1.1.3 Monitoring and Control System

Power generators (removed already) and high tension motors (Distribution Pump x 4 sets except M37 abbreviated by the Equipment List) are monitored and controlled at the Central Operation Room. All other equipment are monitored and controlled by low tension panels (including local control boxes). "Distribution Pump x 4 sets" stated above are operated manually at the local concerned.

1.2 Equipped Condition

1.2.1 Receiving, Transforming and Distributing Systems

The captioned systems have decayed from aging more than 25 years after installation, furthermore from poor maintenance. Resulting from such conditions, many corroded and/or damaged parts are observed in the systems. The damaged parts are repaired by applying the other units' to the parts, or left without repair in case of being unable to apply the other units' to the parts.

OXFAM set a transformer (15 KV/3 KV 3,150 KVA) in 1989 to strengthen the existing transforming facilities. However the transformer has not used yet because of no connecting between the facilities due to lack of Water Authority's budget.

From the conditions stated above, the protection of the systems is insufficient and their functions are not always utilized fully. Furthermore, the guard/protection for operators is not necessarily considered enough for operations.

1.2.2 Monitoring and Control Systems

The said Systems as well as Receiving, Transforming and Distributing Systems are deteriorated, and corroded and damaged parts are observed in the Systems. Intake Pumps are designed as the Pumps can be stopped at Intake site, and started and stopped at Treatment sites. At present, however, the Pumps can be operated only at the Treatment Plant due to damage of the control cable according to the information from the local counterparts.

Some power source cables to the Systems have been altered to cover the aged and damaged facilities without records, and eventually the supply system of power source becomes unknown for all operators.

1.2.3 Results of Insulation Test for Cables

As stated in "Field Survey of Insulation Test for Cables" attached in the Paper, some 50 % of existing low tension cables were tested in the field. The obtained insulation values are more than standard values stated in Technical Standard of Electric Facilities in Japan revised in 1992, although the values have become rather lower. As the remaining 50 % of cables will be in almost same condition, it can be estimated that the cables will be able to still use in operation including cables changed by OXFAM.

2. CHAMCAR MORN TREATMENT PLANT

2.1 Outline Of Facilities

2.1.1 Power Receiving System

The Treatment Plant receives one line of low tension power supply (380 and 220 V) with a transformer (15 KV/380 - 220 V) set in the premises, which belongs to EDP.

2.1.2 Distribution System

After receiving the power by low tension panels and local control boxes, the power is supplied to every facilities. The System does not equip with relay panels and control center, and supply and control circuits are all set into low tension and local panels.

2.1.3 Monitoring and Control System

Monitoring System is not set except ammeters and voltmeters. The operation like starting and stopping is carried out by low tension panels and local control boxes directly.

2.2 Equipped Condition

2.2.1 Receiving and Distributing Systems

The Systems have become deteriorated considerably with the lapse of more than 35 years after installation, and a number of corroded and damaged parts are seen in the Systems. Breakers, power fuses and cables of Distribution and Backwash Pumps, and Backwash Blowers are changed into new ones by Water Authority themselves in 1992.

2.2.2 Monitoring and Control Systems

Same as Receiving and Distributing Systems, a number of aged and corroded damages are seen in the Systems. Although some parts of cables are set on the cable-rack, almost cables are installed directly into concrete without conduit tubes. Ammeters, voltmeters and water level meters are not operated at all.

2.2.3 Results of Insulation Test for Cables

As stated in "Field Survey of Insulation Test for Cables" attached in the Paper, most existing low tension cables were tested in the field. The obtained insulation values are more than standard values stated in

Technical Standard of Electric Facilities in Japan revised in 1992, although the values have become rather lower. It will be able to estimate that the cables can be still used in operation including cables replaced by Water Authority.

No.	Item	No.	Description	Remarks		
				Cor.	Aged	Out.
1.	**Phum Prek Treatment Plant**					
E1)	Local Control Box	1	Flash Mixer x 2 Flocculator x 12	*	*	*
E2)	Operation Table	6	1 Table/[2 Filters] x 6	*	*	
E3)	Measuring Panel	1	Total Flow of Filtered Water	*	*	
E4)	Switch Box	1	Outside and Inside Lighting (for Flocculation & Sedimentation Basins)	*	*	*
E5)	High Tension Panel	3	Raw Water Intake Pump x 3	*	*	*
E6)	- do -	4	Distribution Pump x 3 (France)	*	*	*
E7)	- do -	4	Generator (1500 KVA x 3)	*	*	*
E8)	- do -	8	Distribution Pump x 4 (Japan)	*	*	*
E9)	- do -	12	Power Receiving and Distribution	*	*	*
E10)	Low Tension Panel	8	Low Tension Leading-in Generator (400 KVA) Low Tension Pump Ventilation, Lighting	*	*	*

No.	Item	No.	Description	Remarks		
				Cor.	Aged	Out.
E11)	Power Source Box	4	Air Blower for Back Wash x 1; Air Compressor for Pneumatic Operation System x 2; Air Compressor for Respirator x 1			
E12)	Switch Box	2	Air Compressor for Pneumatic Operation System x 2			
E13)	Local Control Box	4	Vacuum System for Distribution Pump x 4	*	*	*
E14)	Power Source Box	1	Power for Vacuum System	*	*	*
E15)	Low Tension Panel	8	Appurtenances for Generator	*	*	*
E16)	Power Source Box	2	Power Source for Direct Current Power Source Equipment	*	*	*
E17)	Switch Box	2	Inside Lighting	*	*	*
E18)	Central Operation Panel	11	Control and Monitor	*	*	*
E19)	Measuring Panel	1	Water Level for Settled Water channel			
E20)	Switch Box	3	Alum Doser x 3			
E21)	Local Control	1	Alum. Doser, Alum. Agi-	*	*	*

No.	Item	No.	Description	Remarks		
				Cor.	Aged	Out.
	Box		tator, Sulfate Pump			
E22)	Measuring Panel	2	Alum. Doser	*	*	
E23)	Local Control Box	1	Lime Pump x 2 Lime Mixer x 2 Compressor x 1 Lime Lifter x 1	*	*	*
E24)	Switch Box	1	Overhead Traveling Crane (Chlorine Storage Room)	*	*	*
E25)	Switch Box	1	Distribution Pump House (Japan)	*	*	*
E26)	Switch Box	1	Distribution Pump House (France)	*	*	*
E27)	Switch Box	1	Generator Room	*	*	*
E28)	Power Source	2	Power for Work Shop; Distribution Pump House (Japan); Air Conditioner, Outside and Inside Lighting (Administrative Building)	*	*	*
E29)	Power Source Box	5	Lighting, Fan and Machinery (Work Shop)			
E30)	Power Source Box	1	Compressor x 1 Inside and Outside Lighting; Overhead Traveling	*	*	*

No.	Item	No.	Description	Remarks Cor.	Aged	Out.
			Crane (Intake Tower)			
E31)	Operation Table	1	Raw Water Intake Pump x 1 Compressor x 1; Overhead Traveling Crane (Intake Tower)	*	*	*

(Note) Cor. : Corroded
Out. : Out-of-order
* : to fall under the item.

2. Chamcar Morn Treatment Plant

No.	Item	No.	Description	Cor.	Aged	Out.
E101)	Low Tension Panel	1	Low Tension Leading-in Distribution Pump x 3 Backwash Pump x 2 Air Blower for Backwash x 3	*	*	*
E102)	Local Control Box	1	Alum Doser x 2 Lime Doser x 2 Pressure Pump for Chlorinator x 1	*	*	*
E103)	Power Source Box	4	---			
E104)	Switch Box	4	---			
E105)	Power Source Box	1	Welding Machine	*	*	*
E106)	Low Tension Panel	1	Raw Water Pump x 3	*	*	*

Fig_1 SCHEMATIC DIAGRAM FOR HIGH TENSION (Phum Prek)

(1/5)

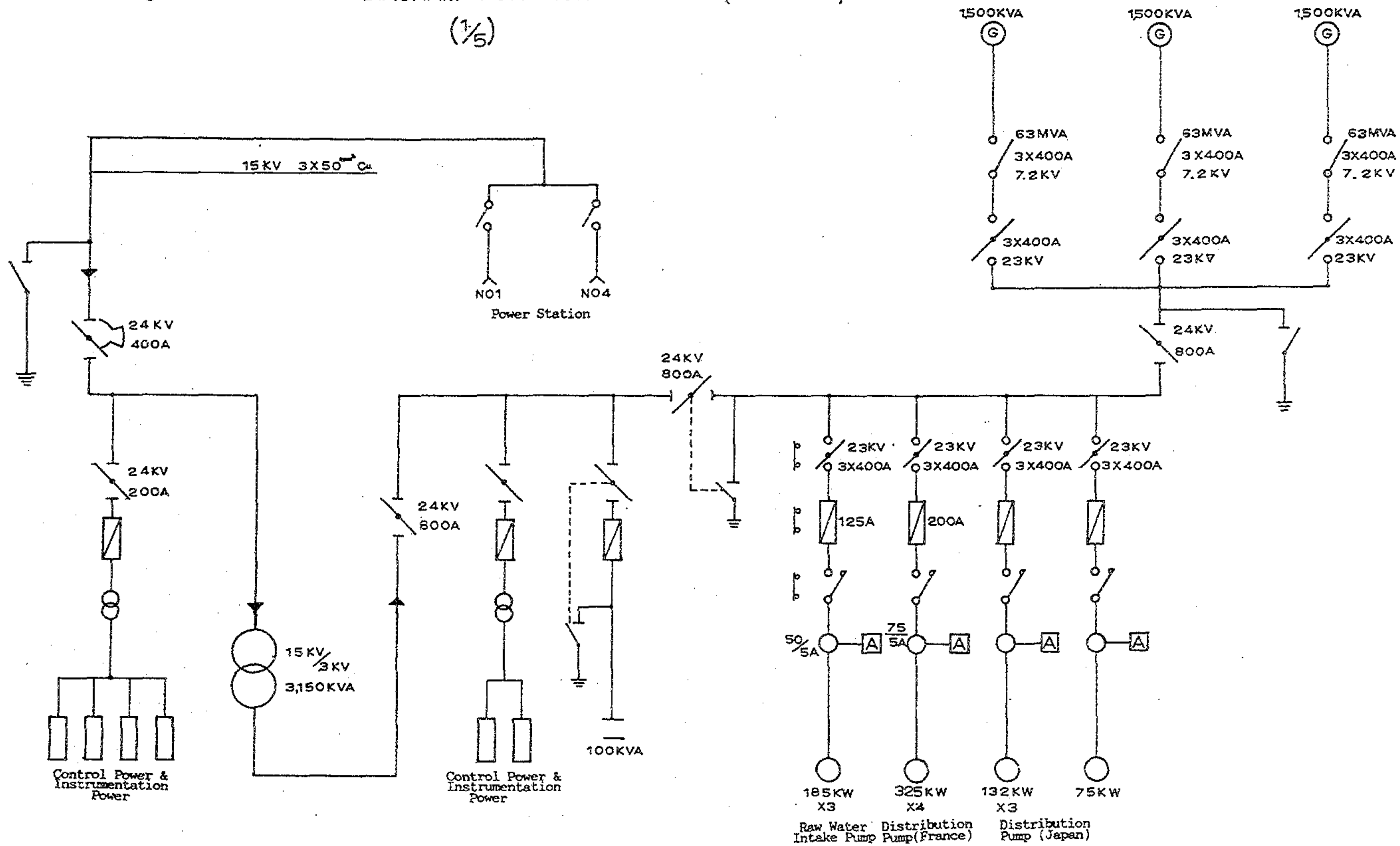


Fig.2 SCHEMATIC DIAGRAM FOR LOW TENSION

(Phum Prek) (2/5)

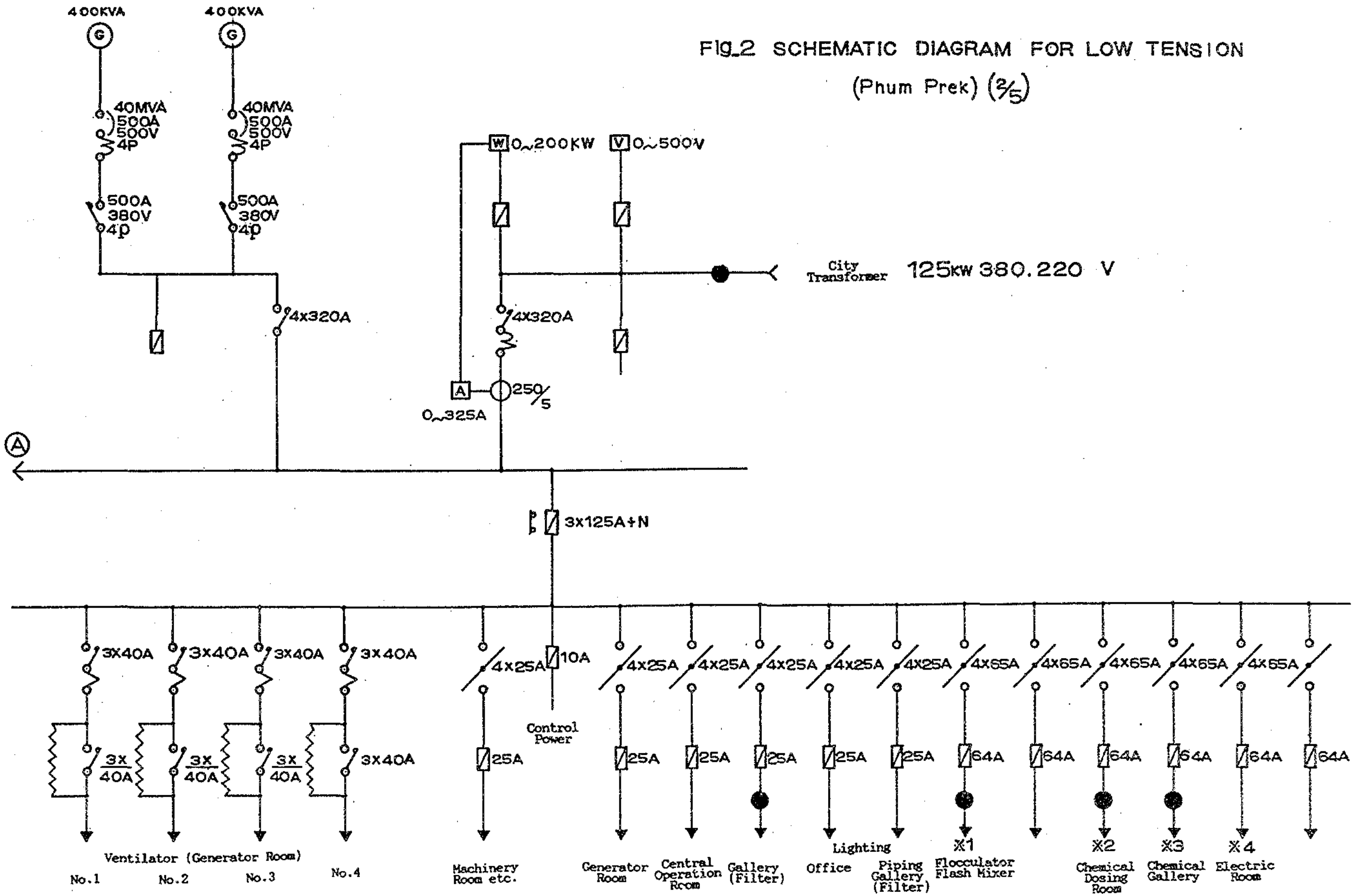
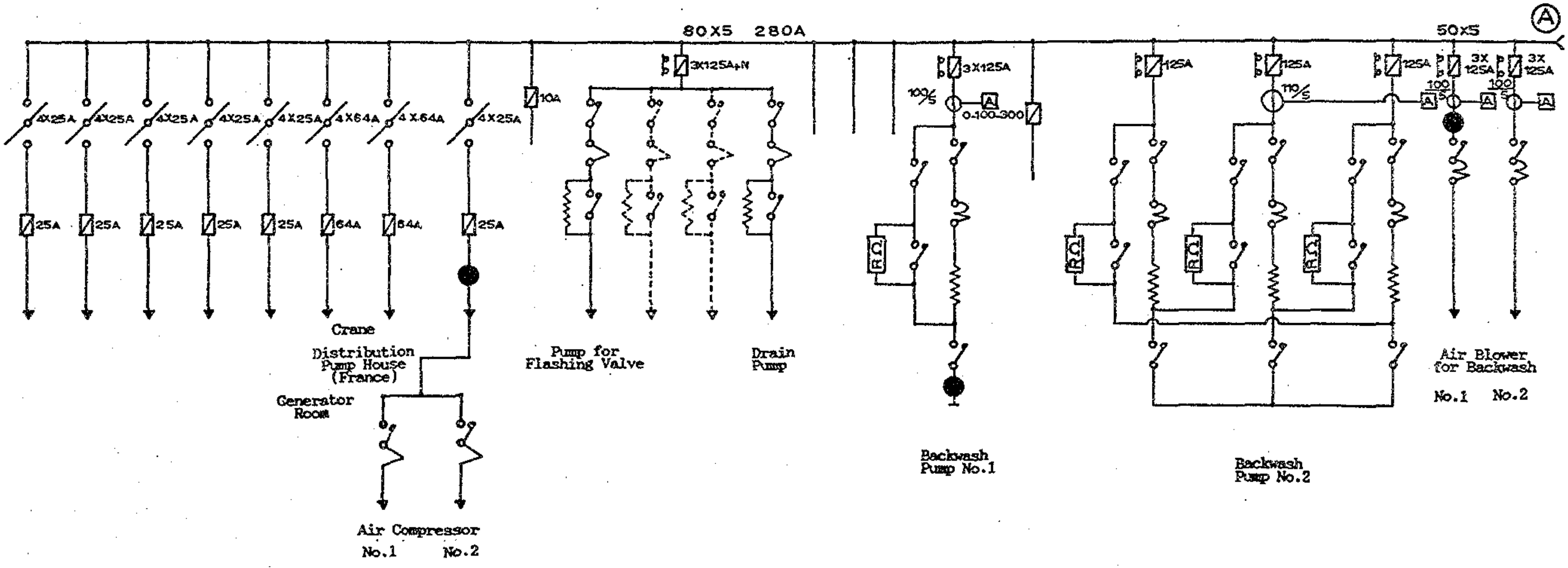


FIG_3 SCHEMATIC DIAGRAM FOR LOW TENSION (Phum Prek)

(3/5)



●: Areas where insulation tests were carried out

FIG_4 SCHEMATIC DIAGRAM FOR LOW TENSION (Phum Prek) (4/5)

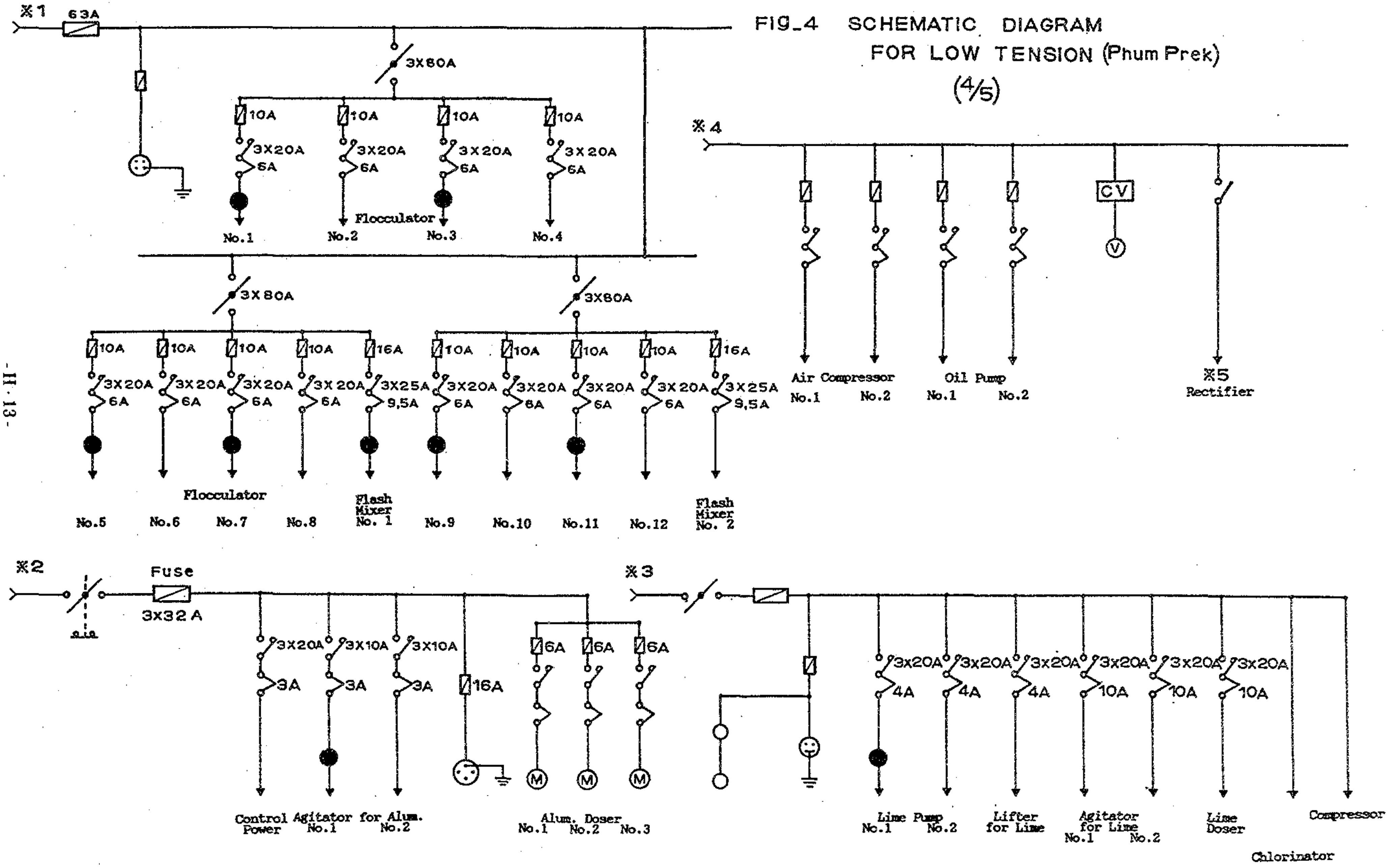


FIG_5 SCHEMATIC DIAGRAM FOR DIRECT CURRENT (PhumPrek)

(5/5)

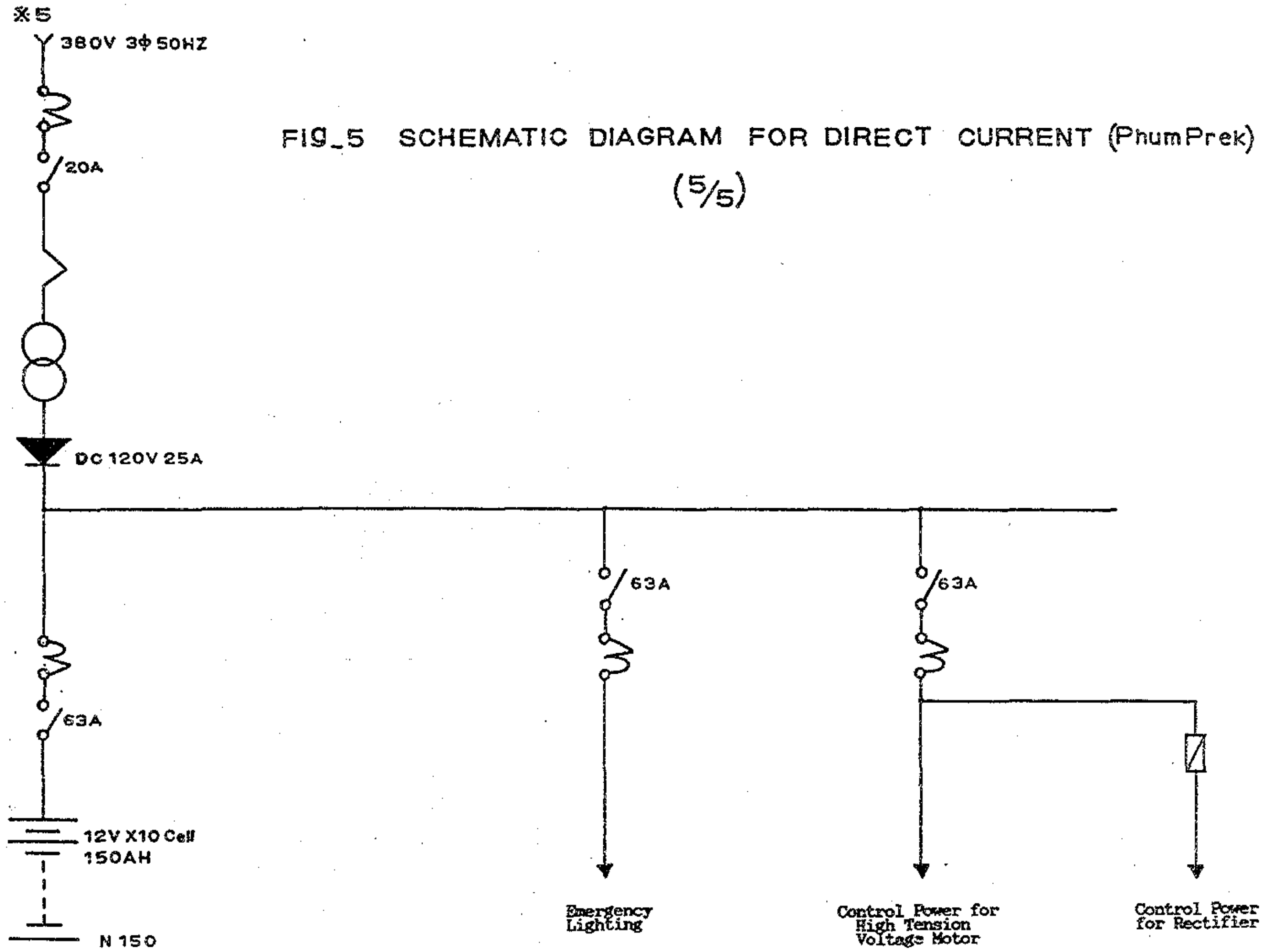
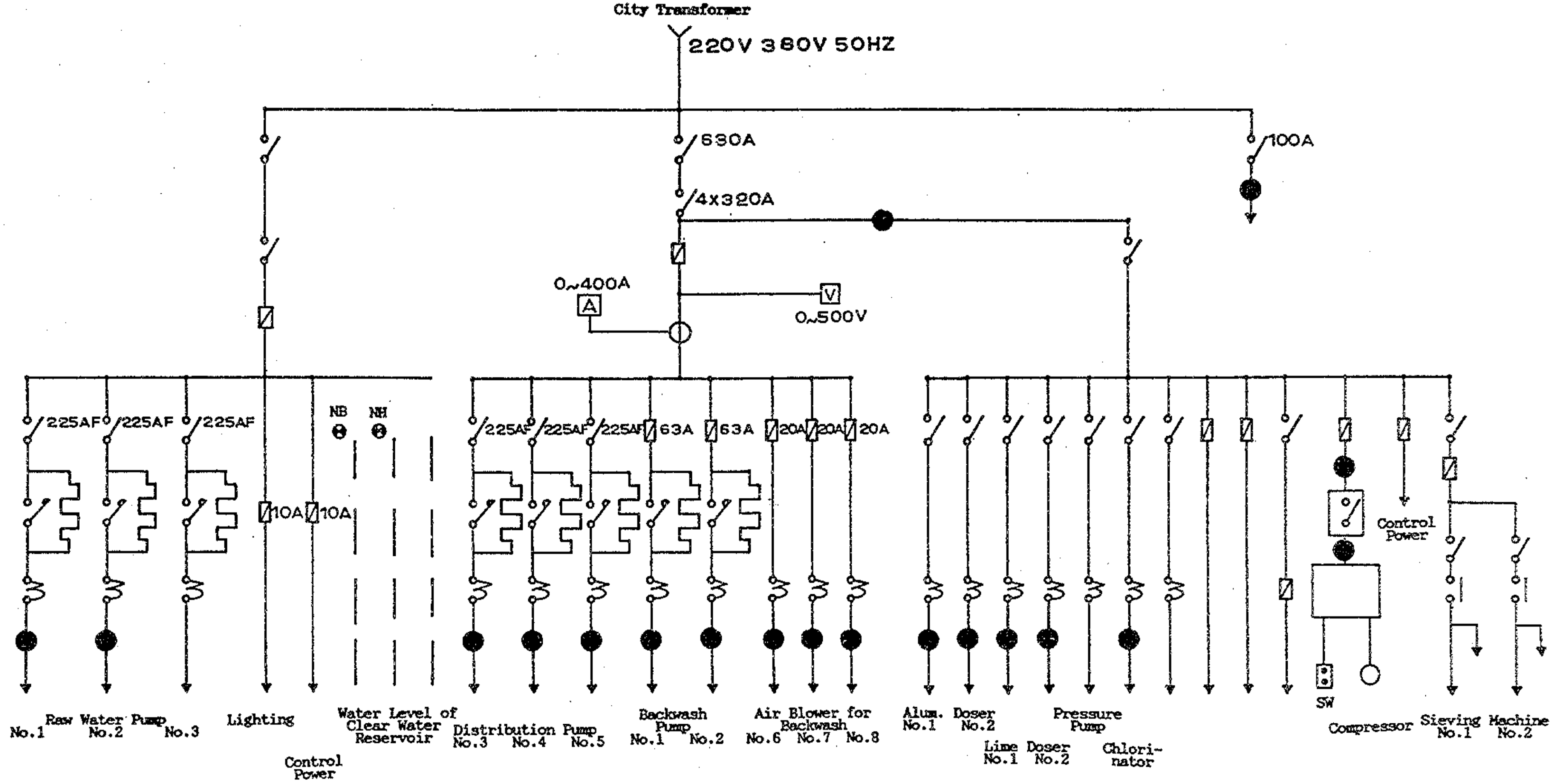


Fig_6 SCHEMATIC DIAGRAM FOR LOW TENSION (Chamcar Morn)



APPENDIX I

FIELD SURVEY OF INSULATION AND VOLTAGE REGULATION TESTS

APPENDIX I

FIELD SURVEY OF INSULATION AND VOLTAGE REGULATION TESTS

CONTENTS

FIELD SURVEY OF INSULATION AND VOLTAGE REGULATION TESTS

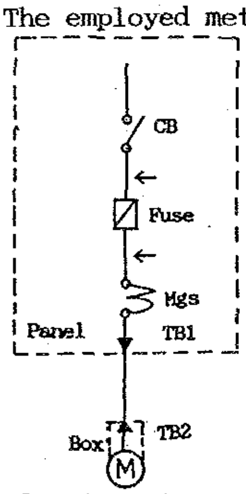
1. FIELD SURVEY OF INSULATION TEST FOR CABLES

The Study Team conducted the field survey of insulation test for cabling at the premises of Phum Prek Treatment Plant as one of on-the-job training as follows:

Date	:	24 to 26 March 1993
Tester	:	Mr. Kazumi KANIE (Study Team member)
Attendant	:	Mr. Long Naro and his Staff (Water Authority) One Staff of Electricite de Phnom Penh
Instrument	:	Insulation Resistance Tester (Model 2407, YOKOGAWA) Circuit Tester (Model 3030, HIOKI)

As the power supply had to be cut for the tests, the tests were carried out in the evening, considering the minimized influences for consumers in the City. The tests were conducted in the presence of the staff of Electric Department in order to open the switch belonging to the Department, together with technical transfer.

The employed method of the insulation tests is:



a) Measuring voltage of CB secondary circuit,
b) Cutting off CB and Fuse,
c) Measuring voltage of Fuse secondary circuit,
d) Detaching cables at TB1,
e) Detaching cables at TB2,
f) Measuring insulation between TB1 and TB2,
g) Connecting cables at TB1 and TB2,
h) Putting on Fuse and CB, and
i) Putting on Motor and confirming its revolution.

Almost test results are acceptable because of more than 0.4 megohm in case of more than 300 V (more than 0.1 megohm at 300 V and less), although insulation between Local Control Box (E23) and No.1 Lime Pump is still questionable. The results of the test are shown in the attached table. The instrument used at the field survey are to be donated to the Water Authority after the Study works, with instructions.

Insulation Test Result
(Phum Prek Treatment Plant)

Tested Area From	Tested Area To	R-S	R-T	S-T (megohm)	R-N	S-N	T-N
Local Control Box (E1)	No. 1 Flocculator	12.6	12.4	12.6	-	-	-
Local Control Box (E1)	No. 3 Flocculator	14.4	17.3	17.0	-	-	-
Local Control Box (E1)	No. 5 Flocculator	17.7	14.4	17.9	-	-	-
Local Control Box (E1)	No. 7 Flocculator	13.1	14.8	15.4	-	-	-
Local Control Box (E1)	No. 9 Flocculator	10.7	7.6	15.5	-	-	-
Local Control Box (E1)	No. 1 Flash Mixer	12.4	15.6	12.4	-	-	-
Low Tension Panel (E10)	Local Control Box (E1)	12.5	11.9	12.6	-	-	-
Low Tension Panel (E10)	Switch Box (E4)	6.0	8.3	11.1	10.4	4.7	1.4
Low Tension Panel (E10)	Power Source Box (E11)	6.9	15.5	6.8	-	-	-
Low Tension Panel (E10)	Local Control Box (E21)	3.2	16.6	16.3	11.5	12.3	28.6
Low Tension Panel (E10)	Local Control Box (E23, 24)	3.8	3.6	5.4	-	-	-
Low Tension Panel (E10)	No. 1 Back Wash Pump	12.4	12.9	12.5	-	-	-
Local Control Box (E21)	No. 1 Agitator for Alum.	10.3	13.7	10.2	-	-	-
Local Control Box (E23)	No. 1 Lime Pump	0.8	5.0	5.0	-	-	-
City Transformer	Low Tension Panel (E10)	16.8	3.7	12.3	12.2	1.4	1.1
Operation Table (E31)	Compressor	7.5	6.5	4.2	2.1	4.6	6.8

(Note) Bracketed figures like (E31) denote equipment no. in EQUIPMENT LIST in APPENDIX. R, S, T & N : Name of Phase

Insulation Test Result
(Chamcar Morn Treatment Plant)

Date : 15 - 19 April 1993
Attendant : Mr. Long Naro
Mr. Samreth Sovithyea

Tested Area From	Tested Area To	R-S	R-T	S-T	R-N	S-N	T-N
		(megohm)					
Local Tension Panel (E101)	No. 1 Back-Wash Pump	11.1	7.9	13.0	-	-	-
Low Tension Panel (E101)	No. 2 Back-Wash Pump	16.8	8.3	14.0	-	-	-
Low Tension Panel (E101)	No. 3 Distri-bution Pump	12.2	15.5	7.3	-	-	-
Low Tension Panel (E101)	No. 4 Distri-bution Pump	12.6	14.8	5.6	-	-	-
Low Tension Panel (E101)	No. 5 Distri-bution Pump	9.5	9.2	15.6	-	-	-
Low Tension Panel (E101)	No.6 Air Blower for BackWash Pump	4.5	5.4	12.2	-	-	-
Low Tension Panel (E101)	No.7 Air Blower for BackWash Pump	6.0	10.5	14.7	-	-	-
Low Tension Panel (E101)	No.8 Air Blow-er for BackWash Pump	16.7	5.6	12.3	-	-	-
Local Control Box (E102)	No. 1 Lime Pump	7.0	9.0	15.7	-	-	-
Local Control Box (E102)	No. 2 Lime Pump	12.4	14.9	16.1	-	-	-
Local Control Box (E102)	Chlorinator	14.7	1.8	15.5	-	-	-
Power Source Box (E103)	Compressor	3.1	3.7	14.5	-	-	-
Low Tension Panel (E101)	Power Source	12.3	17.0	17.9	-	-	-
City Trans-former Room	Power Source Box (E105)	4.2	12.0	11.8	-	-	-
Low Tension Panel (E106)	No. 1 Raw Water Pump	15.1	5.5	14.1	-	-	-
Low Tension Panel (E106)	No. 2 Raw Water Pump	10.8	11.8	3.9	-	-	-

2. FIELD SURVEY OF VOLTAGE REGULATION TEST

The Study Team conducted the field survey of the voltage regulation for the supplied power at Phum Prek and Chamcar Morn Treatment Plants to understand the present supply condition and get data for the future expansion project which is to be planned in the Master Plan stage.

Date	: 14 to 30 April 1993
Tester	: Mr. Kazumi KANIE (Study Team member)
Attendant	: Mr. Long Naro (Water Authority)
	Mr. Sek Saman (Water Authority)
Instrument	: Voltage Tester (Model 2407, YOKOGAWA)

The obtained test results are shown in the attached table. The range of the voltage regulation is some 329 to 380 V at Phum Prek and 328 to 358 V at Chamcar Morn Treatment Plants. They are beyond the allowable range of voltage regulation in which motor can be operated without any troubles and should be within $\pm$ 10 % of the rated voltage.

When the electric facilities will be replaced or newly designed, therefore, the following countermeasures should be thoroughly considered for the coming replacement or design to diminish voltage regulation as far as possible:

a) To install exclusive cable(s) for power supply,
b) To make power supply by high tension,
c) To select appropriate cable(s) in diameter, and
d) To set condenser(s).

Voltage Regulation Test Result

(Unit : V)

Conducted Date	Phum Prek R - S	Phum Prek R - T	Chamcar Morn R - S	Chamcar Morn R - T
14 Apr 93 (Wed)	372/374 15:25 - 15:35	372/374 15:35 - 15:45	349/355 16:00 - 16:10	348/355 16:10 - 16:20
16 Apr 93 (Fri)	367/370 14:25 - 14:35	367/372 14:35 - 14:45	340/347 15:00 - 15:10	336/341 15:10 - 15:20
19 Apr 93 (Mon)	352/360 16:20 - 16:30	352/364 16:30 - 16:40	353/358 14:05 - 14:15	343/356 14:15 - 14:25
21 Apr 93 (Wed)	342/370 14:50 - 15:00	343/354 15:00 - 15:10	331/350 14:15 - 14:25	350/355 14:25 - 14:35
22 Apr 93 (Thu)	358/379 14:20 - 14:30	351/374 14:30 - 14:40	328/346 15:00 - 15:10	328/355 15:10 - 15:20
23 Apr 93 (Fri)	343/378 11:20 - 11:30	376/379 11:30 - 11:40	341/347 15:55 - 16:05	338/350 16:05 - 16:15
24 Apr 93 (Sat)	340/360 09:25 - 09:35	339/367 09:35 - 09:45	341/348 11:25 - 11:35	347/355 11:35 - 11:45
25 Apr 93 (Sun)	342/352 09:30 - 09:40	348/354 09:40 - 09:50	- -	- -
26 Apr 93 (Mon)	366/370 14:25 - 14:35	365/369 14:35 - 14:45	- -	- -
27 Apr 93 (Tue)	362/365 13:30 - 13:40	364/366 13:40 - 13:50	- -	- -
28 Apr 93 (Wed)	361/366 09:05 - 09:15	359/369 09:15 - 09:25	- -	- -
29 Apr 93 (Thu)	341/368 13:50 - 14:00	329/374 14:00 - 14:10	- -	- -
30 Apr 93 (Fri)	375/380 15:40 - 15:50	373/377 15:50 - 16:00	- -	- -
R-S; R-T MIN/MAX	340/380	329/379	328/358	328/356
MIN/MAX	329/380 (380)		328/358 (380)	

(Note) 372/374 means "MIN/MAX".

APPENDIX J

FIELD SURVEY OF SCHMIDT CONCRETE HAMMERING

APPENDIX J

FIELD SURVEY OF SCHMIDT CONCRETE HAMMERING

CONTENTS

PAGE

FIELD SURVEY OF SCHMIDT CONCRETE HAMMERING

1. FIELD SURVEY

The Study Team conducted the field survey of Schmidt Hammer Tests for the existing structures of Phum Prek, Chamcar Morn, and Chrouy Chang-war Treatment Plants with Elevated Tank. The tests were at the same time carried out as one of on-the-job training for the local staff.

Date	:	20 to 22 April 1993
Tester	:	Mr. Takayuki TANGE (Study Team member)
		Mr. Kazumi KANIE (Study Team member)
Attendant	:	Mr. Long Naro (Water Supply Authority)
		One Staff of Water Supply Authority
Instrument	:	Schmidt Concrete Test Hammer (Model : N Type)

The field tests at Phum Prek Treatment Plant were eventually conducted 18 points as shown in Table-1. Of the results, most of the obtained estimated results of the strength are more than 300 kg/cm2 except two points which are also more than 250 kg/cm2.

The test results show more than 270 kg/cm2 consisting of 9 points of Chamcar Morn Treatment Plant. Their locations are as shown in Fig-2 attached herein, and test results are in Table-2.

The test results of Chrouy Changwar Treatment Plant are as shown in Table-3. Of the conducted 13 points, about half of the results are less than 300 kg/cm2, but all of them are more than 240 kg/cm2 as shown in the Table-3.

According to the results of Elevated Tank, which are in Fig-4 and Table-4, the points which show less than 300 kg/cm2 are located mostly on the upper structure.

From these test results, every strength of all tested points is acceptable, even though some of them are 240 - 250 kg/cm2. The structures of Chrouy Changwar Treatment Plant as well are mostly acceptable in their strength in practical, although some spots were observed that concrete was deteriorated.

Fig-1 LOCATION OF SCHMIDT HAMMER TESTS IN PHUM PREK TREATMENT PLANT

Scale = Non.

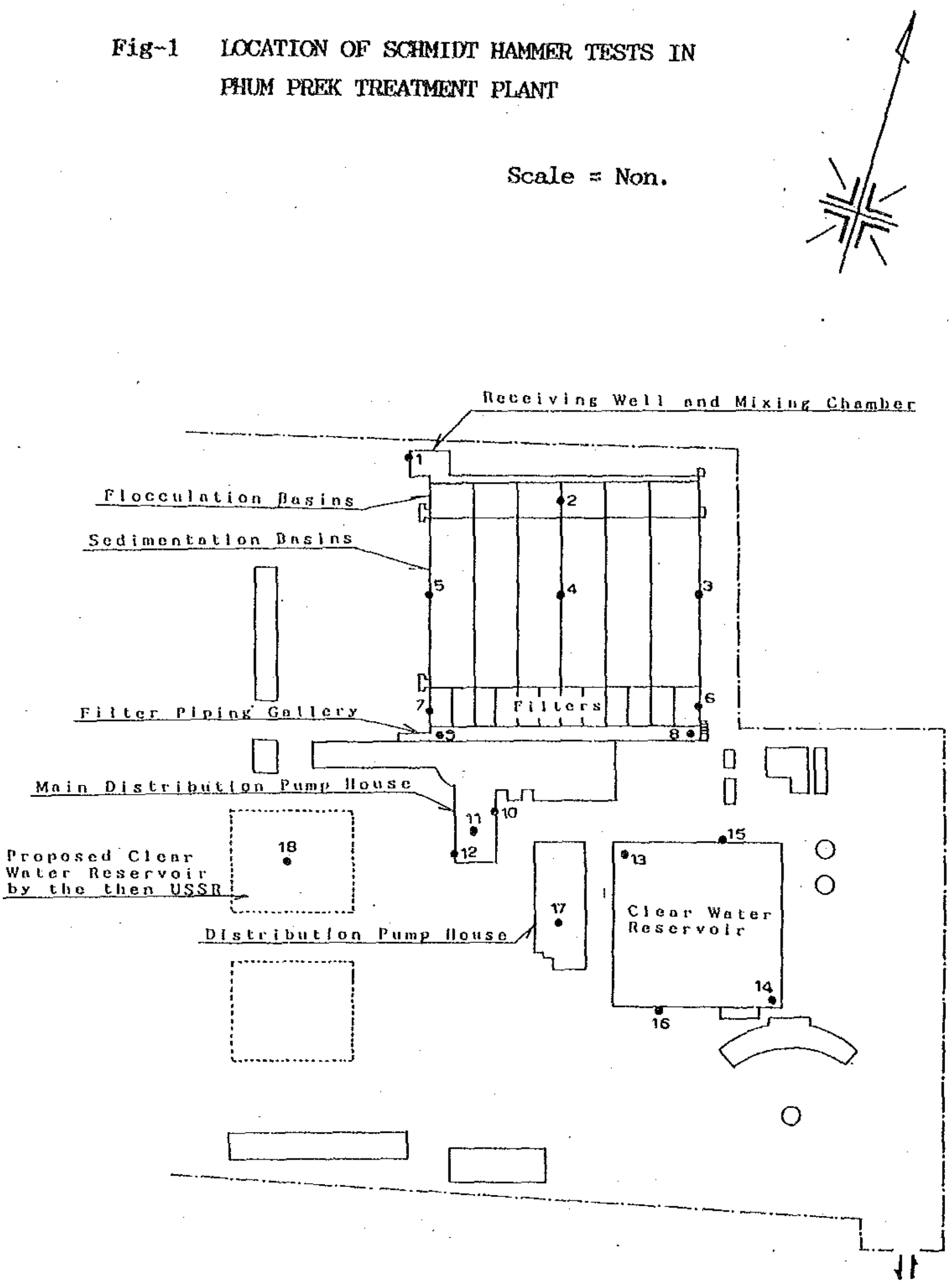


Fig-2 LOCATION OF SCHMIDT HAMMER TESTS IN CHAMCAR MORN TREATMENT PLANT

Scale = Non.

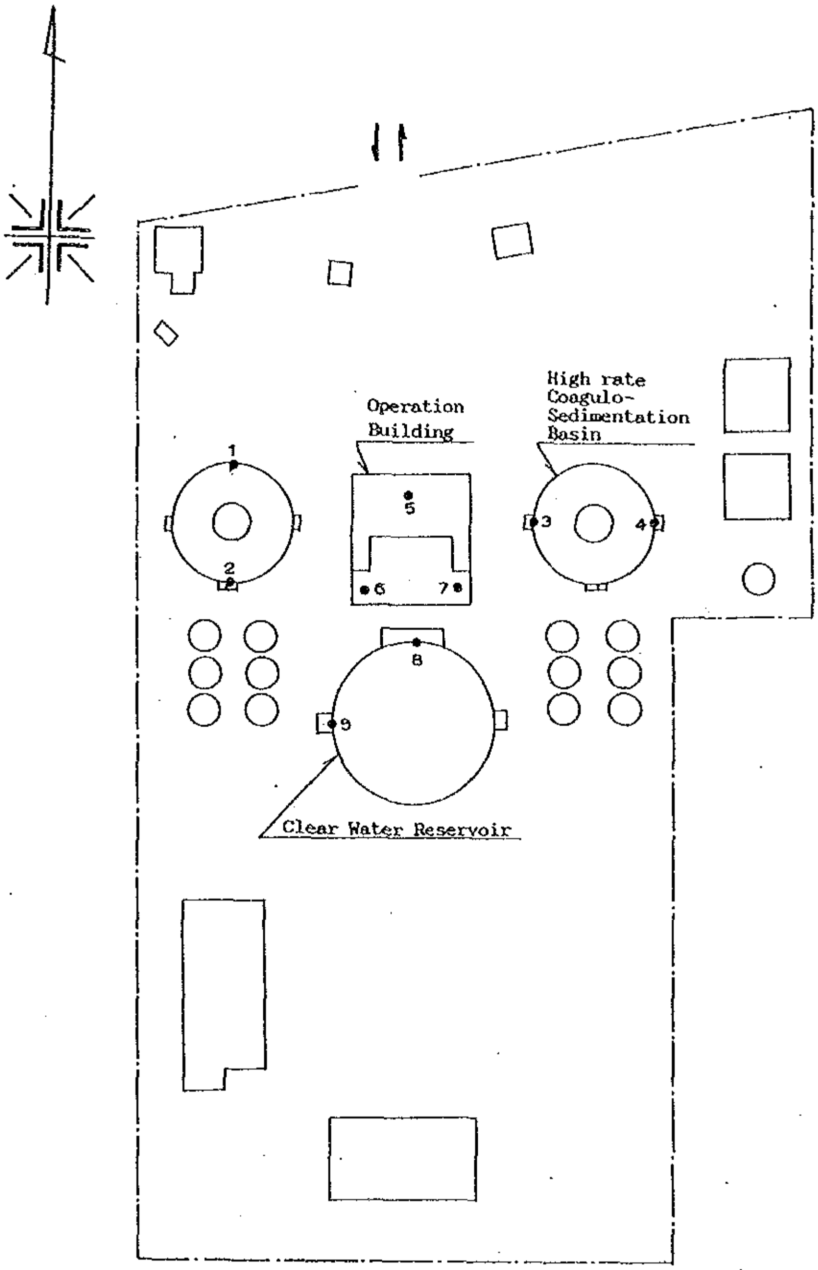


Fig-3 LOCATION OF SCHMIDT HAMMER TESTS IN CHROUY CHANGWAR TREATMENT PLANT

Scale = Non.

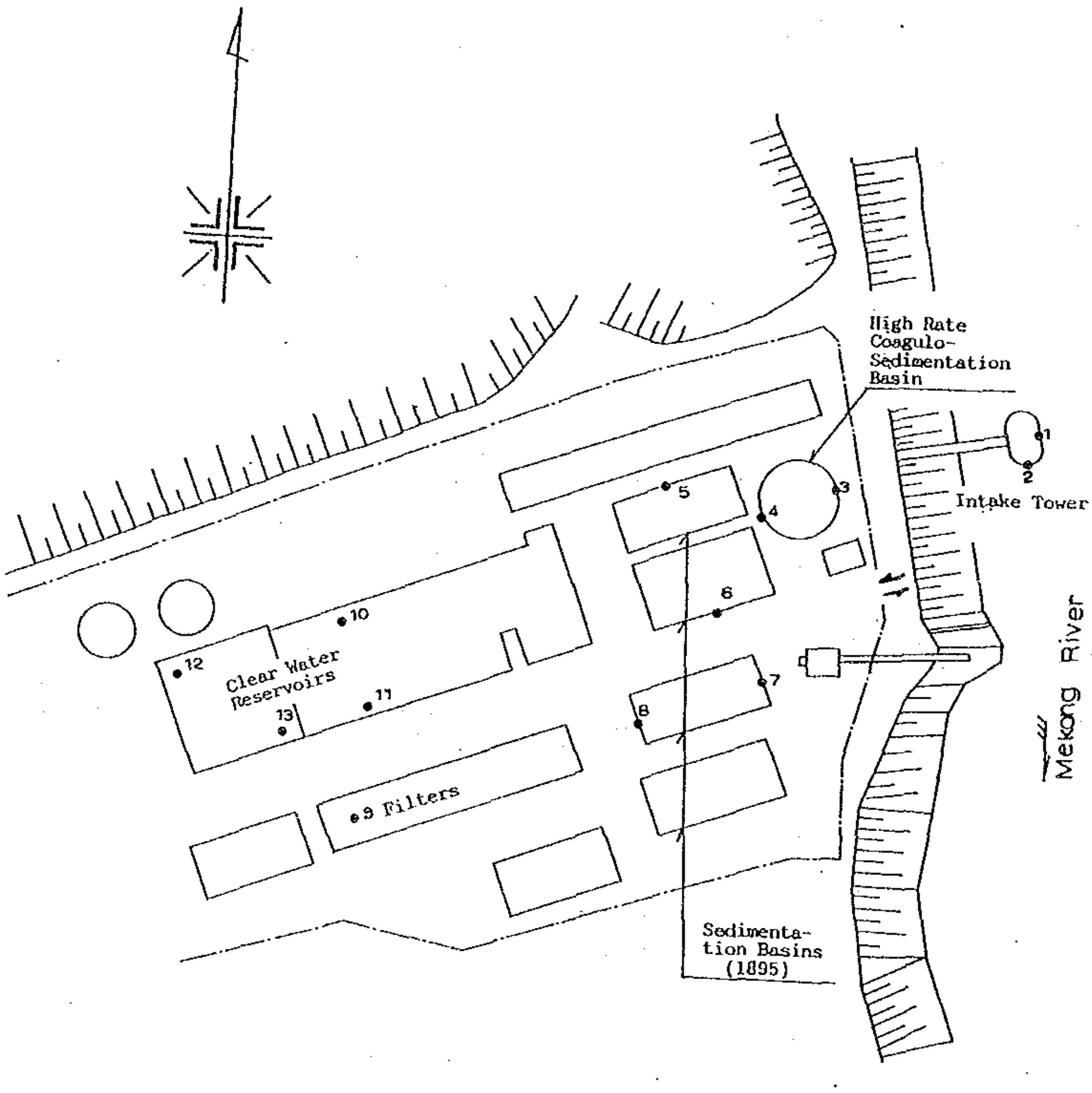


Fig-4 LOCATION OF SCHMIDT HAMMER TESTS AT ELEVATED TANK

Scale = Non.

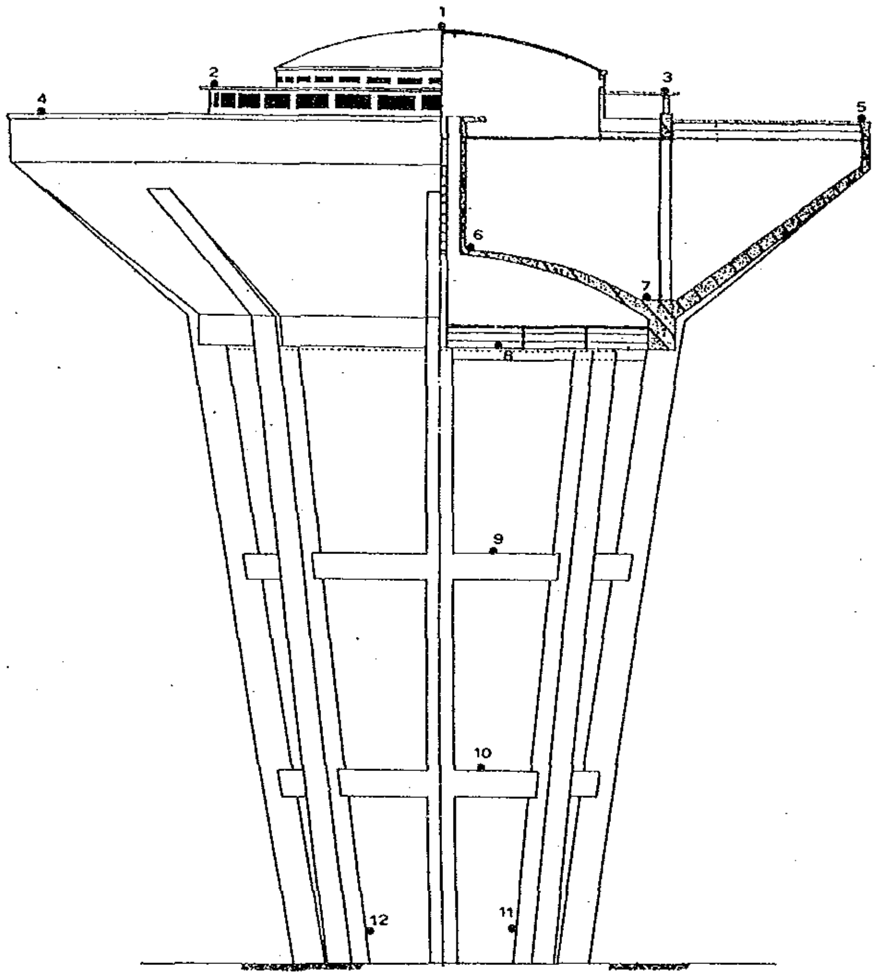


Table-1 SCHMIDT HAMMER TEST RESULTS AT PHUM PREK TREATMENT PLANT

Test No.	Cylinder Compressive Strength (kg/cm^2) 1st	2nd	3rd	Average*	Estimated Strength * x 0.63 (kg/cm^2)
1	550	540	550	546	344
2	520	520	520	520	328
3	500	490	490	493	310
4	500	500	500	500	315
5	480	490	480	483	304
6	480	480	480	480	302
7	500	510	510	507	319
8	480	470	480	477	300
9	480	480	480	480	302
10	520	500	500	507	319
11	500	490	490	493	310
12	500	500	500	500	315
13	490	490	470	483	304
14	490	490	490	490	309
15	490	490	490	490	309
16	490	480	480	483	304
17	450	450	440	447	282
18	400	400	410	407	256

Table-2 SCHMIDT HAMMER TEST RESULTS AT CHAMCAR MORN TREATMENT PLANT

Test No.	Cylinder Compressive Strength (kg/cm²) 1st	2nd	3rd	Average*	Estimated Strength * x 0.63 (kg/cm²)
1	470	470	470	470	296
2	470	470	470	470	296
3	490	490	480	487	307
4	490	490	490	490	309
5	440	430	430	433	273
6	440	440	430	437	275
7	440	440	440	447	277
8	490	490	490	490	309
9	490	490	490	480	309

Table-3 SCHMIDT HAMMER TEST RESULTS AT CHROUY CHANGWAR TREATMENT PLANT

Test No.	Cylinder Compressive Strength (kg/cm²) 1st	2nd	3rd	Average*	Estimated Strength * x 0.63 (kg/cm²)
1	550	550	550	550	347
2	550	550	550	550	347
3	540	530	530	533	336
4	540	530	540	537	338
5	480	480	480	480	302
6	480	480	480	480	302
7	470	470	460	467	294
8	470	470	470	470	296
9	500	500	500	500	315
10	420	420	410	417	263
11	420	420	420	420	265
12	400	400	390	397	250
13	390	390	390	390	246

Table-4 SCHMIDT HAMMER TEST RESULTS AT ELEVATED TANK

Test No.	Cylinder Compressive Strength (kg/cm²) 1st	2nd	3rd	Average*	Estimated Strength * x 0.63 (kg/cm²)
1	420	420	420	420	256
2	330	340	340	337	212
3	340	340	340	340	214
4	460	470	460	463	292
5	450	450	450	450	284
6	460	460	460	460	290
7	510	520	520	517	326
8	420	420	420	420	265
9	540	550	540	543	342
10	550	550	550	550	347
11	580	600	600	593	374
12	580	580	580	580	365

APPENDIX K

FIELD SURVEY OF DISTRIBUTION PUMPS AT PHUM PREK TREATMENT PLANT

APPENDIX K

FIELD SURVEY OF DISTRIBUTION PUMPS AT PHUM PREK TREATMENT PLANT

CONTENTS

FIELD SURVEY OF DISTRIBUTION PUMPS AT PHUM PREK TREATMENT PLANT

The amount treated and distributed at/from Phum Prek Treatment Plant is not made clear at present. Because every measuring equipment is out of order and the Plant operation has been carried out from the estima-tion of flow including chemical dosing.

To make the capacities of the distribution pumps clear, the Study Team conducted the field survey of every pump at Phum Prek Treatment Plant with staff of Water Supply Authority, as follows:

Date : 2 to 12 April 1993
Tester : Takayuki TANGE (Study Team Member)
Kazumi KANIE (- do -)
Bertrand CLOCHARD (- do -)
Attendant : Long Naro (Water Supply Authority)
Two Operators of Water supply Authority

1. METHOD OF FIELD SURVEY ON DISTRIBUTION PUMPS

a) Delivery Head of Pumps
To survey the delivery head of pumps, an examined manometer was set at the delivery pipe of the pumps,

b) Measurement of Delivery Flow of Pumps
The depth of the suction pit water level decreased during the survey period was inspected to estimate the delivery flow, as the existing flow meters were damaged already.

c) Operation of Valves
To estimate the delivery flow, the line valve and connection valve shown in the attached figure are closed/opened.

The designed specifications of the existing pumps are:

Manufacturer	E & S Saarbrucken (set by France)	Kubota (set by Japan)
Flow (m^3/hr)	2,100	900
Head (m)	42	27
Motor (kw)	325	132

2. FIRST TESTS

For the first tests, one of E&S Saarbrucken pumps was operated with the closed connection valve and opened line valve which are shown in the attached drawing. The obtained test results are:

Case	1st	2nd	3rd
Tested Period	5:05 - 5:20	5:25 - 5:40	5:40 - 5:50
E&S Pump	ON	OFF	OFF
Kubota Pump	OFF	ON(No.1 Pump)	ON(No.2 Pump)
No.1 Manometer (kg/cm2)	4.2	-	-
No.2 Manometer (kg/cm2)	-	0.7	0.7
Decreased Depth (mm) of Water Level at Reservoir	190	200	150

The area (A) of the reservoir which water-level was influenced is as follows:

(A) = Reservoir 2,500.0 + Suction Pit (a) 73.5
+ Suction Pit (b) 38.0 = 2,720.3 m^2

As the delivery pressure of E&S Pump was quite similar to the designed specifications shown above, the 1st case of the tests will be reliable from the results. The pump flow (Q) is estimated below:

$$Q = 2,720.3\ m^2 \times 0.19\ m \times 60/15 = 2,068\ m^3/hr$$

The estimated Q is some 98.5 % of Design Flow 2,100 m^3/hr, and the function of the pump can be estimated being under normal condition without deterioration. The 2nd and 3rd tests' results were questionable because possibly of much leakage adjacent to the test site. From the results, the tests for Kubota Pump was conducted on 12 April 1993 as the Second Tests as shown below.

3. SECOND TESTS

For the second tests, one of Kubota Pumps was operated with the opened connection valve and closed line valve which are shown in the attached drawing. The obtained test results are:

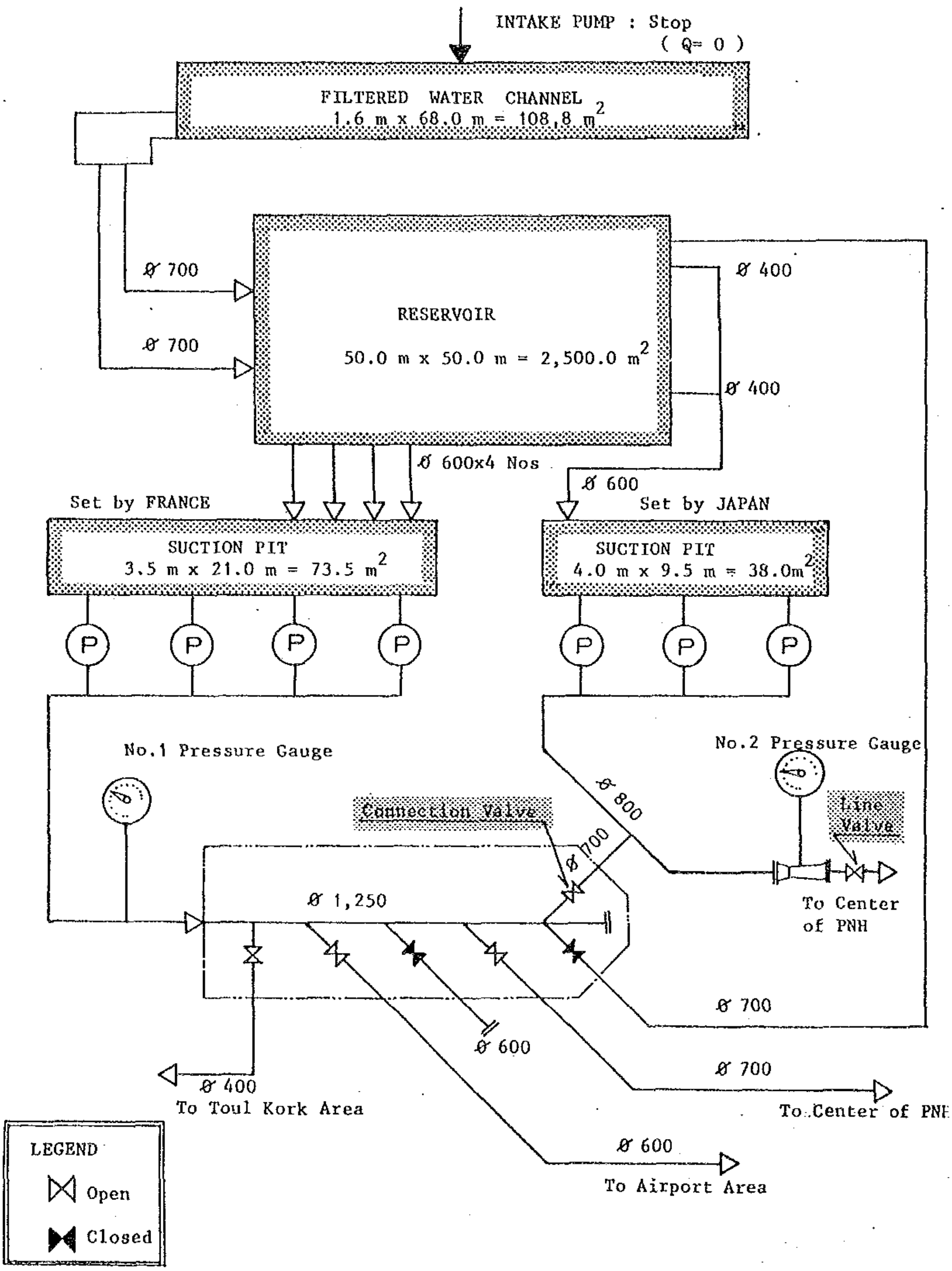
Case		1st	2nd	3rd
Tested Period		5:00 - 5:15	5:20 - 5:40	5:50 - 6:10
Kubota Pump		ON	ON	ON
No.1 Manometer	(kg/cm^2)	1.6	2.7	2.7
No.2 Manometer	(kg/cm^2)	1.6	2.7	2.7
Decreased Depth of Water Level at Reservoir	(mm)	110	100	100

The pump flow (Q) is estimated as :

$$Q = 2{,}720.3 \text{ m}^2 \times 0.1 \text{ m} \times 60/20 = 816 \text{ m}^3/\text{hr}$$

The estimated Q (816 m^3/hr) is similar to 90.7 % of Design Capacity of the Pumps 900 m^3/hr, and the deterioration of pump capacity seems negligibly small in spite of aged.

Fig-1 SCHEMATIC FLOW DIAGRAM OF PHUM PREK TREATMENT PLANT



APPENDIX L

FUNCTION OF PHUM PREK TREATMENT PLANT

APPENDIX L

FUNCTION OF PHUM PREK TREATMENT PLANT

CONTENTS

FUNCTION

OF

PHUM PREK TREATMENT PLANT

1. OBJECTIVES OF THE TESTS

The objectives of the tests aim at studying the function of Phum Prek Treatment Plant together with one of on-the-job training for the local staff through tests conducted by the Study Team.

2. STUDIED DATE AND STAFF

The tests were carried out as follows:

Date : 21 April 1993 (1:30 p.m. - 4:30 p.m.)

Staff Engaged :

Study Team - Mr. Takumi; Mr. Suzuki; Mr. Jimbo

Water Authority - Mrs. Cni Vanna; Miss Mono Charya

3. STUDY METHOD FOR PLANT FUNCTION

The Plant is functionally studied by means of the following:

a) To get the most optimum dosage of chemicals by means of Jar Tests for raw water,

b) To estimate the Plant function from turbidity of filtered water after applying the optimum dosage, and

c) To study every function of unit activity on facilities.

4. OPTIMUM DOSAGE

The existing Plant is designed to utilize aluminum sulfate as coagu-lant and lime as coagulation aid. As the raw water quality shows some 30 ppm in alkalinity and 7.3 or so in pH, lime will be unnecessary and is not used practically.

The river water of Tonle Sap river was observed rather clear on the day when the jar tests were carried out, but the raw water was turbid when the tests were carried out. The reason why the raw water was so was a dredging works were under way upstream from the Intake Tower, and the right bank of the river was turbid. As of 26 April 1993 the turbid condition has been continuing.

According to the conducted jar tests, alum dosage 30 - 35 ppm was fit to get clear supernatant water and reasonable flocks in size having good sedimentation. In most cases, filtered water turbidity generally becomes 0 degree together with sedimented one 5 degree or so. As the dosage to get 5 degree supernatant water was 25 ppm in the tests, alum dosage for the function tests is decided as 25 ppm.

The Results of the Jar Tests are shown below:

Raw Water Quality	:	Turbidity	- 27 degree
		pH	- 7.4
		Water Temperature	- 30.6°C

Jar Tester	:	Hydrocure (SP45) Type - FLH6
Testing	:	Beaker - 1 liter
		Mixing - (150 rpm x 5 min & 40 rpm x 15 min) + putting quietly 20 min
Measuring	:	Supernatant turbidity and pH
Used Chemical	:	Aluminum sulfate made in Vietnam
		Contained Alum - 16 %
		Diluted liquid Alum 1 % was used for tests.

Alum Dosage (ppm)	Supernatant Water Turbidity (NTU)	pH	Features of Flocks: Size	Super-natant	Sedimentary Trend
5	21.0	7.3	Very Small	TiW	Not Good
10	18.0	7.2	Very Small	TiW	Not Good
15	13.0	7.1	Small	RTiW	Good
20	10.0	7.0	Middle	RTiW	Good
25	5.3	6.9	Rather Big	Clear	Very Good
30	3.0	6.8	Big	Clear	Very Good
35	3.0	6.6	Big	Clear	Very Good
40	7.0	6.5	Big	FlFlo	Not Good

(Note) TiW : Turbid in White
RTiW : Rather Turbid in White
FlFlo : Floating Flocks

Sedimented water at the time of the tests:

Alum Dosage	: 20 ppm
Supernatant Turbidity	: 10 (NTU); Turbid in White
pH	: 7.0
Size of Flocks	: Middle
Sedimentary Trend	: Good

According to the interview for the operators, they informed alum dosage was some 7 ppm. However, the informed dosage was equivalent to 20 ppm of the tests' results.

5. SURVEY OF DESLUDGING WORK FOR SEDIMENTATION

a) Objectives

No.6 Sedimentation Basin was desludged to survey the easiness and function of desludging, and confirming the function of *Sprit Roll*.

b) Date and Procedure

Date and Time : 22 April 1993 (6:00 a.m. - 10:30 a.m.)

Staff Engaged :

Study Team -	Takumi; Tange; Suzuki; Jimbo
Water Authority -	Long Naro and his Staff

Procedure :

Commencement of Dewatering	: 6:00 a.m.
Commencement of Desludging	: After completing dewater at about 9:20 a.m., desludging was commenced continuously.
Completion of Desludging	: 10:30 a.m.

Capacity of Sedimentation Basin	: V = 1,070 m^3/Basin
Desludging Valve Size and No.	: Top Valve Ø200 x 3 sets
Depth of Sedimented Sludge	: Some 50 cm
Workers engaged in Desludging Work	: 1 Foreman and 4 Workers (under Contract)

When the desludging work was carried out, turbidity of raw water was about 20 degree, and the last desludging was 2 months before. The work was executed with one hose from pressurized water. The liquidity was quite much for washing-out with pressure water.

Much of adhered algae and planktons were on the walls and collecting troughs, and the removal/cleaning of them looked to be laborious. The drain pipeline (Ø800 RCP) is opened downstream from Intake Tower with 1/4 depth of the pipe, and the pipeline will have quite enough capacity for the work.

6. TREATMENT FACILITIES

6.1 Survey for the Facilities

Date and Time : 23 April 1993 (9:00 a.m. - 12:00 a.m.)
Staff Engaged :
Study Team - Mr. Takumi; Mr. Tange; Mr. Suzuki; Mr. Jimbo
Water Authority - Mrs. Cni Vanna; Miss Mono Charya
Operated Pump : Intake Pump Q2,200 m^3/hr x 2 units

1) Objects of the Study

The objects for the Study were Receiving Well, Mixing Chamber, Flocculation Basins, Filters, and Chemical Dosing Equipment.

2) Confirmation of Treated Water Capacity

The treated water volume has been estimated from the operating pump(s) number and operated length of time because of no water meter. To confirm the treating capacity, the velocity of Inlet Channel between Mixing Chamber and Flocculation Basins was surveyed with a semi-submerged float to estimate the flow broadly.

Size of Channel : Length = 5.7 m

Section of Flow = 1.5 m x 1.25 m = 1.875 m^2

Surface Velocity : V = 0.57 m/sec

Coefficient : 0.7 (Assumed)

Water Flow : Q = 1.875 x 0.57 x 0.7 = 0.748 m^3/sec

≑ 64,600 m^3/day

The surveyed result will be less reliable because of too small comparing the planned capacity.

6.2 Receiving Well

The Receiving Well is equipped with one alarm equipment for overflow. The depth between the bottom of the Well and water level at the time when 2 raw water pumps were in operation was surveyed.

6.3 Mixing

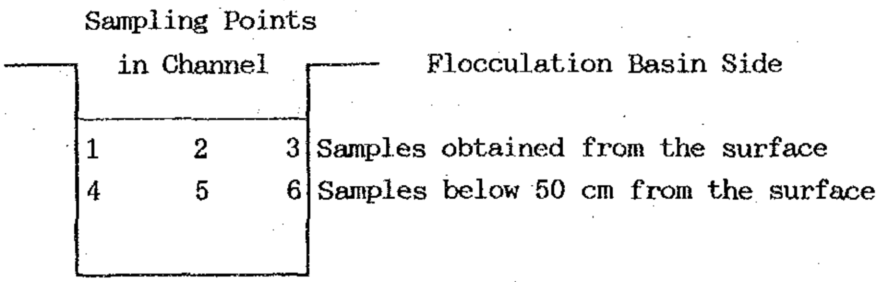
1) Confirmation of Chemical Dosage

Two chemical dosing pumps (stroke : 60 %) were operated when tested. The alum conveyed at Mixing Chamber was as follows:

Alum Volume : 1,500 cc/6 sec (15 lit/min)

2) Mixing Efficiency

To study the mixing efficiency, pH values at the Inlet Channel between Mixing Chamber and Flocculation Basins were surveyed and the jar tests of samples obtained from points shown below were conducted to compare their coagulation.



Jar Tests Results

a) Before Jar Tests

Sample No.	1	2	3	4	5	6
pH Value	6.83	6.87	6.87	6.57	6.45	6.91

b) After Jar Tests

pH Value	-	-	-	7.00	6.82	7.70
NTU	-	-	-	RTiW	Clear	TiW

As shown above, pH's obtained from the tests were scattered widely in value. Further, coagulation of low pH samples was good, and high pH samples' coagulation was not good. These show that the mixing was not uniform.

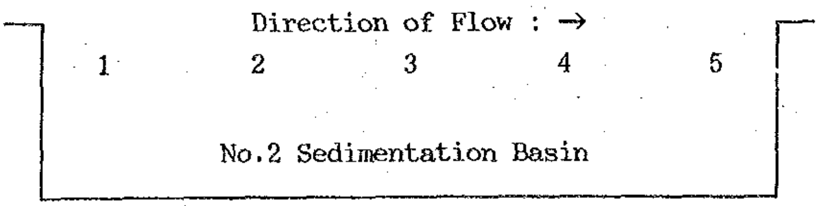
Coagulation condition adjacent to the inlet gate for No.1 Flocculation Basin located at the farthest site from Mixing Chamber was quite good, instead the condition at No.6 Basin inlet was not so good. In addition the condition at the outlet of No.1 Flocculation Basin as well showed quite good.

These tests results show that the mixing time will be too short to get an appropriate Gt value.

6.4 Sedimentation Basin

Turbidity of the surface water of Sedimentation Basin was as follows:

Sampling Place	1	2	3	4	5
pH Value	7.16	7.08	7.07	7.10	7.07
Turbidity	20	4	6	4	5
Water Temperature	32.0	32.0	32.8	32.0	31.8



When the said tests were conducted, one third of the surface of the Sedimentation Basins showed blue because of much increased plankton and wind direction blew from the outlet side to inlet. Some bubbles were observed on the surface of water, and looked to show the bottom of the Basins was short of dissolved oxygen. But odor like hydrogen sulfide was not observed at all. Water above sedimented sludge was expected to flow down to the outlet side, and not to catch any odor.

As much plankton could be observed in the Sedimentation Basin water, choke of filters will occur after becoming normal in their activities. Pre-chlorine system will be necessary to protect such choking.

The function of Split Roll was not always clear. However, comparatively dense slurry might be crawling on the bottom, as the turbidity at No.2 steeply descended from No.1 turbidity. Much carry-over of flocks was occurring at the last trough of the Basins because possibly of the following; a) Insufficient Coagulation and/or b) Inadequate Sedimentation.

6.5 Filters

The multi-holed board type is employed for the under-drain system of the filters. However, one filter is out-of-order and 10 filters have no filter sand on the porous concrete layer. Remaining one filter only has been operated normally. Filtered water samples were got from the normally operated and no filter-sand filters respectively, and their turbidity was measured. The results are shown below:

No. of Filter	Condition	pH	Water Temperature(C°)	Turbidity(NTU) Before Fil.	After Fil.
No.2	Normal	7.04	31.2	5.0	0 - 1
No.3	No Sand	7.08	31.3	5.0	5.0

(Note) Fil. means "Filtered".

From the study above, filtered water of turbidity 0 - 1 degree is obtainable in the present Treatment Plant as far as sedimented water is some 5 degree or so in turbidity.

Some floating scums were found on the filter surface operated normally when the survey was conducted at the field. When one no-filter-sand filter made dry for inspection, sedimented sludge made layer on the surface with much plankton. From such condition, it can be supposed that filters may not always satisfactorily have been backwashed.

6.6 Chemical Dosing Equipment

1) Alum Dosing Equipment

Aluminum Sulfate Dosing Equipment consists of a) Alum Solution Tanks, and b) Dosing Equipment, as shown below:

a) Alum Solution Tanks

At present solid type of Alum contained in sack (50 kg) has been imported from Vietnam for the Plant use. The Alum sacks stored in the basement are lifted by a hoist to the solution tank. Wooden drainboard is equipped in the middle of the tanks and water is to be showered on the solid Alum. The solution of Alum is mixed with agitators to make Alum solution completely.

There are two tanks and they are used alternately. Switching the tank is operated manually.

b) Alum Dosing Equipment

Alum solution is dosed with chemical doser in fixed quantity. The adjustment of dosage is controlled with plunger stroke of dosing pumps and concentration of Alum solution. Of three dosers, one doser is out-of-order. At present two dosers are used for dosing.

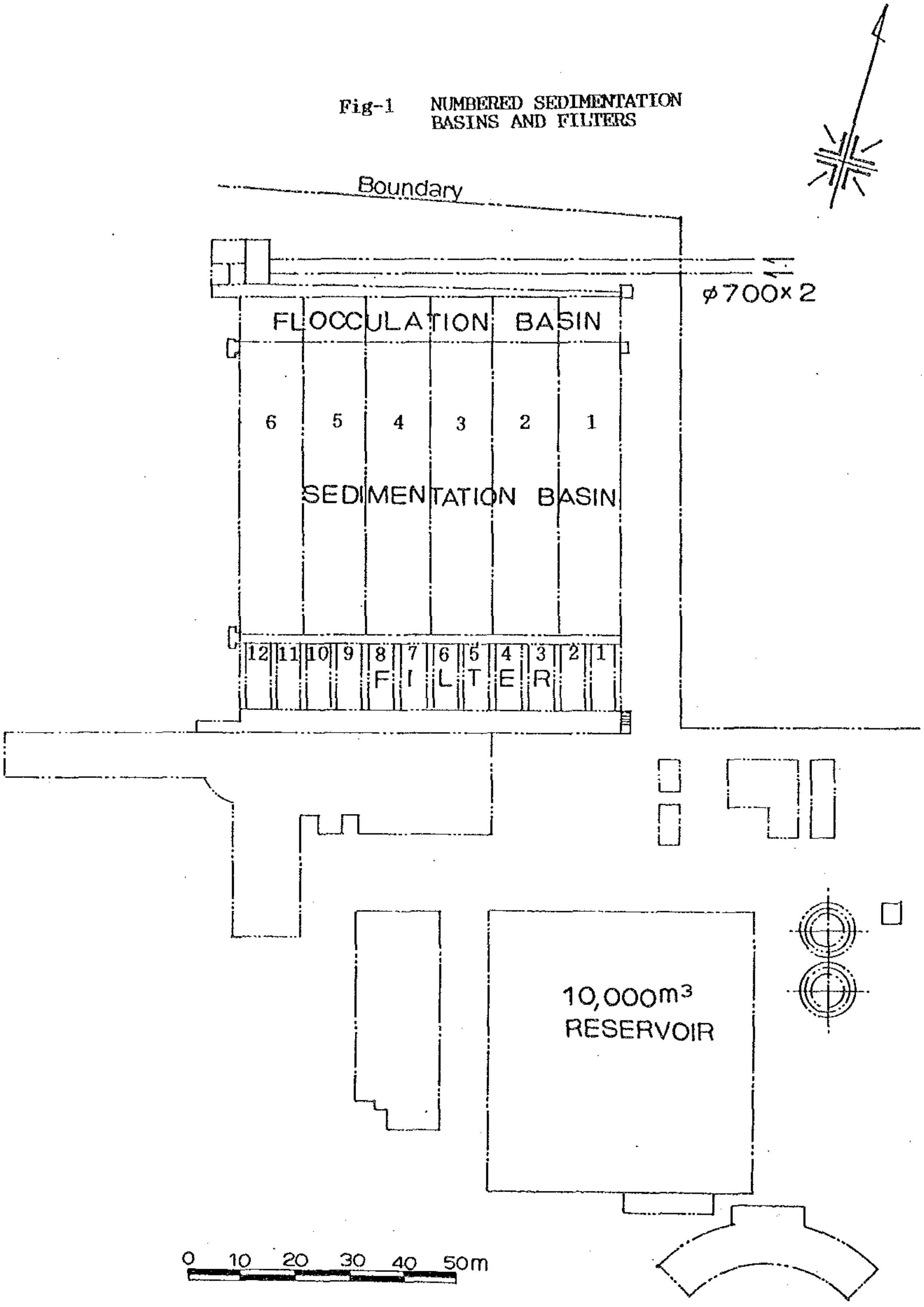
Sedimented water should at least be less than 5 degree in turbidity, as most filters do not work satisfactorily and it is already demonstrated by the Study Team that such sedimented water is available as far as employing optimum dosage.

Presently, however, chemicals do not necessarily have been supplied satisfactorily because of shortage of local fund.

2) Chlorination Dosing Equipment

The chlorinator in operation is only one set at present; and stocked chlorine containers are not always enough for the dosage. The reliable chlorine dosing work and arrangement of dosing equipment as routing duties are one of inevitable matters for stable and secure Plant operation.

Fig-1 NUMBERED SEDIMENTATION BASINS AND FILTERS



APPENDIX M

BALANCE OF MATERIALS AT PHUM PREK TREATMENT PLANT

APPENDIX M

BALANCE OF MATERIALS IN PHUM PREK TREATMENT PLANT

CONTENTS

BALANCE OF MATERIALS IN PHUM PREK TREATMENT PLANT

1. OBJECTIVES

As for water and solid materials which form main materials in treatment plant, their treated tendency is studied to survey every activity and function of facilities. The methodology employed herein for the tendency follows the guideline released by Japan Society of Civil Engineers in 1981, "Guideline for Experiments on Sanitary Engineering".

2. BALANCE OF TREATED WATER

2.1 Actual Condition of Plant Operation

At present there are no reference data related to balance of treated water at Phum Prek Treatment Plants. The Plant is operated based on the information estimated from operated time and capacity of pumps because of no measuring apparatus like venturi tube and orifice meter.

The filters of the Plant are not in normal condition except for one filter, and 11 filters are operated without filter sand. Filter wash system is employed with water and air. The actual condition of filter washing, however, was not necessarily made clear in spite of the field survey and inquiries for the local staff concerned.

Considering such practical condition, washing water for filters was estimated with standard washing capacity of water for the balance of the treated water.

The desludge of the sedimentation basins has been operated manually. The information of the interval of desludge and desludging methods was obtained by inquiries for staff, and the yearly desludge volume was estimated from the information.

2.2 Desludged Water

1) Estimation of Desludged Capacity

According to the obtained information, the desludging work of sedimentation basins has been carried out as follows:

a) Every two weeks during high turbid period, and
b) Every two months during low turbid period.

Actually the turbidity of the raw water cannot be same every year, and therefore desludging interval must depend on accumulated sedimentary condition. As the operation record of the Plant is not kept in hand, the frequency of the desludging works and desludged capacity were estimated from the record of laboratory tests in 1992.

As the flushing water for desludge of sedimentation was got from one Ø65 mm hydrant and the work was continued for two hours, the flushing water capacity also was considered.

The data cited from the laboratory tests in 1992 are shown in Table-1.

2) Frequency of Desludging

The frequency of desludging was estimated from the laboratory test data shown in Table-1 as follows:

a) Desludging per every two weeks in maximum turbidity (136 FTU)
b) Desludging per every two months in minimum turbidity (9 FTU)
c) When turbidity is between above two FTU's, desludging frequency is estimated from proportional distribution of the FTU and above two FTU's. For the estimation, the equation shown below is employed.

$$\text{Frequency} = 60 - [(60 - 14)/(136 - 9)] \times (\text{FTU} - 9)$$

d) Desludging time is about 6 hours a desludging work.

Based on the conditions above, the desludging frequency was estimated as 9 times a year as shown in Table-2.

3) Desludged Water

The total desludged water a year is as follows:

Number of Sedimentation Basins	: 6 basins
Volume of Sedimentation Basin	: 1,470 m^3/basin
Flushing Water a desludging Work	: 0.5 m^3/min x 2 hr x 60 min = 60 m^3/work
Yearly Frequency of Desludging	: 9 times
Total Desludged Water a Year	: (1,470 + 60) x 6 x 9 = 82,620 m^3/year

The desludged water a day, therefore, is estimated as shown below:

Desludged Water a Day : 82,620/365 ≒ 223 m^3/day

2.3 Washing Water Amount of Filters

As stated previously, the filters are not operated under normal condition and any operation records are kept in the Water Authority. To estimate the washing water amount of filters, therefore, design standard capacity (0.36 to 0.40 m^3/m^2.min) is employed herein.

Filter Area	: 4.5 m x 11.9 m = 53.55 m^2/filter
Unit Washing Water	: 0.36 to 0.40 m^3/m^2.min
Washing Period	: 15 min
Washing Water	: (53.55 x 0.36 to 0.40) x 15 min = 290 to 322 m^3/time
Washing Cycle	: 48 hr/time
Washing Water a Day	: (290 to 322) x 12 filters/(24/48) = 1,740 to 1,932 m^3/day

2.4 Water Consumed in the Plant

The water consumed in the Plant is classified as follows; a) water for chlorination, b) for dissolving chemicals, c) for desludging and flushing of sedimentation basins, and d) miscellaneous water consumed in the Plant. Their amounts are estimated as follows:

a)	Chlorination Water	: 108 m^3/day*)
b)	Dissolving Water for Chemicals	: 20 m^3/day**)
d)	Miscellaneous Water in Plant	: 20 m^3/day***)
	Total	148 m^3/day

(Note) *) : Chlorination Dosing Rate : 3 ppm

Treated Water in Plant : 97,000 m^3/day (4,050 m^3/hr)

Dosing Cl_2 a Hour : 3 ppm

Dosed Chlorine a Hour : 4,050 x 3/1,000,000 ≑ 12.5 kg/hr

Chlorinator' Water : 60 lit/10 kg/hr

Chlorination Water a Day :

(12.5 kg/hr/10 kg/hr) x 60 lit/min
= 75 lit/min

75 x 1,440 min = 108 m^3/day

**) : Alum Dissolving Tank Capacity : 10 m^3/tank

Dissolving No. a Day : Twice a day in max.

Dissolving Water for Chemicals : 10 x 2 = 20 m^3/day

***) : No. of Persons Engaging in the Plant Operation : 402 persons

Per Capita Consumption of the Persons : 50 lit/person/day

Miscellaneous Water in Plant : 402 x 50 ≑ 20 m^3/day

2.5 Quantity of Raw Water

The amount of the water treated in the Plant is not clear because of no measuring apparatus. In addition, the raw water pumps is deteriorated, and it is impracticable to estimate the conveyed raw water from pump capacity and operated hours of pumps.

The amount of water treated in the Plant, therefore, is estimated from the survey results conducted by the Study Team on 27 April 1993 in the premises of the Plant, which is shown in Table-3.

The amount of water treated in the Plant is estimated, on the assumption that the Plant is operated for 24 hours in spite of 18 hours operation at present.

Amount of Conveyed Raw Water :

4,044 x 24 hr = 97,056 m^3/day in max.
3,500 x 24 hr = 84,000 m^3/day in aver.

2.6 Balance of Treated Water

From the estimation stated above, the balance of the raw and treated water is as follows:

1) Raw Water Conveyed to the Plant : 97,056 to 84,000 m^3/day

2) Desludged Water from Sedimentation Basins

	:	223 m^3/day
Washing Water of Filters	:	1,740 to 1,932 m^3/day
Water Consumed in the Plant	:	148 m^3/day
Sub-Total		2,111 to 2,303 m^3/day

3) Distributed Water : 94,945 to 81,697 m^3/day

Table-1 LABORATORY TEST RESULTS OF RAW WATER OF PHUM PREK TREATMENT PLANT (1/2)

Day	Jan.		Feb.		Mar.		Apr.		May		Jun.	
	FTU	pH	FTU	pH	FTU	pH	FTU	pH	FTU	pH	FTU	pH
1	22	7.1	18	7.2	-	-	7	7.2	12	7.1	10	7.1
2	16	7.2	-	-	13	7.1	8	7.2	7	7.1	18	7.2
3	22	7.0	18	7.1	12	7.1	10	7.1	6	7.1	12	7.1
4	28	7.2	14	7.1	12	7.1	10	7.2	-	-	12	7.0
5	22	7.1	10	7.1	12	7.0	-	-	7	7.1	11	7.0
6	20	7.1	14	7.1	12	7.0	8	7.2	7	7.0	10	7.0
7	-	-	16	7.1	12	7.0	10	7.1	7	7.0	-	-
8	20	7.1	14	7.0	-	-	7	7.1	8	7.0	8	7.1
9	15	7.1	-	-	13	7.2	10	7.0	10	7.0	8	7.0
10	18	7.2	18	7.0	12	7.0	10	7.1	9	7.1	14	7.1
11	16	7.2	18	7.2	12	7.1	10	7.1	-	-	10	7.2
12	-	-	18	7.1	14	7.1	-	-	8	7.0	10	7.1
13	15	7.2	20	7.0	10	7.1	-	-	10	7.0	12	7.1
14	15	7.1	18	7.0	11	7.1	-	-	8	7.0	-	-
15	10	7.2	16	7.1	-	-	-	-	10	7.0	12	7.1
16	14	7.1	-	-	10	7.2	-	-	10	7.0	18	7.0
17	12	7.2	18	7.1	8	7.1	-	-	-	-	20	7.2
18	16	7.2	16	7.2	10	7.1	-	-	8	7.1	20	7.1
19	-	-	10	7.1	7	7.1	-	-	10	7.0	18	7.0
20	10	7.2	10	7.0	9	7.1	7	7.1	8	7.0	20	7.0
21	10	7.2	12	7.0	8	7.1	8	7.1	9	7.0	-	-
22	10	7.2	8	7.0	-	-	8	7.1	8	7.2	28	7.2
23	10	7.2	-	-	10	7.1	10	7.1	10	7.0	46	7.1
24	10	7.2	10	7.1	8	7.1	10	7.1	-	-	56	7.1
25	10	7.1	12	7.2	8	7.2	9	7.1	10	7.2	56	7.1
26	-	-	10	7.1	8	7.1	-	-	8	7.2	56	7.1
27	11	7.2	11	7.1	11	7.2	10	7.1	10	7.2	50	7.0
28	-	-	14	7.2	8	7.1	10	7.0	9	7.1	-	-
29	22	7.2	18	7.1	-	-	8	7.0	10	7.1	57	7.1
30	12	7.2	-	-	8	7.2	10	7.0	10	7.0	80	7.2
31	12	7.1	-	-	7	7.2	-	-	-	-	-	-
Aver.	15	7.2	14	7.1	10	7.1	9	7.1	9	7.1	26	7.1
Max.	28	7.2	20	7.2	14	7.2	10	7.2	12	7.2	80	7.2
Min.	10	7.0	8	7.0	7	7.0	7	7.0	6	7.0	8	7.0

Table-1 LABORATORY TEST RESULTS OF RAW WATER OF PHUM PREK TREATMENT PLANT (2/2)

Day	Jul.		Aug.		Sep.		Oct.		Nov.		Dec.	
	FTU	pH	FTU	pH	FTU	pH	FTU	pH	FTU	pH	FTU	pH
1	80	7.2	200	7.0	125	7.1	76	7.0	11	7.0	29	7.0
2	70	7.0	-	-	100	7.2	60	7.0	10	7.0	32	7.1
3	60	7.0	160	7.0	100	7.0	50	7.0	10	7.0	34	7.0
4	66	7.1	150	7.0	90	7.1	-	-	-	-	38	7.1
5	-	-	125	7.0	94	7.1	56	7.0	13	7.2	33	7.0
6	60	7.1	100	7.2	-	-	45	7.1	15	7.1	-	-
7	52	7.1	100	7.0	92	7.1	25	7.1	16	7.1	35	7.0
8	48	7.1	110	7.0	76	7.0	25	7.1	15	7.1	30	7.0
9	48	7.0	-	-	70	7.2	25	7.1	15	7.0	34	7.0
10	50	7.1	135	7.0	70	7.1	19	7.1	23	7.1	-	-
11	48	7.2	130	7.1	73	7.1	-	-	22	7.1	27	7.1
12	48	7.0	140	7.1	56	7.1	13	7.0	-	-	28	7.0
13	-	-	130	7.2	-	-	14	7.1	25	7.0	-	-
14	75	7.1	130	7.1	74	7.1	14	7.1	20	7.0	29	7.0
15	61	7.1	140	7.0	91	7.0	14	7.0	-	-	27	7.1
16	58	7.1	150	7.2	73	7.1	15	7.1	25	7.1	20	7.0
17	62	7.1	155	7.1	63	7.1	13	7.1	32	7.1	20	7.0
18	68	7.1	150	7.2	65	7.0	-	-	25	7.0	26	7.0
19	-	-	-	-	48	7.1	18	7.0	28	7.2	24	7.0
20	98	7.0	145	7.1	-	-	20	7.0	30	7.0	-	-
21	120	7.0	155	7.1	30	7.1	31	7.1	26	7.1	28	7.0
22	100	7.1	145	7.0	30	7.1	32	7.1	-	-	20	7.1
23	98	7.0	150	7.1	32	7.0	35	7.1	27	7.0	20	7.2
24	85	7.0	130	7.1	30	7.1	33	7.1	30	7.1	18	7.0
25	97	7.1	130	7.1	25	7.1	-	-	24	7.2	32	7.1
26	-	-	140	7.1	-	-	29	7.0	27	7.0	25	7.1
27	125	7.1	125	7.1	-	-	21	7.0	30	7.1	-	-
28	190	7.0	110	7.2	125	7.1	15	7.1	27	7.0	26	7.0
29	180	7.0	125	7.1	98	7.0	12	7.0	-	-	30	7.1
30	180	7.0	-	-	90	7.0	11	7.1	25	7.1	24	7.0
31	180	7.0	120	7.1	-	-	11	7.0	-	-	20	7.0
Aver.	89	7.1	136	7.1	73	7.1	27	7.1	22	7.1	27	7.0
Max.	190	7.2	200	7.2	125	7.2	76	7.1	32	7.2	38	7.2
Min.	48	7.0	100	7.0	25	7.0	11	7.0	10	7.0	18	7.0

Table-2 MONTHLY AVERAGE TURBIDITY AND DESLUDGING FREQUENCY

Month	Monthly Aver.Turb. (FTU)	Interval of Desludging (A=No. of Days)	No. of Days (B=Day)	Frequency of Desludging (C=B/A)
1	15	57	31	0.54
2	14	58	28	0.48
3	10	60	31	0.52
4	9	60	30	0.50
5	9	60	31	0.52
6	26	54	30	0.56
7	89	31	31	1.00
8	136	14	31	2.21
9	73	37	30	0.81
10	27	53	31	0.58
11	22	55	30	0.55
12	27	53	31	0.58
Total (Yearly Desludging Frequency)				8.85 ≑ 9 times

Table-3 *FIELD SURVEY OF TREATED WATER FLOW IN PHUM PREK PLANT*

Tester : Mr. Katsutoshi IWASAKI
Mr. Hironobu TAMAZAWA
Survey Date : 27 April 1993
Equipment for Flow Survey
: Ultrasonic Flow Meter
Survey Site : Pipes between Treated Water Conduit and Clear Water Reservoir

Time	Flow (m^3/hr)		Total (m^3/hr)
	Pipe - 1	Pipe - 2	
10:50	1,538	1,436	2,974
11:00	1,640	1,538	3,178
:10	1,415	1,661	3,076
:20	1,547	1,751	3,298
:30	1,596	1,730	3,326
:40	1,790	1,980	3,770
:50	1,827	1,733	3,560
12:00	2,044	1,712	3,756
:10	2,002	1,684	3,686
:20	1,740	1,989	3,729
:30	1,994	1,856	3,850
:40	2,064	1,980	4,044
:50	2,068	1,795	3,863
13:00	1,538	1,761	3,299
:10	1,622	1,943	3,565
:20	1,733	1,851	3,584
:30	1,716	1,614	3,330
:40	1,689	1,572	3,261
:50	1,716	1,823	3,539
14:00	1,601	1,710	3,311
:10	1,652	1,994	3,646
:20	1,629	1,775	3,404
:30	1,663	1,792	3,455
Average	1,731	1,769	3,500
Maximum	2,068	1,994	4,044
Minimum	1,415	1,436	2,974

3. BALANCE OF SOLID MATERIALS

3.1 Solid Material by Coagulant Dosage

The solid materials to be considered in Phum Prek Treatment Plant consist of materials suspended in the raw and treated water and dosed chemicals. According to the jar tests conducted by the Study Team, the dosing rate of coagulant (Aluminum Sulfate) was 20 ppm at raw water turbidity 20 FTU, 25 ppm at 27 FTU and 13 ppm at 28 FTU, respectively.

As the reliable records for the coagulant dosage at high turbid period at the Plant are available and the jar tests by the Study Team were conducted during comparatively low turbid period, the coagulant dosage at high turbidity was estimated from the data of Kaolieo Water Treatment Plant in Laos which raw water has been obtained from the upstream Mekong river. The estimated coagulant dosage and daily average turbidity are shown below:

Month	Daily Ave.Turb. (FTU)	Alum Dosage (ppm)	Solid Materials by Alum (kg/day)
1	15	15	1,456
2	14	15	1,456
3	10	10	970
4	9	10	970
5	9	10	970
6	26	20	1,941
7	89	28	2,718
8	136	31	3,009
9	73	26	2,523
10	27	20	1,941
11	22	17	1,650
12	27	20	1,941
Total	457		21,545
Average	38		1,795

The above table is estimated providing that the treated capacity of the Plant is 97,056 m^3/day.

3.2 Solid Materials by Turbid Raw Water

As the reliable data as to relation between suspended solid and FTU are not available at present, the solid materials originating from the turbid raw water are estimated providing that turbidity 1 FTU is similar to Suspended Solid 1 ppm.

From the average turbidity 38 FTU obtained previously, the amount of solid materials contained in the raw water is able to estimate as follows:

Solid Materials in Raw Water
= (38 FTU x 97,056)/1,000,000 = 3,686 kg/day

3.3 Estimation of Balance on Solid Materials

On the assumption that 5 FTU of sedimented water and 1 FTU of filtered water are obtainable by means of dosing coagulant as stated in the above table, the balance of solid materials at the Plant is shown below:

Solid Materials (SM) Conveyed to Receiving Well
: 3,686 kg/day

SM Conveyed to Flocculation Basins
: 3,686 + 1,795
= 5,481 kg/day

SM of Sedimented Water : 5 FTU x 97,056/1,000,000
= 485 kg/day

SM of Filtered Water : 1 FTU x 97,056/1,000,000
= 97 kg/day

SM of Supplied Water : 1 FTU x 97,056/1,000,000
= 97 kg/day

APPENDIX N

EXISTING MACHINERY LIST

APPENDIX N

MACHINERY LIST

CONTENTS

MACHINERY LIST

No.	Item	Size & No.	Remarks
1.	**Phum Prek Treatment Plant**		
M1)	Inlet Gate	(H1.0 m x W1.1 m x 4 sets Intake Tower)	: 2 sets fully opened and unoperationable 2 sets with incomplete closure
M2)	Raw Water Intake Pump	(Ø500 x Q2,200 m^3/hr x H21.0 m x 185 kw x 3 sets Intake Tower)	: 2 sets OK 1 set out-of-order
M3)	Overhead Traveling Crane	(6.0 ton Rated Load x 10.0 m Traveling x 8.0 m Cross Movement x 10.0 m Span x 5.0 m Lifting x 1 set Intake Tower)	: OK
M4)	Access Bridge	(Steel Truss 42 m Span x 4.0 m Width Intake Tower)	: Questionable Roller Support
M5)	Anti Water Hammer Device	(Capacity 15 m^3/tank x P5.0 kg/cm^2 x 2 Tanks Beside Access Bridge)	: OK
		Air Compressor 400 lit. Tank x 4 kw x 1 set; Intake Tower)	: Questionable Operation Condition
M6)	Raw Water Main	(Ø700 CIP x 1.5 km x 2 lines Intake - Receiving Well)	: Corroded

No.	Item	Size & No.	Remarks
M7)	Drain Valve	(Ø100 x 1 No. Receiving Well)	: OK
M8)	Overflow	(W1.335 m x 3 Nos. Receiving Well)	: Incorrect Overflow level
M9)	Inlet Gate	(H1.0 m x W1.0 m x 2 Nos. Mixing Chamber)	: Fully opened, Unoperationable
M10)	Chemical Dosing Device	(Mixing Chamber)	: No lime dosing. Dosing point of chemicals is not adequate.
M11)	Flash Mixer	(Propeller Ø320 x 348 rpm x 4 kw x 2 sets Mixing Chamber)	: OK
M12)	Outlet Gate	(H1.0 m x W1.0 m x 2 Nos. Mixing Chamber)	: OK
M13)	Top Valve	(Ø80 x 2 Nos. Mixing Chamber)	: Leakage
M14)	Inlet Valve	(Ø300 Non-rising Stem Type x 12 sets Flocculation Basin)	: Fully opened, but unoperationable (2 sets/basin x 6 basins = 12 sets)
M15)	Flocculator	(Ø4.5 m x H2.5 m x 2.5 rpm - 3.7 rpm x 1.3/2.0 kw x 12 sets Flocculation Basin)	: Puddles and Shafts are not good.
M16)	Drain Valve	(Top valve Ø200 x 18 sets	: Rods and Valve

No.	Item	Size & No.	Remarks
		Sedimentation Basin)	Bodies necessitate repair. (3 sets/basin x 6 basins = 18 sets)
M17)	Sprit Roll	(Lumber W11.0 m x 3 Nos. x 6 sets; Sedimentation Basin)	: Several nos. deteriorated
M18)	Outlet Gate	(W0.8 m x H1.4 m x 6 sets; Settled Water Channel of Sedimentation Basin)	: OK
M19)	Drain Valve	(Ø100 Top Valve x 6 sets, Settled Water Channel of Sedimentation Basins)	: Fully Closed, Unoperationable
M20)	Inlet Gate	(DIFCLAP Gate W0.82 m x H0.265 m x 2 sets/Filter x 12 Filters; Filter)	: Several gates cannot be closed during Backwashing, & remainings deteriorated
M21)	Drain Gate Valve	(Ø250 x 12 sets; Filter)	: Fully closed and unoperationable
M22)	Operation Table	(1 Table/2 Filters x 6 Tables Pneumatic Type)	: Partly out-of-order
M23)	Chlorinator	(40.0 kg/hr x 3 sets; Chemical Dosing Gallery)	: 1 set operated 2 sets out-of-order
M24)	Alum. Doser	(Ø1.$^1/_2$" x 0.23 lit/sec x 3 kg/cm^2 x 0.75 kw x 3 sets Chemical Dosing Gallery)	: 1 set out-of-order (Pump-dosing type)
M25)	Alum. Doser	(40 cm^3/sec - 300 cm^3/sec	: Out-of-order

No.	Item	Size & No.	Remarks
		x 2 sets; Gravity dosing type Chemical Dosing Gallery)	
M26)	Lime Doser	(50 cm^3/sec - 200 cm^3/sec x 2 sets; Gravity dosing type Chemical Dosing Gallery)	: Out-of-order
M27)	Generator	(1,500 KVA x 3,000 V/50 Hz x 3 sets Generator Room)	: Transported
M28)	Generator	(300 KVA x 220 V/380 V/50 Hz x 2 sets Generator Room)	: Transported
M29)	Overhead Traveling Crane	(6.0 ton Rated Load x 20.0 m Traveling x 10.0 m Cross movement x Span 14.0 m x Lifting 3.0 m x 1 set Generator Room)	: Transported
M30)	Flashing Valve	(Ø60 x 28 valves Sedimentation Basin)	: Not equipped with hoses and nozzles
M31)	Pump for Flashing Valves	(Ø80 x Q30 m^3/hr x H61.55 m x 17.6 kw x 1 set Subsidiary Equipment Room)	: Foot valve & Check valve leaking
M32)	Backwash Pump	(Ø250 x Q964 m^3/hr x H8.35 m x 42 kw x 2 sets Subsidiary Equipment Room)	: 1 set operated 1 set out-of-order, Vacuum system out-of-order.
M33)	Air Blower	(Ø200 x Q4,140 m^3/hr	: Questionable

No.	Item	Size & No.	Remarks
	for Backwash	x P0.3 bar x 47.8 kw x 1 set ~ Roots type blower Subsidiary Equipment Room)	operation condition
M34)	Air Blower for Backwash	(Ø200 x Q3,700 m^3/hr x P0.3 bar x 45 kw x 1 set ~ Roots type blower Subsidiary Equipment Room)	: Not yet operation- able
M35)	Air Compressor for Pneumatic Operation System	(Q11.42 m^3/hr x P21 bar x 1.5 kw x 2 sets with Tank 300 lit. x 1 set Subsidiary Equipment Room)	: 1 set of Air Compressor is not yet operation- able.
	Air Container	(Tank Capacity 490 lit. x H21 bar Subsidiary Equipment Room)	: OK
M36)	Distribution Pump (Set by Puech-Chabal, France)	(Ø500 x Q2,100 m^3/hr x H42.0 m x 325 kw x 4 sets Main Distribution Pump House)	: Capacity reduced about half 2,100 -> 1,200 m^3/hr Check and Sluice Valves should be replaced.
M37)	Distribution Pump (Set by Kubota Const. Japan)	(Ø350 x Ø300 x Q900 m^3/hr x H27.0 m x 175 HP [or 132 kw] x 3 sets Distribution Pump House)	: OK
M38)	Distribution Pump (Set by Kubota Const.	(Ø300 x Q600 m^3/hr x H30.0 m x 75 kw x 1 set Distribution Pump House)	: OK

No.	Item	Size & No.	Remarks
	Japan)		
M39)	Overhead Traveling Crane (Set by Puech-Chabal, France)	(3.0 ton Rated Load x 19.0 m Traveling x 5.0 m Cross Movement x 6.25 m Span x 5.0 m Lifting Main Distribution Pump House)	: OK
M40)	Drain Pump for Subsidiary Equipment Room	(Ø200 x Q270 m^3/hr x H9.45 m x 14 kw 1 set Subsidiary Equipment Room)	: Out-of-order
M41)	Venturi Meter for Total Flow of Filtered Water	(Ø700 x 2 sets Venturi Meter Room)	: Transmitter & Receiver out-of-order.
M42)	Venturi Meter for Distribution	(Ø800 x 1 set Venturi Meter Chamber in front of Main Building)	: Out-of-order
M43)	Agitator for Alum. Preparation Tank	(Propeller Dia. Ø330 x 287 rpm x 1.1 kw x 2 sets Chemical Dosing Gallery)	: OK
M44)	Service Water Pumps	(Ø150 x Q2.5 m^3/min x H30 m x 22 kw x 1 set Main Distribution Pump House)	: Transported
M45)	Ventilator	(11 kw x 4 sets, Generator Room)	: OK

No.	Item	Size & No.	Remarks
M46)	Aspirator for Lime	(1.5 kw x 1 set Chemical Dosing Room)	: Out-of-order
M47)	Lime Pump	(Ø70 x Q36 m^3/hr x H15 m x 7.5 kw x 2 sets Chemical Dosing Room)	: Out-of-order
M48)	Agitator for Lime	(Propeller Dia. Ø330 x 125 rpm x 2.2 kw x 2 sets Chemical Dosing Room)	: Out-of-order
M49)	Lifter for Alum.	(3.0 ton/hr x 1.5 kw x 1 set, Chemical Dosing Room)	: Out-of-order
M50)	Compressor for Diesel Engine	(5 kw x 2 sets Generator Room)	: Transported
M51)	Oil Pump for Diesel Engine	(1 kw x 2 sets Oil Pump Room)	: Transported
M52)	Vucuum Pump	(1.5 kw x 2 sets Vucuum Pump Room)	: Out-of-order
M53)	Air Compressor for Respirator	(4 kw x 1 set Subsidiary Equipment Room)	: OK
M54)	Overhead Traveling Crane	(Rated Load 2.0 ton x 10.0 m Traveling x 3.0 m Lifting x 1 set, Chlorine Container Storage Room)	: OK

No.	Item	Size & No.	Remarks
M55)	Service Water Pump for Chlorine Dosing	(Ø50 x Q14 m³/hr x H32 m x 5.5 kw x 1 set, Venturi Meter Room)	OK

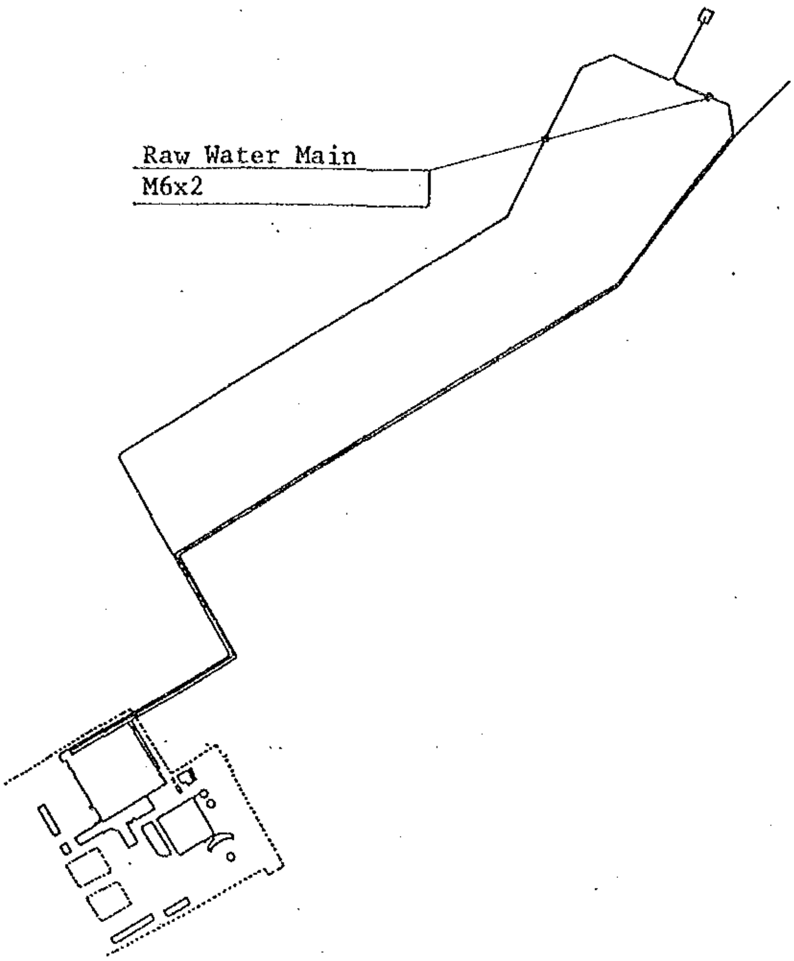
2. **Chamcar Morn Treatment Plant**

No.	Item	Size & No.	Remarks
M1)	Raw Water Pump	(Ø200 x Ø125 x Q290 m³/hr x H30.0 m x 37 kw x 3 sets[1 set-standby] Intake Pump House)	OK (Temporarily)
M2)	Intake Pump House	(Inclined Rail Type W2.8 m x L9.7 m Intake Pump House)	OK
M3)	Anti Water Hammer Device	(Capacity 0.9 m³/tank x P3.0 kg/cm² x 2 Tanks Inclined Rail Top)	OK
M4)	Raw Water Main	(Ø250 CIP x 1.2 km x 2 lines Intake - Plant)	OK
M5)	High Rate Coagulo-sedimentation Basin	(Ø10.8 m x H4.5 m x 2 sets Aver. Rising Velocity=43 mm/min Capacity = 360 m³; Plant)	Questionable mixing with chemicals
M6)	Alum. Doser	(Ø1.¹/₄" x Q1,600 lit/hr x P16 kg/cm² x 3.0 kw x 2 sets Chemical Dosing Room)	OK (Temporarily)

No.	Item	Size & No.		Remarks
M7)	Lime Doser	(Ø1.1/4" x 630 lit/hr x P10 kg/cm² x 1.1 kw x 2 sets Chemical Dosing Room)	:	Not operated
M8)	Filter	(Pressure Type Ø3.0 m x H2.4 m x 12 sets Q = 910 m³/day/set; Plant)	:	Questionable Filter Media and Valves
M9)	Air Blower for Backwash	(Ø100 x Q42 lit/sec x P0.5 kg/cm² x 4 kw x 3 sets Distribution Pump Room)	:	OK (Temporarily)
M10)	Backwash Pump	(Ø150 x Ø100 x Q160 m³/hr x H20 m x 15.0 kw x 2 sets Distribution Pump Room)	:	OK (Temporarily)
M11)	Chlorinator	(Max. 10 kg/hr x 1 set Chlorinator Room)	:	OK Intermittently used
M12)	Service Water Pump for Chlorine Dosing	(Ø1.1/2" x Q20 m³/hr H32.0 m x 5.5 kw x 1 set Chlorinator Room)	:	OK
M13)	Clear Water Reservoir	(Ø15.0 m x H3.0 m x V500 m³ x 1 No. Plant)	:	OK
M14)	Distribution Pump	(Ø200 x Ø125 x Q290 m³/hr x H30 m	:	OK (Temporarily)

No.	Item	Size & No.	Remarks
		x 37 kw x 3 sets Distribution Pump Room)	
M15)	Vibration Sieving Machine	(L2.0 m x W1.2 m H1.5 m x 11 kw x 2 sets Beside Sediment. Basin)	: 1 set OK 1 set Transported

(Note) : "OK (Temporarily)" stated above means Presently operated but under questionable condition.


Raw Water Main
M6x2

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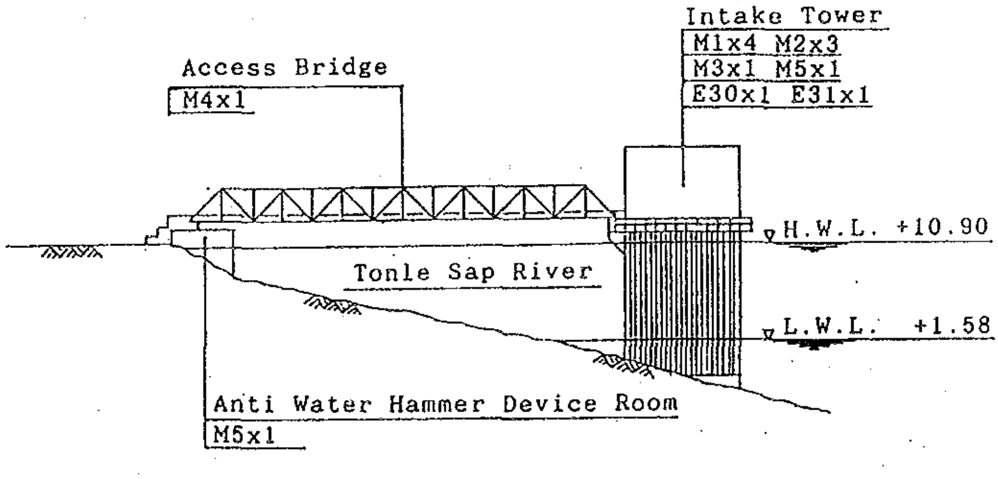
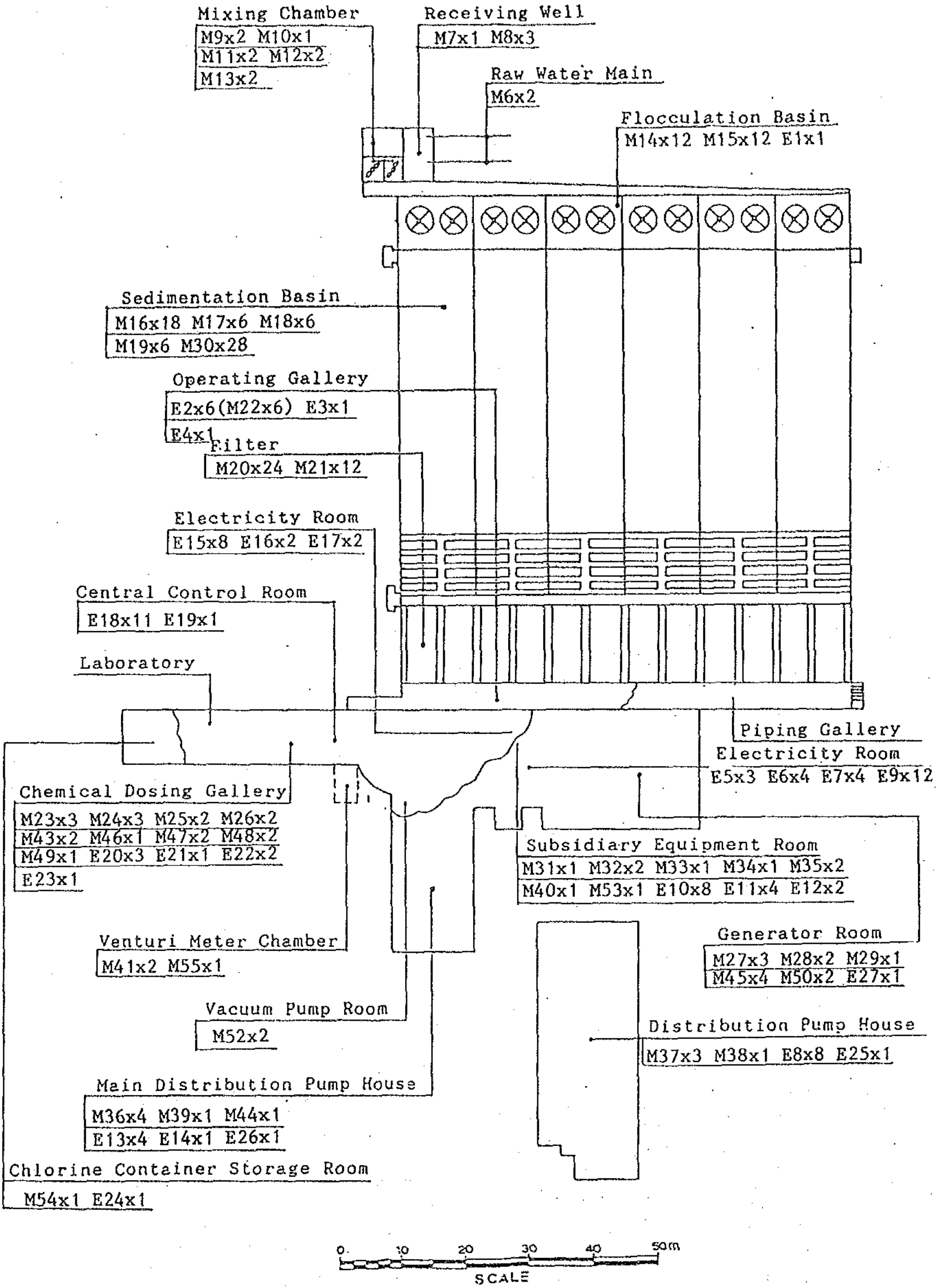

Intake Tower
M1x4 M2x3
M3x1 M5x1
E30x1 E31x1
Access Bridge
M4x1
H.W.L. +10.90
Tonle Sap River
L.W.L. +1.58
Anti Water Hammer Device Room
M5x1


Mixing Chamber
M9x2 M10x1
M11x2 M12x2
M13x2
Receiving Well
M7x1 M8x3
Raw Water Main
M6x2
Flocculation Basin
M14x12 M15x12 E1x1
Sedimentation Basin
M16x18 M17x6 M18x6
M19x6 M30x28
Operating Gallery
E2x6(M22x6) E3x1
E4x1
Filter
M20x24 M21x12
Electricity Room
E15x8 E16x2 E17x2
Central Control Room
E18x11 E19x1
Laboratory
Piping Gallery
Electricity Room
E5x3 E6x4 E7x4 E9x12
Chemical Dosing Gallery
M23x3 M24x3 M25x2 M26x2
M43x2 M46x1 M47x2 M48x2
M49x1 E20x3 E21x1 E22x2
E23x1
Subsidiary Equipment Room
M31x1 M32x2 M33x1 M34x1 M35x2
M40x1 M53x1 E10x8 E11x4 E12x2
Venturi Meter Chamber
M41x2 M55x1
Generator Room
M27x3 M28x2 M29x1
M45x4 M50x2 E27x1
Vacuum Pump Room
M52x2
Distribution Pump House
M37x3 M38x1 E8x8 E25x1
Main Distribution Pump House
M36x4 M39x1 M44x1
E13x4 E14x1 E26x1
Chlorine Container Storage Room
M54x1 E24x1
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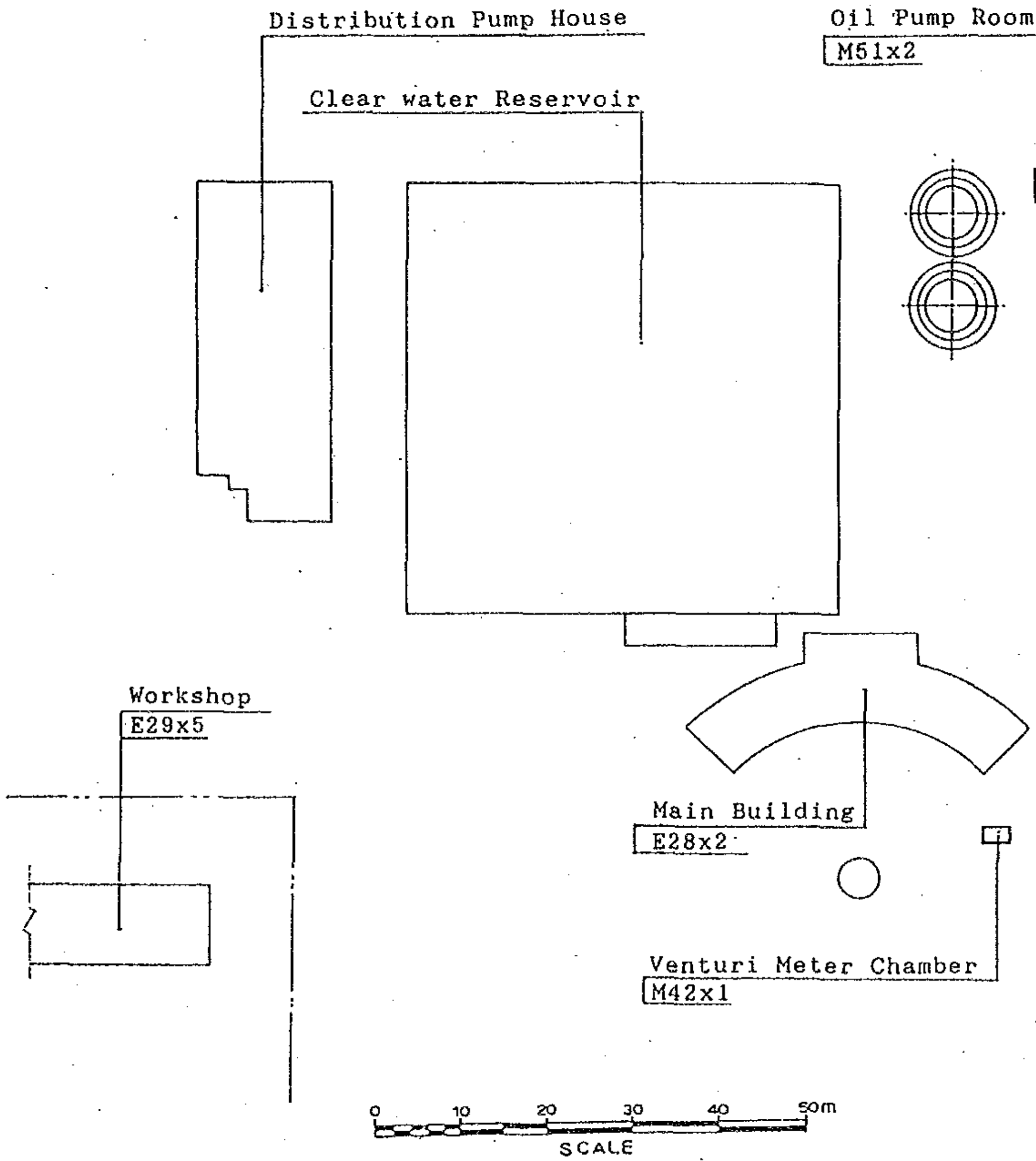
Distribution Pump House
Oil Pump Room
M51x2
Clear water Reservoir
Workshop
E29x5
Main Building
E28x2
Venturi Meter Chamber
M42x1
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10
20
30
40
50m
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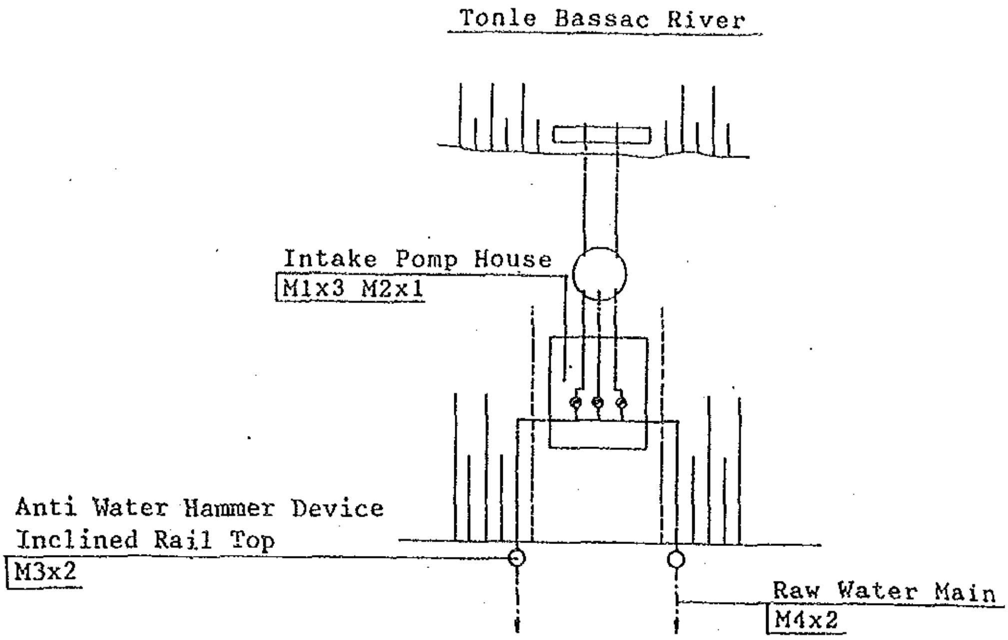
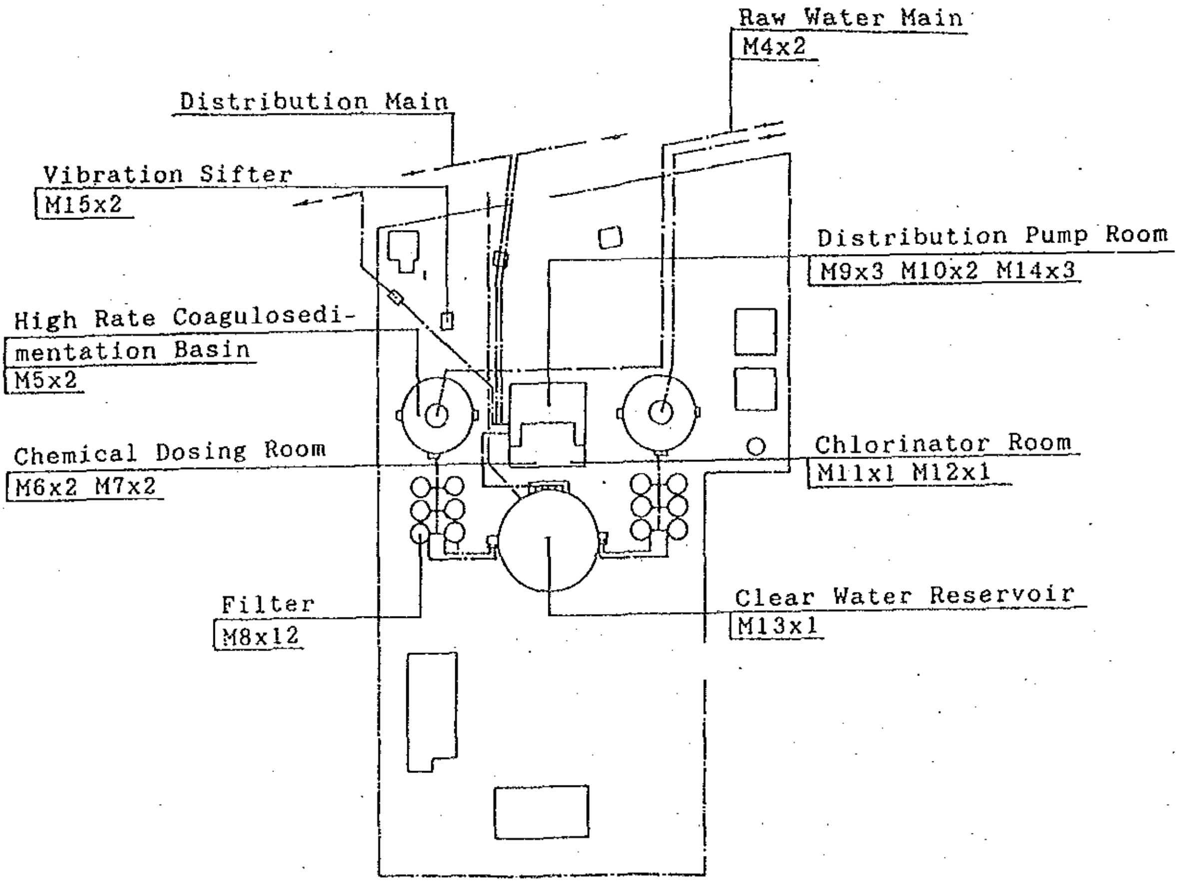
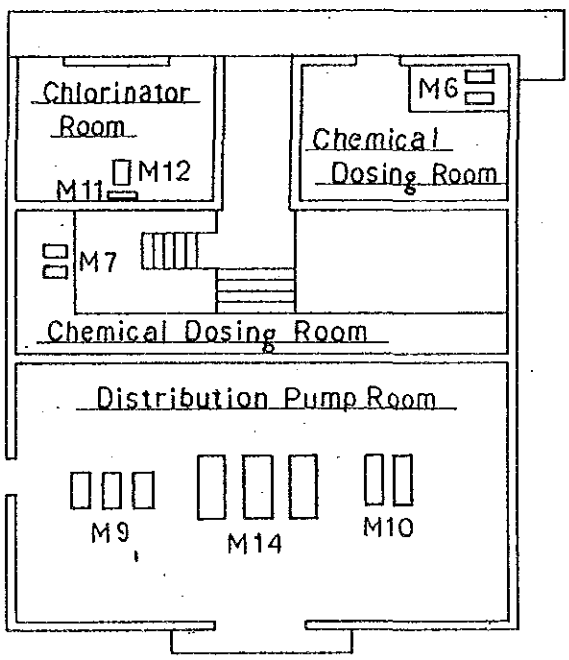


Tonle Bassac River
Intake Pomp House
M1x3 M2x1
Anti Water Hammer Device
Inclined Rail Top
M3x2
Raw Water Main
M4x2



Raw Water Main
M4x2
Distribution Main
Vibration Sifter
M15x2
Distribution Pump Room
M9x3 M10x2 M14x3
High Rate Coagulosedi-
mentation Basin
M5x2
Chemical Dosing Room
M6x2 M7x2
Chlorinator Room
M11x1 M12x1
Filter
M8x12
Clear Water Reservoir
M13x1

CHANCAR MORN TREATMENT PLANT



Operation Building

APPENDIX O

CONSTRUCTION AND OPERATING COST

APPENDIX O CONSTRUCTION AND OPERATING COST

CONSTRUCTION AND OPERATING COST

For presentation of Table O - 1,
Construction and operating cost has been studied as follows:

1. The table consist of three items; sales volume estimation construction cost and operating cost.

2. Expansion cost of 10,000 m3/day in Chamcar Morn treatment plant is estimated as 4.22 million US Dollars as shown in the table. The construction is executed by French Government.

3. Installation cost of meters and laying cost of house connections are not included in the construction cost, which are supposed to be fully paid by users. The construction cost and the design fee of them are 47.52 million US Dollars and 1,33 million US Dollars respectively.

4. Design fee of the construction cost in the table is allocated as a capital cost.

5. Chemical cost in the operating cost is calculated as shown in the table.

6. Production water volume is larger than the supply water volume by 6%.

Table O - 1 Construction and Operating Cost

No.	Year	Sales Volume Estimation: Plant Capacity: Existing m3/day	Expansion m3/day	Supply Water Volume m3/day	Leakage Ratio %	Sales Volume m3/day	Annual Sales Volume m3/year	Construction Cost (Million US$): Structure	Pipes	Mechanical Equipment	Electric Equipment	Design Fee	Total
a	b	c	d	e	f	g	h	i	j	k	l	m	n
								1.27	0.63	1.05	1.27		4.22
1	1994	63,000		63,000	50	31,500	11,497,500	4.63	1.65	2.58	6.60	1.18	16.64
2	1995	63,000	10,000	73,000	50	36,500	13,322,500	5.74	6.17	6.98		1.31	20.19
3	1996	110,000	50,000	154,000	48	80,080	29,229,200						
4	1997			163,000	46	88,020	32,127,300		5.62	0		0.56	6.18
5	1998			170,000	44	95,200	34,748,000		5.62	0		0.56	6.18
6	1999			170,000	42	98,600	35,989,000		5.62	0		0.56	6.18
7	2000			170,000	40	102,000	37,230,000		5.62	0		4.16	9.78
8	2001			170,000	38	105,400	38,471,000	20.27	29.63	0		4.11	54.01
9	2002			170,000	36	108,800	39,712,000		24.56	15.63	10.42	4.11	54.72
10	2003		65,000	219,000	34	144,540	52,757,100		24.59	0		2.83	27.42
11	2004			229,000	32	155,720	56,837,800		6.59	0		0.76	7.35
12	2005			235,000	30	164,500	60,042,500		6.59	0		0.76	7.35
13	2006			235,000	28	169,200	61,758,000		6.59	0		0.76	7.35
14	2007			235,000	26	173,900	63,473,500		6.59	0		3.12	9.71
15	2008			235,000	24	178,600	65,189,000	13.5	25.94	0		3.52	42.96
16	2009			235,000	22	183,300	66,904,500		22.57	10.13	6.76	3.52	42.98
17	2010		65,000	300,000	20	240,000	87,600,000		22.68	0		2.69	25.37
18	2011			300,000	20	240,000	87,600,000						
19	2012			300,000	20	240,000	87,600,000						
20	2013			300,000	20	240,000	87,600,000						
21	2014			300,000	20	240,000	87,600,000						
22	2015			300,000	20	240,000	87,600,000						
23	2016			300,000	20	240,000	87,600,000						
24	2017			300,000	20	240,000	87,600,000						
25	2018			300,000	20	240,000	87,600,000						
26	2019			300,000	20	240,000	87,600,000						
27	2020			300,000	20	240,000	87,600,000						
28	2021			300,000	20	240,000	87,600,000						
29	2022			300,000	20	240,000	87,600,000						
30	2023			300,000	20	240,000	87,600,000						
31	2024			300,000	20	240,000	87,600,000						
32	2025			300,000	20	240,000	87,600,000						
33	2026			300,000	20	240,000	87,600,000						
34	2027			300,000	20	240,000	87,600,000						
35	2028			300,000	20	240,000	87,600,000						
36	2029			300,000	20	240,000	87,600,000						
37	2030			300,000	20	240,000	87,600,000						
38	2031			300,000	20	240,000	87,600,000						
39	2032			300,000	20	240,000	87,600,000						
40	2033			300,000	20	240,000	87,600,000						
Total								45.41	207.26	36.37	25.05	34.50	348.59

No.	After allocation of Design Fee: Structure 40years	Pipes 40years	Mechanical Equipment 15years: 1	2	3	Sub-total	Electric Equipment 10years: 1	2	3	Sub-total	Total
a	o	p	q	r	s	t	u	v	w	x	y
1	6.25	2.41	3.83			3.83	8.37			8.37	20.86
2	6.14	6.59	7.46			7.46					20.19
3						0.00					0.00
4		6.18	0.00			0.00					6.18
5		6.18	0.00			0.00					6.18
6		6.18	0.00			0.00					6.18
7		9.78	0.00			0.00					9.78
8	21.94	32.07	0.00			0.00					54.01
9		26.48	16.90			16.90	11.27			11.27	54.65
10		27.42	0.00			0.00					27.42
11		7.35	0.00			0.00					7.35
12		7.35	0.00			0.00					7.35
13		7.35	0.00			0.00					7.35
14		9.71	0.00			0.00					9.71
15	14.70	28.26	0.00			0.00					42.96
16		24.49	11.03	3.83		14.86	7.36	8.37		15.73	55.08
17		25.37	0.00	7.46		7.46					32.83
18						0.00					0.00
19				0.00		0.00					0.00
20				0.00		0.00					0.00
21				0.00		0.00					0.00
22				0.00		0.00					0.00
23				0.00		0.00					0.00
24				16.90		16.90		11.27		11.27	28.17
25				0.00		0.00					0.00
26				0.00		0.00					0.00
27				0.00		0.00					0.00
28				0.00		0.00					0.00
29				0.00		0.00					0.00
30				0.00		0.00					0.00
31				11.03	3.83	14.86		7.36	8.37	15.73	30.59
32				0.00	7.46	7.46					7.46
33						0.00					0.00
34					0.00	0.00					0.00
35					0.00	0.00					0.00
36					0.00	0.00					0.00
37					0.00	0.00					0.00
38					0.00	0.00					0.00
39					16.90	16.90			11.27	11.27	28.17
40					0.00	0.00					0.00

No.	Operating Cost (US$): Chemical: Aluminum Sulfate 40mg/l ton	219 US$/ton	Slaked Lime 10mg/l ton	140 US$/ton	Chlorine 4mg/l ton	572 US$/ton	Total US$	Electric Charge: 0.381 kw/m3 kw	0.068US$ 170Riels/kwh US$	Repair Cost 10% x (ag)	No. of Employee	Personnel Expenses 14 US$/Person	Office Expenses 25% x (al)	Total US$	Year	No.
a	aa	ab	ac	ad	ae	af	ag	ah	ai	aj	ak	al	am	an	ao	ap
1	975	213,525	244	34,160	97	55,484	303,169	9,286,761	631,500	110,852	300	50,400	12,600	1,108,521	1994	1
2	1,130	247,470	282	39,480	173	64,636	351,586	10,760,850	731,738	127,369	300	50,400	12,600	1,273,693	1995	2
3	2,383	521,877	596	83,440	238	136,136	741,453	22,700,971	1,543,666	261,929	344	57,792	14,448	2,619,288	1996	3
4	2,523	552,537	631	88,340	252	144,144	785,021	24,027,651	1,633,880	276,793	344	57,792	14,448	2,767,934	1997	4
5	2,631	576,189	658	92,120	263	150,436	818,745	25,059,513	1,704,047	288,337	344	57,792	14,448	2,883,369	1998	5
6	2,631	576,189	658	92,120	263	150,436	818,745	25,059,513	1,704,047	288,337	344	57,792	14,448	2,883,369	1999	6
7	2,631	576,189	658	92,120	263	150,436	818,745	25,059,513	1,704,047	288,337	344	57,792	14,448	2,883,369	2000	7
8	2,631	576,189	658	92,120	263	150,436	818,745	25,059,513	1,704,047	288,337	344	57,792	14,448	2,883,369	2001	8
9	2,631	576,189	658	92,120	263	150,436	818,745	25,059,513	1,704,047	288,337	344	57,792	14,448	2,883,369	2002	9
10	3,389	742,191	847	118,580	339	193,908	1,054,679	32,282,549	2,195,213	371,646	452	75,936	18,984	3,716,458	2003	10
11	3,544	776,136	886	124,040	354	202,488	1,102,664	33,756,638	2,295,451	388,115	452	75,936	18,984	3,881,150	2004	11
12	3,637	796,503	909	127,260	364	208,208	1,131,971	34,641,092	2,355,594	398,054	452	75,936	18,984	3,980,539	2005	12
13	3,637	796,503	909	127,260	364	208,208	1,131,971	34,641,092	2,355,594	398,054	452	75,936	18,984	3,980,539	2006	13
14	3,637	796,503	909	127,260	364	208,208	1,131,971	34,641,092	2,355,594	398,054	452	75,936	18,984	3,980,539	2007	14
15	3,637	796,503	909	127,260	364	208,208	1,131,971	34,641,092	2,355,594	398,054	452	75,936	18,984	3,980,539	2008	15
16	3,637	796,503	909	127,260	364	208,208	1,131,971	34,641,092	2,355,594	398,054	452	75,936	18,984	3,980,539	2009	16
17	4,643	1,016,817	1,161	162,540	464	265,408	1,444,765	44,222,670	3,007,142	507,443	548	92,064	23,016	5,074,430	2010	17
18	4,643	1,016,817	1,161	162,540	464	265,408	1,444,765	44,222,670	3,007,142	507,443	548	92,064	23,016	5,074,430	2011	18
19	4,643	1,016,817	1,161	162,540	464	265,408	1,444,765	44,222,670	3,007,142	507,443	548	92,064	23,016	5,074,430	2012	19
20	4,643	1,016,817	1,161	162,540	464	265,408	1,444,765	44,222,670	3,007,142	507,443	548	92,064	23,016	5,074,430	2013	20
21	4,643	1,016,817	1,161	162,540	464	265,408	1,444,765	44,222,670	3,007,142	507,443	548	92,064	23,016	5,074,430	2014	21
22	4,643	1,016,817	1,161	162,540	464	265,408	1,444,765	44,222,670	3,007,142	507,443	548	92,064	23,016	5,074,430	2015	22
23	4,643	1,016,817	1,161	162,540	464	265,408	1,444,765	44,222,670	3,007,142	507,443	548	92,064	23,016	5,074,430	2016	23
24	4,643	1,016,817	1,161	162,540	464	265,408	1,444,765	44,222,670	3,007,142	507,443	548	92,064	23,016	5,074,430	2017	24
25	4,643	1,016,817	1,161	162,540	464	265,408	1,444,765	44,222,670	3,007,142	507,443	548	92,064	23,016	5,074,430	2018	25
26	4,643	1,016,817	1,161	162,540	464	265,408	1,444,765	44,222,670	3,007,142	507,443	548	92,064	23,016	5,074,430	2019	26
27	4,643	1,016,817	1,161	162,540	464	265,408	1,444,765	44,222,670	3,007,142	507,443	548	92,064	23,016	5,074,430	2020	27
28	4,643	1,016,817	1,161	162,540	464	265,408	1,444,765	44,222,670	3,007,142	507,443	548	92,064	23,016	5,074,430	2021	28
29	4,643	1,016,817	1,161	162,540	464	265,408	1,444,765	44,222,670	3,007,142	507,443	548	92,064	23,016	5,074,430	2022	29
30	4,643	1,016,817	1,161	162,540	464	265,408	1,444,765	44,222,670	3,007,142	507,443	548	92,064	23,016	5,074,430	2023	30
31	4,643	1,016,817	1,161	162,540	464	265,408	1,444,765	44,222,670	3,007,142	507,443	548	92,064	23,016	5,074,430	2024	31
32	4,643	1,016,817	1,161	162,540	464	265,408	1,444,765	44,222,670	3,007,142	507,443	548	92,064	23,016	5,074,430	2025	32
33	4,643	1,016,817	1,161	162,540	464	265,408	1,444,765	44,222,670	3,007,142	507,443	548	92,064	23,016	5,074,430	2026	33
34	4,643	1,016,817	1,161	162,540	464	265,408	1,444,765	44,222,670	3,007,142	507,443	548	92,064	23,016	5,074,430	2027	34
35	4,643	1,016,817	1,161	162,540	464	265,408	1,444,765	44,222,670	3,007,142	507,443	548	92,064	23,016	5,074,430	2028	35
36	4,643	1,016,817	1,161	162,540	464	265,408	1,444,765	44,222,670	3,007,142	507,443	548	92,064	23,016	5,074,430	2029	36
37	4,643	1,016,817	1,161	162,540	464	265,408	1,444,765	44,222,670	3,007,142	507,443	548	92,064	23,016	5,074,430	2030	37
38	4,643	1,016,817	1,161	162,540	464	265,408	1,444,765	44,222,670	3,007,142	507,443	548	92,064	23,016	5,074,430	2031	38
39	4,643	1,016,817	1,161	162,540	464	265,408	1,444,765	44,222,670	3,007,142	507,443	548	92,064	23,016	5,074,430	2032	39
40	4,643	1,016,817	1,161	162,540	464	265,408	1,444,765	44,222,670	3,007,142	507,443	548	92,064	23,016	5,074,430	2033	40
Total																Total

APPENDIX P

INTERVIEW LIST

APPENDIX P

INTERVIEW LIST

CONTENTS

INTERVIEW LIST

Day & Time	Name	Position	Remark
Apr. 6 (15-17)	Mr. Long Naro	Chief of Engineer Section	General Information (English)
Apr. 7 (10-12)	Mr. Ros Kim Leang	Accounting Section	Accounting, Education, Salary (English)
Apr. 7 (17-19)	Mr. David G. Hunter	World Bank/UNDP Cambodia	General Information about Int. Organizations' activity
Apr. 8 (11-12)	Mr. So Sam On	Chief of Exploitation Office	Meter Reader, Billing,(Khmer)
	April 10 - 17	New Year Holiday	
Apr. 20(15-17)	Mr. Kao Sary (50)	Chief of Adim. & Personnel Office	Personnel, Old System(before 1975) he works since 1965 Organization (Khmer)
Apr. 21(15-17)	Mr. Ek Chuon	Chief of Administration Div.	Revenue Collection, System, (Khmer)
Apr. 22(10-12)	Mr. So Sam On	Chief of Exploitation Office	Billing System details (Khmer)

INTERVIEW LIST (CONT.)

Day & Time	Name	Position	Remarks
Apr. 23(14-16)	Mr. Van Chea Mr. Seung Heug Ly	Chief of Financial Office Chief of Payroll	Salary System Financial reports Appointment for next interview with Mr. Chea (Khmer)
Apr. 27 (8:30 - 10:30)	Mr. Van Chea	Chief of Financial Office	Report,Subsidy, Balance Sheet (Khmer)
Apr. 27 (2 - 3:15)	Mr. Soeung Sothea	Vice Chief of Admin. Div.	Budget making, No.32 Decree (English)
Apr. 28 (8:30 - 11:00)	Mr. Noun Sam Ang	Meater Reader for Toul Kork District	Meater Reading 17 Meters/ 2 hours (Khmer)
Apr. 30 (8:50 - 10:00)	Mr. Yim Son	Chief of Phum Prek WTP	Organization, O & M (Khmer)
May 4 (9 - 10)	Mr. Sin Vorn	Chief of Network Office	Organization, House Connection

Brief Summary Of the Meeting On April 6 with Mr. Long Naro

JICA STUDY TEAM: Mr. Wakamoto, Nakagome
Time: 15:00 - 17:00
Re: General Discussion about Administration

The following points are mentioned.

1. WATER TARIFF

2. SALARY

3. METER

Data: April 7, 1993
Time: 9:00 - 11:30
File: INT407.WP
Interviewee: Mr. Ros Kim Leang, Accountant, Financial Office

1. HOUSE CONNECTION, POPULATION UNDER DIRECTLY-CONNECTED SUPPLY

2. EDUCATION SYSTEM IN CAMBODIA

3. PUBLIC SERVANTS' HIERARCHY AND SALARY SCALE

4. 1992 REVENUE AND EXPENDITURE

5. APPLICATION AND PERMISSION OF NEW HOUSE CONNECTION

6. WHOLESALE AND RETAIL OF WATER

7. WATER RETAIL BUSINESS

Date:April 8, 1993
Time:10:00 - 12:00
File:INT408.WP

Interviewee: Mr. So San On, Chief of Exploitation Of Exploitation Office

1. Organization

2. Related Works by Other Office/Division

3. PRACTICES REGARDING METER AND DELAYED PAYMENT OF TARIFF

Date: 1993 4.20
Time: 14:30 - 15:20
File: INT420.WP
Interviewee: Mr. Kao Sary (Chief of Administration)

1. PERSONAL HISTORY
   Mr. Kao Sary:

2. STAFFING (RECRUITING SYSTEM)

3. PROMOTION

4. ATTENDANCE RECORDS

5. ORGANIZATION

Date: April 21, 1993
Time: 15:00 - 16:45
File: INT421.WP
Interviewee: Mr. Ek Chuon (Chief of Revenue Collection Office)
Mr. Hak Vuthy (No.1 Vice Chief)

1. Personal History
   Mr. Ek Chuon (50):
   Mr. Hak Vuthy (32):

2. Staffing No. of this Office

Permanent Staff: 45 (women 9)
Temporary Staff: 88 (women 7)
Total 143 (women 16)

3. Organization

4. Type of Bills

5. Disconnection Procedure

6. Collected Money

7. Bonus System for Money Collectors

Date: April 22, 1993
Time: 10:00 - 11:45
File: INT422.WP
Interviewee: Mr. So Sam On (Chief of Exploitation Office)
(This is second time interview. First time was on April 8)
Re: Meters and Billing

1. METERS

2. SPECIAL BILL ESTIMATION

Date: April 23, 1993
Time: 14:25 - 16:15
File: INT423.WP
Interviewee: Mr. Seung Heug Ly (30 minutes, Chief of Payroll in Financial Office)
Mr. Van Chea (Chief of Financial Office)

1. PERSONAL HISTORY

Mr. Van Chea (52)
Mr. Seung Heug Ly (52)

2. SALARY SYSTEM

3. REPORTS

4. OTHERS

Date: April 27, 1993
Time: 8:30 - 10:10
File: INT427A.WP
Interviewee: Mr. Van Chea (Chief of Financial Office)
Mr. Ros Kim Leang (Accounting Sec.)

1. PREPARED REPORTS

Mr. Van Chean prepared the following data for us,
- 1992, 93(Jan. - March) Expenditure and Revenue Report
- Fixed Asset List in 1986 riel

2. ASSET

3. BALANCE SHEET

4. TOTAL EXPENDITURE AND REVENUE IN 1992

5. OTHERS

Date: April 27, 1993
Time: 14:30 - 15:10
File: INT427B.WP
Interviewee: Mr. Seung Sothea(Vice Chief of Administration Div.)

1. Mr. Sothea's MAIN RESPONSIBILITY

2. YEARLY BUDGED

3. OTHERS (METER REPAIR SHOP)

Date: April 30, 1993
Time: 8:50 - 10:10

File: INT430.WP

Interviewee: Mr. Yim Son(Chief of Phum Prek WTP)

1. PERSONAL HISTORY

2. GENERAL INFORMATION

In 60's, there were more than 50 people working at Phum Prek WTP. .....

3. OTHERS

- All OXFAM's reports are available at WTP.

<Do you have any idea to save electricity ? >

- Yes, to control (intake) motor running, it should be done, because sometimes, motors are running even though the reservoir is full.

<Do you think is it good idea to have telephone system for operation control ? >

- Yes, but now we have walkie-talkie. The daily operation is decided by chiefs of shift groups (3 shifts for 24 hours, each group is consist of 6 people including one chief.) The experiences of those chiefs are almost <u>20 years in this field.</u>

<Operation Records>

- Just after finishing shift's duty, the following information have to be recorded on a master book.
  . Present situation of Intake
  . Voltage fluctuation at Intake
  . Chemicals dosing amount
- Deputy Chief is in charge of repair records.

<Regular Checking>

- there is a rule for regular checking,
  Main Motors: every 15,000 hours due to overhaul
  & every 600 hours due to check
  Pumps every 2,000 hours due to grease

- we got a <u>organization chart</u> of this office.

Date: May 4, 1993
Time: 8:50 - 10:00
File: INT504A.WP
Interviewee: Mr. Sin Vorn(Chief of Network Office)

1. MAIN RESPONSIBILITY

2. PIPE CLEANING

3. HOUSE CONNECTION

4. OTHERS

- There is a house connection registration book but no maps for house connection.
- Leakage Repair 2 - 3 places/week
- Recently, pipes are broken by heavy traffic (some of pipes are laid under roads. In old time, pipe is laid under footpath.)

CLEANING EQUIPMENT FOR 200 mm (PHOTO)

CLEANING EQUIPMENT FOR 200 mm (PHOTO)

Date:May 4,1993
Time:16:30 - 17:30
File:INT504B.WPW
Interviewee: Mr. Iwasaki, Tamazawa

1. DISTRIBUTION NETWORK

2. WATER PRESSURE

3. WATER SOURCES FOR LIVING

4. PIT TANKS AND WATER VENDORS

5. ILLEGAL TAPPING

6. MULTI-STORED BUILDING

7. ANTIPATHY AGAINST RdE

8. CO-WORKERS OF THE SURVEY TEAM

Date:May 12, 1993
Time:Afternoon
File:INT512A.WP
Interviewee:Messrs. Takumi and Machida

Q. What is the most urgently needed for the treatment operation ?

Date:May 12, 1993
File:INT512B.WP
Interviewee:the Interpreter
Subject: Income of various occupations

1. LIVING COST VS. INCOME
    A Daily worker working for RdE
    Permanent staff
    Beggar
    Minimum Living Cost
    Middle Class

2. OWNERSHIP OF HOUSE

JICA