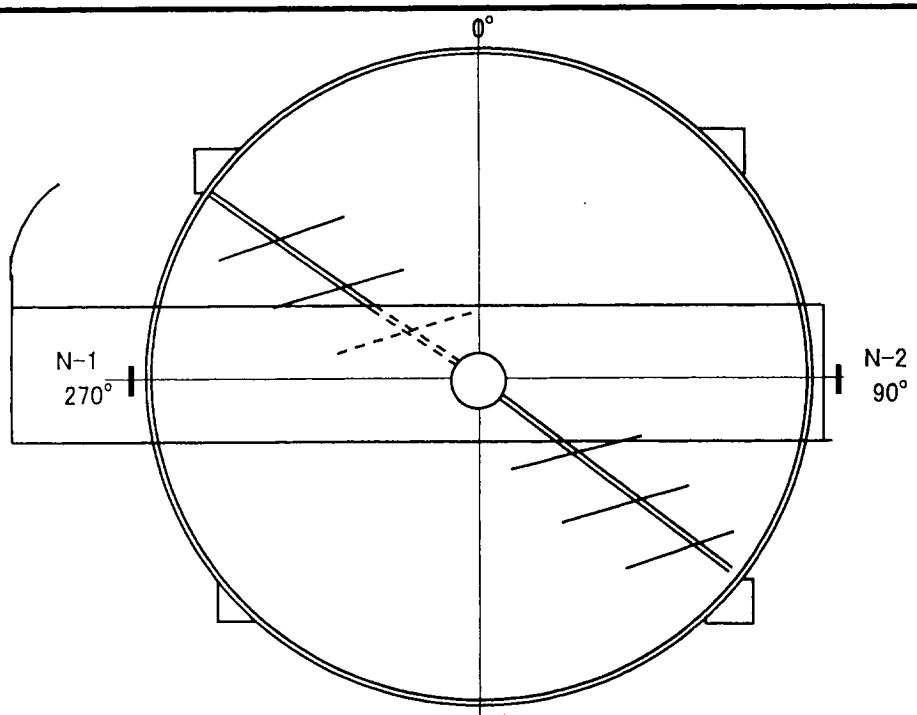


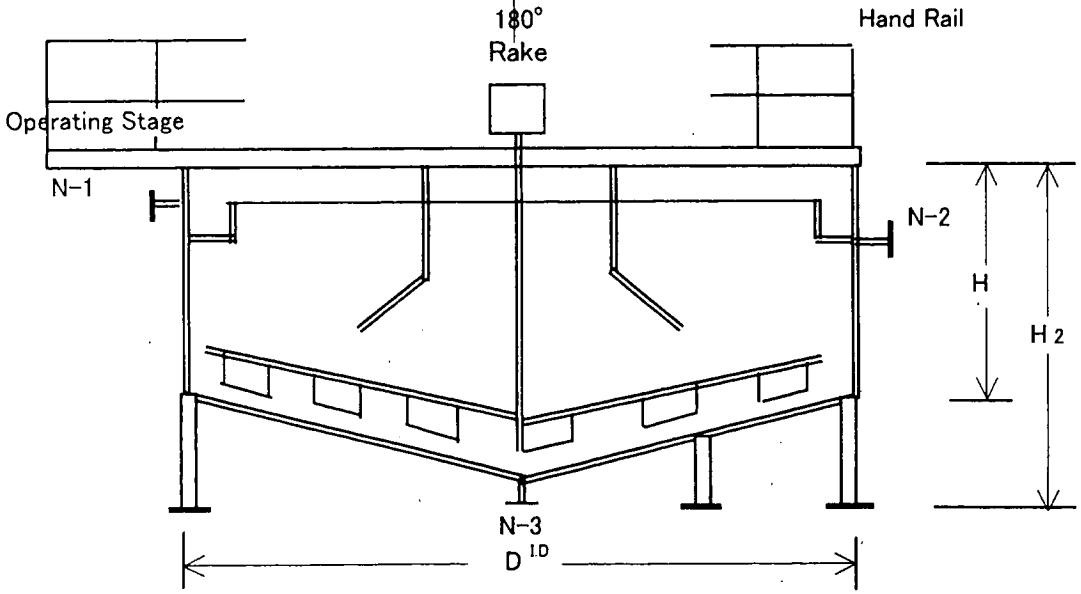
1)Type: Cylindrical Tank
(Cone Roof Tank)
2)Materials: Carbon Steel
inside Epoxy Coating
3)Accessories: Stairway



Nozzle No	Name	Size	No	Note
N-8	Roof Manhole	450A	1	
N-7	Manhole	500A	1	
N-6	Air Vent		1	
N-5	Level Instrument		1	
N-4	Over Flow		1	
N-3	Drain		1	
N-2	Raw Water Outlet		1	
N-1	Raw Water inlet		1	

CLIENT	JAPAN INTERNATIONAL COOPERATION AGENCY
TYTLE	FOR: WASTE WATER TREATMENT UNIT STANDARD DRAWING OF _____m^3 STORAGE TANK (T-2)
DWG. NO.	STD - CD - 22 - SK02 REV.0

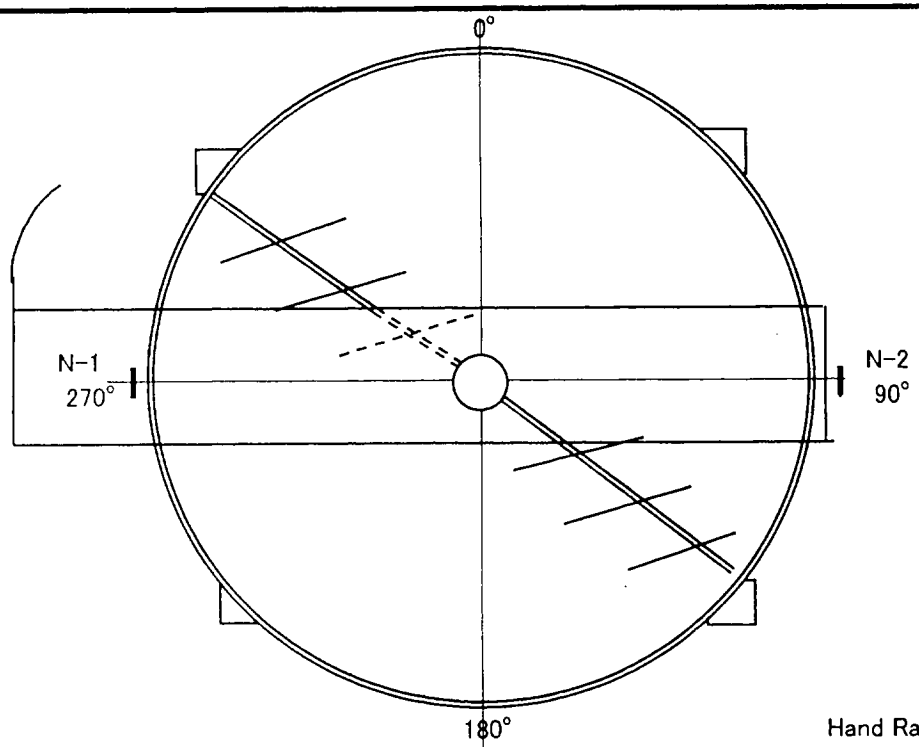




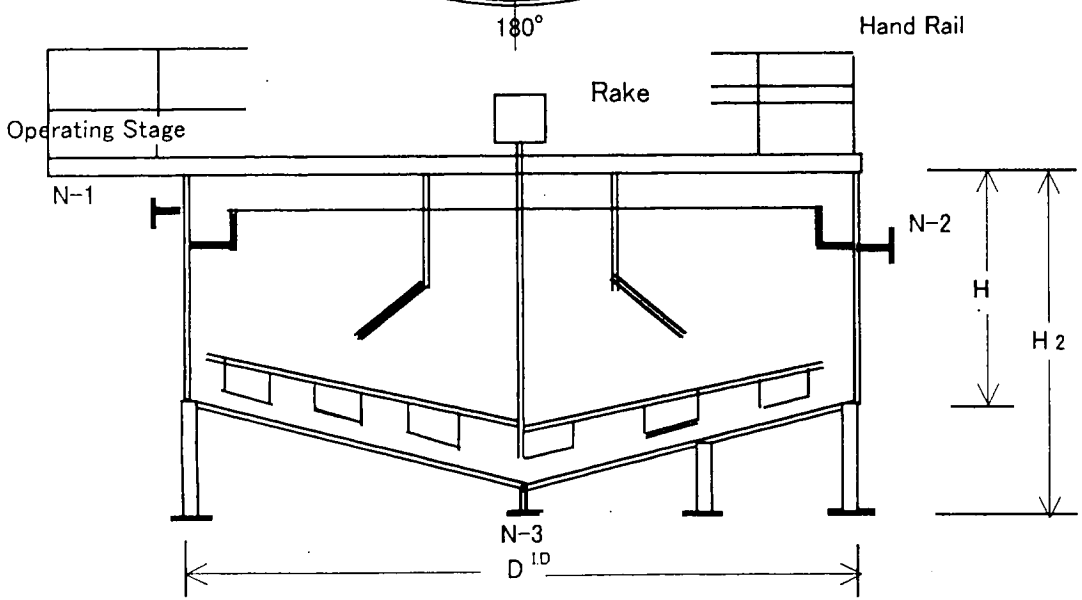
Materials: Carbon Steel/Epoxy coating
Accessories: Sludge Collection Rake
Operating Stage
Stairway

Nozzle No	Name	Size	No	Note
N-4				
N-3	Sludge Outlet		1	
N-2	Treated Water Outlet		1	
N-1	Raw Water inlet		1	

CLIENT	JAPAN INTERNATIONAL COOPERATION AGENCY
TYTLE	FOR: WASTE WATER TREATMENT UNIT STANDARD DRAWING OF _____m^3/h CLARIFIER (MZ-1)
DWG. NO.	STD - CD - 29 - SK01 REV.0

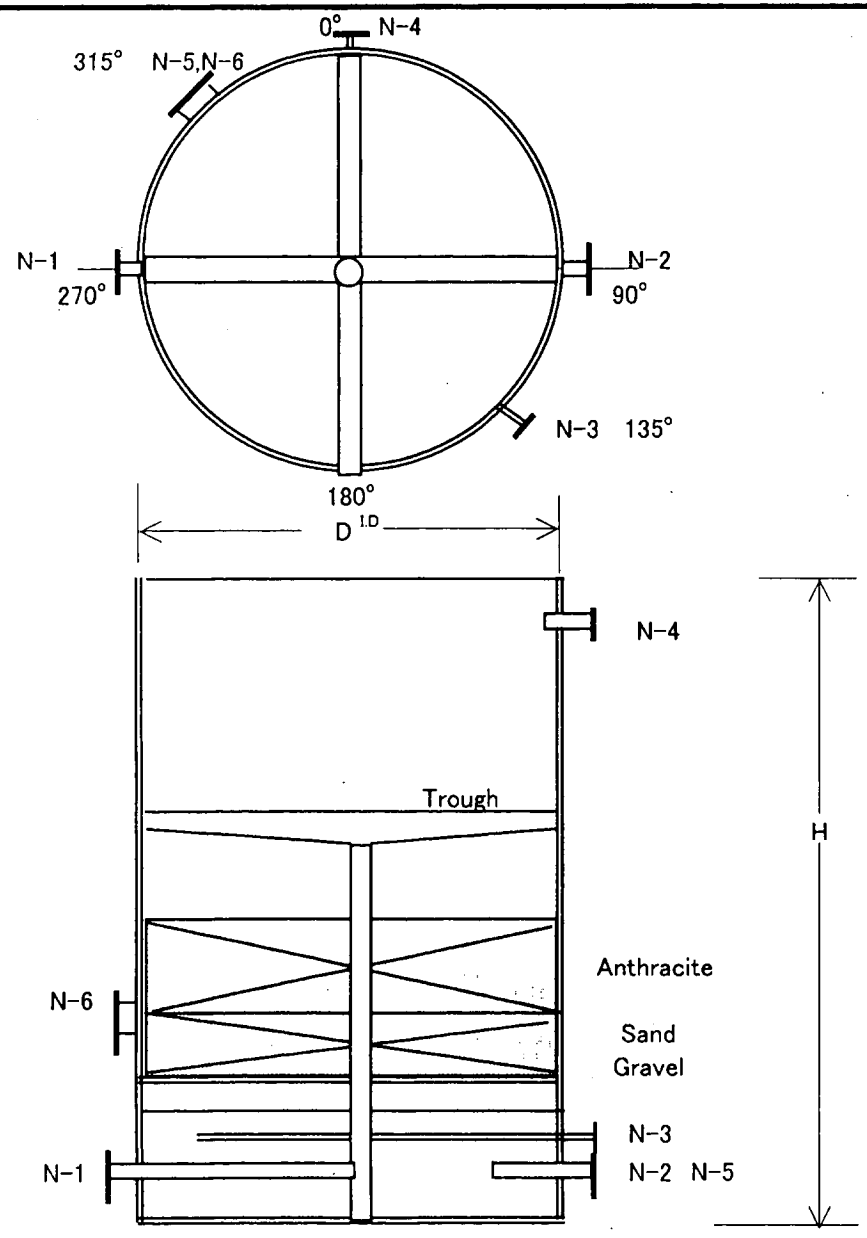


Materials: Carbon Steel/Epoxy coating
Accessories: Sludge Collection Rake
Operating Stage
Stairway



Nozzle No	Name	Size	No	Note
N-1	Raw Water inlet		1	
N-2	Treated Water Outlet		1	
N-3	Sludge Outlet		1	
N-4				

CLIENT	JAPAN INTERNATIONAL COOPERATION AGENCY
TYTLE	FOR: WASTE WATER TREATMENT UNIT STANDARD DRAWING OF _____m^3/h SLUDGE THICKENER (MZ-3)
DWG. NO.	STD - CD - 29 - SK03 REV.0



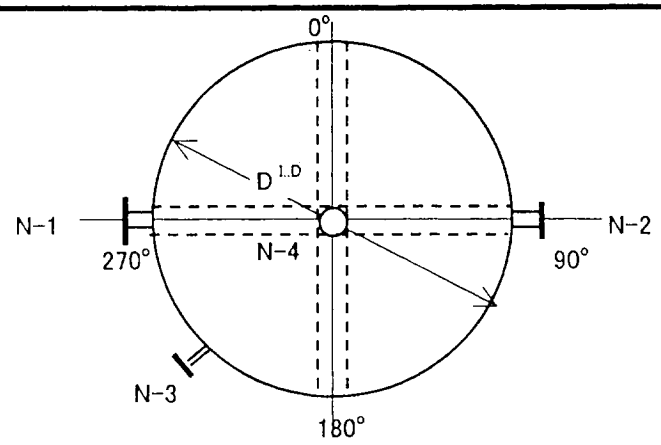
Material: Carbon steel/Epoxy Coating

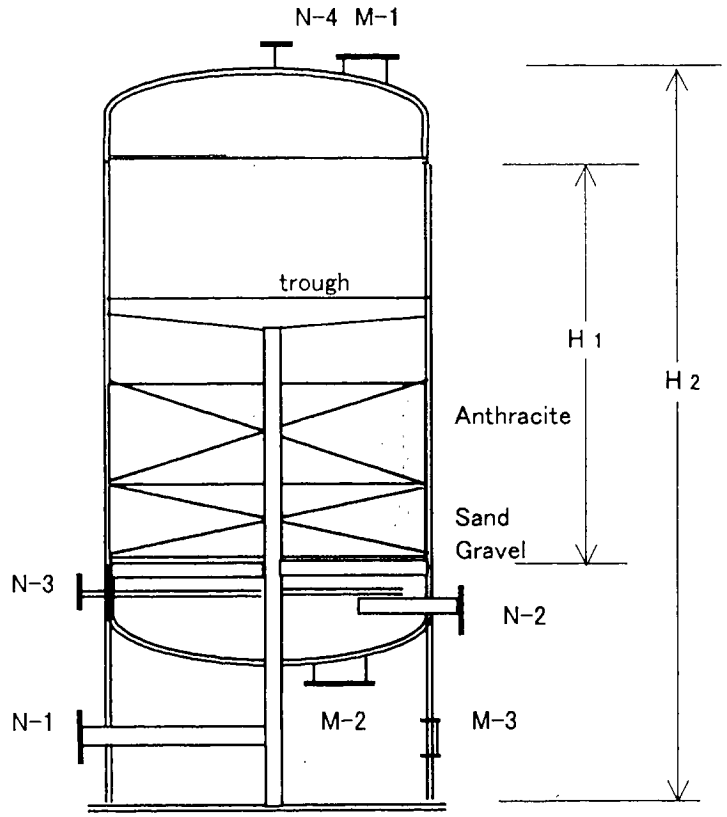
Filter Media: Anthracite + Sand/Gravel

Accessories: Operating Stage
Ladder

Nozzle No	Name	Size	No	Note
N-6	Handhole	200A	1	
N-5	Manhole	500A	1	
N-4	Over Flow		1	
N-3	Air Inlet		1	
N-2	Filtered Water Outlet/		1	
	Backwash Water Inlet			
N-1	Clarified W.ater inlet/		1	
	Backwash Waste Ouktlet			

CLIENT	JAPAN INTERNATIONAL COOPERATION AGENCY
TYTLE	FOR: WASTE WATER TREATMENT UNIT STANDARD DRAWING OF _____ m^3/h *SAND FILTER* (F-1) (GRAVITY TYPE)
DWG. NO.	STD - CD - 29 - SK03 REV.0





Materials: Carbon Steel/Epoxy Coating

Filter Media: Anthracite + Sand/Gravel

Accesary: Operating Stage
Ladder

Nozzle No	Name	Size	No	Note
M-3	Manhole	500A	1	
M-2	Manhole	500A	1	
M-1	Manhole	500A	1	
N-4	Auto Air Vent		1	
N-3	Air Inlet		1	
N-2	Filtered Water Outlet/		1	
	Backwash Water Inlet		1	
N-1	Clarified W.ater inlet/		1	
	Backwash Waste Ouktlet		1	

CLIENT	JAPAN INTERNATIONAL COOPERATION AGENCY
TYTLE	FOR: WASTE WATER TREATMENT UNIT STANDARD DRAWING OF _____m^3/h SAND FILTER (F-1) (PRESSURE TYPE)
DWG. NO.	STD - CD - 29 - SK04 REV.0

Client: JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Project Name: THE STUDY ON INDUSTRIAL WASTE WATER POLLUTION CONTROL IN THE ARAB REPUBLIC OF EGYPT

Factory Name: DELTA STEEL MILL CO.

CONCEPTUAL DESIGN

Document Title:

CALCULATION SHEET

FOR

W.W.T. DEMONSTRATION PLANT

Issued Date: September 2000

Consultant: JICA STUDY TEAM

CHIYODA DAMES AND MOORE CO.

CHIYODA CORPORATION

1. Object

This design calculation sheet is applied to the study of W.W.T. Recommendation Plant planning for "Delta Steel Mill Co.".

2. Wastewater to be treated : Air Station Wastewater

3. Design Conditions

(1) Waste management system in the Factory should be organized, and operated adequately under the responsible managers.

(2) Suitable routine works, periodical maintainances should be conducted in the whole company.

4. Contents of Wastewater Treating Facility

(1) Primary Treatment : API Type Oil separator

(2) Secondary Treatment : Chemical Clarifier

(3) Tertiary Treatment : Sand Filter

(4) Addvanced Treatment : Softener (Out of scope of work)

5. Design Basis

(1) Quality and Quantity of Influent Wastewater

Shown on Table-1.

(2) Quality and Quantity of Treated Water

The Law48/82 Discharge into Mastorod drainage canal is to Conceptional Design.

Treated water qualities are shown on Table-1.

Table-1 Design Basis of Wastewater Qualities and quantity

Items		Raw Water	Treated Water	Law48/82
Flow Rate	[m^3/h]	120	120	
pH	[-]	6 ~7	6 ~7	6 ~9
SS	[mg/L]	200	2	30
BOD	[mg/L]	20	15	20
COD	[mg/L]	30	20	30
Oil & Grease	[mg/L]	1,000	2	5
Temperature	[℃]	27.9	29.1	< 35

6. Unit Design

6.1 API Oil Separator

The API Oil Separator is to reduce the level of oil content in the wastewater from Air Station.

(1) Design Condition

1) Flow Rate : Q= 120 m^3/h= 0.0333 m^3/sec
2) Specification : Rectangular, Underground, Reinforced Concrete
3) Diameter of Globules : D= 0.015 cm
4) Horizontal Velocity : V_H= Less Than 0.9 m/min Take 0.6 m/min= 0.01 m/sec
5) Oil content of Effluent Less than 30 mg/L
6) Temperature : 25 ℃
7) Specific gravity : 25 ° API

(2) Sizing

1) Inlet Channel

a) Max. Velocity : Ymax= 0.1 m/sec Take 0.05 m
b) Required Sec. Area : A= 0.6667 m^2 W= 0.8 m ∴ H= 0.8333 m
c) Retention Time : T= 2 min
d) Inlet Channel Length: L= 6 m

2) API Oil Separator

a) Oil Globules in Wastewater

Vt= 0.1225 (Sw-So)/μ(mm/sec)= 1.78 mm/sec

Sw= Specific Gravity of Wastewater@25℃ 0.997
So= Specific Gravity of Oil @25℃ 0.869
μ = Absolute viscosity of wastewater @25℃ 0.0088 Poises

Maximum allowable mean horizontal velocity, V_H = 15Vt, not exceed 15 mm/sec.

V_H= 26.7

This exceed 15 mm/sec; therefore, use limiting V_H=15.

b) Minimum Area and Dimension

① Numbers of channels

$n \geqq Q/V_H \times A_c max \times 3.6$ = 0.1543 (n_{min}=2)

n= Numbers of channels 2
Q= Flow Rate 120 m^3/h
V_H= Maximum allowable mean horizontal velocity 15 mm/sec
$A_c$max= Maximum allowable sectional area 14.4 m^2
B= Width 1.8-6.0 m take 2.3
d= Depth 0.9-2.4 m take 0.9
d/B= 0.3-0.5 m take 0.4

② Minimum cross-section area per channel

q_a= Q/n = 60 m^3/h
A_c= $q_a/V_H \times 3.6$ = 1.11 m^2
Take: $1.7^B \times 0.7^d$: d/B= 0.7/1.7 = 0.41 OK

③ Length of separator chamber

$L = F \times d \times V_H / V_t =$ 8.7 m

L= Length of separator chamber

F= Factor $V_H/V_t =$ 8.4 ⇒ 1.48

Take: $3,400^W \times 9,000^L \times 1,200^H$

3) Pump Pit

1) Retention Time : 0.2 h
2) Required Volume : $V_P =$ 24 m^3
3) Effective Height : $H_P =$ 1 m (Take)
4) Required Area : $A_P =$ 24 m^2 W= 5 m ∴ L= 4.8 m

Take: $5,000^W \times 5,000^L \times 1,200^H$

6.2 Equalization Tank

The wastewater from API Oil Separator is stored in the Equalization Tank for equalization of wastewater quantities and qualities for further treatment.

(1) Design Conditions

1) Flow Rate : Q= 120 m^3/h
2) Specification : Rectangular, Underground, Reinforced Concrete
3) Retention Time : $T_E =$ 2 hr
4) Others : Air bubbling device

(2) Sizing

1) Required Volume : V_E= 240 m^3

2) Effective Height : H_E= 3 m

3) Required Area : A_E= 80 m^2 W= 8 m ∴ L= 10 m

Take: $8{,}000^{W} \times 10{,}000^{L} \times 3{,}500^{H}$

6.3 Rapid Mixing Tank

(1) Design Conditions

1) Retention Time : T_R= 5 min (Take)

2) Specification : Vertical Cylindrical, Carbon Steel

3) Others : Mechanical Mixing Device

(2) Sizing

1) Required Volume : V_R= 10 m^3

2) Effective Height : H_R= 2.5 m

3) Required Area : A_R= 4 m^2 D_R= 2.2573

Take: $2{,}400^{\phi} \times 3{,}000^{H}$

6.4 Flocculation Tank

(1) Design Conditions

1) Retention Time : T_F= 30 min (Take)

2) Specification : Vertical Cylindrical, Carbon Steel

3) Others : Mechanical Mixing Device

(2) Sizing

1) Required Volume : V_F= 60 m^3

2) Effective Height : H_F= 4 m (Take)

3) Required Area : A_F= 15 m^2 D_R= 4.3713 m

Take: $4{,}770^{\phi} \times 5{,}000^{H}$

6.5 Clarifier

The function of Chemical Clarifier is to reduce suspended solids (SS) and free oil of the wastewater.

(1) Design Conditions

1) Surface Load : U_C= 3 $m^3/m^2/h$ (Take)

2) Specification : Vertical Cylindrical, Carbon Steel

3) Others : Mechanical Scraper

(2) Sizing

1) Effective Height : H_C= 4 m (Take)

2) Required Area : A_C= 40 m^2 D_R= 7.1383 m

Take: $8{,}000^{\phi} \times 4{,}500^{H}$

(3) Generated Sludge

1) Generated Sludge : Wdry= 23.76 kg/hr= 570.24 kg/day
2) Conc. of Sludge : C_S= 1 %
3) Sludge Quantity : Qs= 2376 kg/hr %= 1.98
4) Dewatered Sludge(85%): W_{85}= 158.4 kg/hr= 3801.6 kg/day

6.6 Sand Filter

To remove overflow floc (SS) from Chemical Clarifier.

(1) Design Conditions

1) Surface Load : U_F= 180 m/day= 7.5 m/h
2) Specification : Vertical Cylindrical, Carbon Steel, Pressure Type
3) Number of Filter : 3 Sets (2 Operation + 1 standby)
4) Filter Media : Anthracite + Sand + Gravel
5) Backwashing : Backwashing Pump, Air Blower

(2) Filter Sizing

1) Effective Height : H_F= 4 m (Take)
2) Required Area : A_F= 8 m^2 D_R= 3.1923 m

Take: $3{,}200^{\phi} \times 4{,}000^{H}$

3) Filter Detail :

Backwash Trough - Tangential Line	0.5 m
Backwash Trough - Filter Media	1 m
Anthracite	0.8 m
Sand + gravel	0.7 m
Support - Tangential Line	0.7 m
Allowance	0.3 m
Total Height	4 m

(3) Treated Water Pond and Waste Water Pond

1) Retention Time : 0.5 h
2) Required Volume : V_T= 60 m^3
3) Effective Height : H_T= 2.5 m (Take)
4) Required Area : A_E= 24 m^2 W= 5 m ∴ L= 4.8 m

Take: $5{,}000^{W} \times 5{,}000^{L} \times 3{,}000^{H}$

(4) Backwashing Pump

1) Backwash Rate : U_B= 40 m/h (Take)
2) Flow Rate : Q_B= 320 $m^3/h \times 15\ m^{H}$
3) Backwash Time : T_B= 10 min (Take)
4) Backwash Water Volume : V_B= 53 m^3/h/Cycle