3.7 DEMINERALIZED WATER TRANSFER PUMPS

3.7.1 SCOPE OF SUPPLY

The demineralized water transfer pump shall include the following components with complete accessories.

(1) Pumps and motors

(2) Coupling and guard

(3) Common baseplate

(4) Foundation bolts, nuts and sleeves

(5) Pressure gauges and switches

(6) Painting

3.7.2 GENERAL INFORMATION

3.7.2.1 APPLICABLE STANDARDS AND CODES

The demineralized water transfer pump shall be designed and constructed in accordance with the requirements of Clause 6 of "Applicable Standards and Codes" in Part I.

3.7.2.2 OUTLINE

(1) The demineralized transfer pump shall be able to transfer make up water from the demineralized water tank to the Units 1 and 2 make up water tank.

(2) Three (3) make up transfer pumps shall be provided.

(3) Pumps shall be able to be controlled from the water treatment control room.

3.7.2.3 DESIGN DATA

(1)	Installation	Indoor (water treatment building) water tank
(2)	Type	Horizontal, centrifugal pump
(3)	Number	Two (2) sets

(4) Capacity 100 Ton/hr (tentative)

(5) Total head To be decided by the Contractor

(6) Motor Outdoor, horizontal type

3.7.2.4 PERFORMANCE

(1) The demineralized water transfer pump shall perform as shown in the Tenderer's Data Sheet".

(2) The pump shall be able to operate without cavitation, pitting and excessive vibration.

(3) The Contractor shall submit performance curves to the Engineer for approval.

3.7.2.5 TESTING

(1) The Contractor shall execute the following shop tests and shall submit the test and inspection results to the Engineer for approval.

(a) Dimension check

(b) Performance check

(c) Vibration check

(d) Overhaul inspection

(e) Hydrostatic test

(f) Noise check

(2) The Contractor shall execute the following field tests and shall submit the test and inspection results to the Engineer.

(a) Alignment inspection during assembling

(b) Motor running test (isolated)

(c) Pump running test

(d) Vibration test

(e) Noise check

3.7.3 TECHNICAL INFORMATION

3.7.3.1 The materials shall be as follows.

(1)	Casing	Cast iron (JIS G5501, or equivalent)
(2)	Impeller	Stainless steel or equivalent
(3)	Shaft	Stainless steel or equivalent

3.7.3.2 CONSTRUCTION

(1) The casing shall be cast with smooth interior and exterior surfaces, free from blow holes, sand holes and other faults.

(2) The impellers shall be enclosed, accurately machined and balanced to eliminate vibration, and shall be securely keyed to the pump shaft.

(3) The shaft shall be of sufficient diameter to transfer the full load requirements of the pump, and shall be of such dimension so as to transfer the full load torque requirements of the pump without excessive deflection, vibration, distortion or whip.

(4) All shaft surfaces shall be smoothly grounded to accurate dimensions.

(5) The shaft sleeves shall have a smooth surface allowing minimum pressure on the packing so as to prevent leakage.

(6) The drain connections shall be provided at all low points of the volute and all other points where drainage is possible.

(7) The high points of each volute shall be provided with a

vent valve.

(8) The pressure gauge shall be provided at pump suction and discharge.

3.7.3.3 MOTOR

The motor shall be in conformity with Clause 2.2 of "Electric Motor" in Section II of Part I.

3.7.3.4 PAINTING

Painting shall be in conformity with Clause 1.13 of "Painting for Piping and Equipment" in Section II of Part I.

4. DRAINAGE AND WASTE WATER TREATMENT SYSTEM

4.1 SCOPE OF SUPPLY

The drainage and waste water treatment equipment shall be provided with all components and complete accessories, but these shall not be limited to the following items.

(1) Main building mechanical drainage system

- (a) Turbine room sump pump and motor
- (b) Condenser pit sump pump and motor
- (c) Turbine oil sump pump and motor
- (d) Drainage piping
- (e) Pit level controller
- (f) Control panel

(2) Unit neutralizing pit equipment for Units 1 and 2

- (a) Pit pump and motor
- (b) Agitating air blower and motor
- (c) Piping and valves (including agitating air piping and valves)
- (d) Instruments
- (e) Level controller
- (f) Control panel

(3) Waste water storage pond equipment

- (a) Pond pump and motors
- (b) Agitating air blower and motor
- (c) Piping and valves
- (d) Level controller
- (e) Instruments

(4) pH control oxidation pit and mixing pit equipment

(a) Automatic pH controller

(b) Mixing pit agitator and motor

(c) Level controller

(d) Instruments

(e) Piping and valves (including pH control oxidation pit agitating air piping and valves)

(5) Coagulation-sedimentation tank equipment

(a) Agitator and motor

(b) Sludge pump and motor

(c) Piping and valves

(d) Instruments

(6) Clear water pit equipment

(a) Filter feed pumps and motors

(b) Level controller

(c) Piping and valves

(d) Instruments

(7) Filter equipment

(a) Filter

(b) Filter air scrubbing agitator blower and motor

(c) Piping and valves

(d) Instruments

(8) Neutralizing pit equipment

(a) Pump and motor

(b) Agitator and motor

(c) Automatic pH controller

(d) Level controller

(e) Piping and valves

(f) Instruments

(9) Purified waste water pit equipment

(a) Filter backwashing pump and motor

(b) Level controller

(c) Piping and valves

(d) Instruments

(10) Sludge enrichment tank equipment

(a) Agitator and motor

(b) Sludge pump and motor

(c) Piping and valves

(d) Instruments

(11) Chemical injection equipment

(a) Dil. HCl Tank including agitator and motor

(b) HCl gas seal tank

(c) Dil. HCl dosing pumps and motors

(d) Dil. NaOH Tank including agitation and motor

(e) Dil. NaOH dosing pumps and motors

(f) Coagulant tank

(g) Coagulant dosing pumps and motors

(h) Coagulant aid tank including agitator and motor

(i) Coagulant aid dosing pumps and motors

(j) Concentrated HCl transfer pump and motor

(k) Concentrated NaOH transfer pump and motor

(l) Chemical storage yard pit pump and motor

(m) Sludge transfer pump and motor

(n) Concentrated HCl Tank and concentrated NaOH tank

(o) Level controllers (for respective tanks)

(p) Piping and valves

(q) Instruments

(12) Dehydrator equipment

(a) Dehydrator

(b) Slurry pump and motor

(c) Air commpressor

(d) Piping an valves

(e) Instruments

(13) Control unit system

(a) pH monitor and controller

(b) Flow integrating meter

(c) Control panel (including graphic panel)

(d) Instruments

(14) Stack drainage pit equipment

(a) Pump and motor

(b) Level controller

(c) Piping and valves

(d) Instruments

(15) Piping

(16) Painting

(17) Special tools and standard tool sets

(18) Cables

(19) Foundation materials

(20) Scaffold, handrail, ladder

(21) Lighting

Note: The Contractor shall provide any and all equipment, materials and accessories as required for a complete set of waste water treatment equipment as well as the cost for installation and trial operation of the equipment in addition

to the items specified in the above.

Although not clearly specified in the above, any embedded materials for foundation, base plates, grouting materials, supports, electric motors, accessory piping, valves, instruments and blower silencers for the waste water treatment equipment as well as the piping rack foundation related to the waste water treatment equipment shall be included in the scope of work.

4.2 GENERAL INFORMATION

The drainage and waste water treatment equipment to be procured and installed in accordance with these specifications is the equipment to integratedly treat drainage and waste water discharged from the power plant and discharge the treated waste water into the sea. Consequently, this equipment constitutes one of the most important factors in view of environmental pollution control.
Therefore, the equipment shall be highly reliable, and in no way shall the performance be deteriorated through years of operation.

4.2.1 APPLICABLE STANDARDS AND CODES

The drainage and waste water treatment equipment shall be designed and constructed in accordance with the requirements of Clause 6 of "Applicable Standards and Codes" in Part I.

4.2.2 OUTLINE

(1) The following drainage and waste water shall be discharged from the equipment and shall be treated as follows.
However, this equipment is intended for treatment of waste water containing inorganic substances indicated in Table 1. Therefore, sewage and organic substances other than the waste water listed in Table 1 are not included in the scope of supply of this equipment.

(a) Regularly discharged waste water treatment process
Waste water to be treated by this equipment is as follows.

- o Waste water from water treatment system
- o Waste water from turbine floor
- o Waste water from boiler floor

o Blow off water from machinery

Waste water normally discharged is sent to and stored in the No. 1 or No. 2 waste water storage pond. Here, the waste water is agitated by air atomized from the air diffuser pipe (tube) to make the quality of water uniform. Then, it is sent to the pH control and oxidation pit and, after its pH value has been regulated to an optimum level for coagulation - sedimentation treatment, the coagulant and coagulant aid are injected into the waste water. Next, the waste water is sent to the mixing pit, coagulation - sedimentation tank where suspended solids are removed.

The clear water that has flowed out of the coagulation - sedimentation tank is collected in the clear water pit, pumped into the filter, and finally clarified. After the pH value has been regulated in the neutralizing pit to the level permissible to discharge it, the water is discharged into the sea through the purified waste water pit.

However, should the pH value of clear waste water exceed the specified level, discharge of waste water into the sea will be suspended, and such water will be returned to the No. 1 or No. 2 storage pond and treated again.

The suspended solids removed in the coagulation - sedimentation tank are collected and concentrated in the sludge enrichment tank. Then, they are sent to the dehydrator and treated for dewatering. After undergoing

these processes, the Sparated sludges are transported to outside of site area.

The filter is automatically washed by periodically returning clear water. The water used for filter washing is returned to and treated again in the No. 1 or No. 2 storage pond.

(b) Irregular waste water treatment process

The water to be treated in this process is as follows.

- o Waste water discharged during air preheater cleaning
- o Waste water discharged during boiler chemical cleaning and boiler blow off
- o Waste water discharged during boiler furnace washing
- o Fuel oil pump room drain from heavy fuel oil service tanks and storage tanks.

The waste water having irregular discharge, such as boiler blow off and boiler chemical cleaning, shall be treated separately.

The reason is that the waste water discharged on the occasion of boiler blow off and boiler chemical washing contains a high concentration of C.O.D.

Therefore, such water is required to undergo oxidative destruction in the waste water storage pond prior to treatment in the waste water treatment equipment.

(c) Treatment of waste water discharged on the occasion of blow off and chemical cleaning of boiler

After the water has undergone oxidative destruction by injecting C.O.D. reduction agents such as (H_2O_2 or

NaC10) in the No. 1 or No. 2 waste water storage pond and sent to the pH control and oxidation pit, this water is treated according to the same process as that for the normally discharged waste water.

(d) Treatment of irregularly discharged waste water other than that discharged on the occasion of blow off and chemical cleaning of boiler

Since this irregularly discharged water contains a large amount of suspended solids mainly consisting of Fe contents, it is required to control the pH value at the optimum level for removal of Fe contents by sedimentation.

Therefore, the Fe contents are required to be thoroughly removed through oxidation by aeration in the No. 1 or No. 2 waste water storage pond. Then, this water is sent to the pH control and oxidation pit and treated according to the same process as that for the normally discharged waste water.

(e) Waste water treatment system flow diagram

Regarding the waste water treatment system flow diagram, refer to Drawing No. WMT-1007 "Drainage and Waste Water System Flow Diagram".

(f) Layout of waste water treatment system

Regarding the layout of waste water treatment system, refer to Drawing No. WGT-1102 "Site Layout Plan".

(2) Quantity and quality of waste water to be treated

The quantity and quality of waste water to be discharged from West Wharf Steam Power Plant Units 1 and 2 are as

indicated in Table 1 for reference.

(3) Installation and trial operation of the waste water treatment equipment shall be completed by the date when the hydrostatic test of steam generator is carried out, and the equipment shall be ready for operation.

(4) The Contractor shall assure the continuation of chemical supply, and shall quote other chemicals which are equal in property to the chemical specified in this specification.

(5) Operation of the waste water system shall ensure that the treated water quality (pH and SS) can be maintained even if the chemicals are not available.

(6) Drainage piping shall consit of main piping for Unit 1 and Unit 2 and common piping for outdoor equipment drain to be treated. Drainage system for Unit 1 construction shall have connections with necessary facilities to be supplied by the Contractor for Unit 2 constraction.

(7) Waste water from stack shall be sent the waste water storage pond through the stack drainage pit. Waste water from raw water pretreatment area shall be led by gravitation into the said pit.

(8) Permeation system of discharge and sanitary waste water of new substation shall be provided by the Contractor of Lot II-A before completion of Unit 2 site drainage system. The Contractor of Lot I shall carry out the connection works of the said pipe's terminals to site drainage system after completion of site drainage system.

Waste water from

Table 1 Quantity and Quality of Waste Water to be Treated (Reference)

Name of waste water	Kind of waste water	Amount of waste water (assumed)	Frequency (Freq./unit)	pH	SS (mg/)	C.O.D (mg/)	Oil (mg/)	Fe (mg/)	B.O.D (mg/
Waste water from pre-treatment system	City water	20 m^3/day	daily	3 - 10	1,500	100 - 200	Trace	2 - 5	-
Waste water from water treatment system	Raw water	50 m^3/4th (12.5 m^3/h)	1 time/day	3 - 10	20 - 80	5 - 15	Trace	2 - 5	-
Waste water from boiler floor	Raw water	15 m^3/day	daily	6 - 9	10 - 15	1 - 5	5 - 10	1 - 2	-
Waste water from turbine floor	Raw water	15 m^3/day	daily	7 - 9	5 - 15	1 - 8	10 - 20	1 - 2	-
Blow-off water from machinery	Demineralized water and raw water	20 m^3/day	daily	6 - 9	1 - 5	1 - 20	Trace	3 - 10	-
Sewage water from admi. and main building	Drinking water	20 m^3/day	daily	7 - 8	30 - 50	-	1 - 2	Trace	100
Waste water from air preheater cleaning	Raw water	1,500m^3/10h/once	4 times/day	2 - 6	50 - 6,000	500 - 1,000	10 - 50	50 - 10,000	-
Waste water from boiler furnace	Raw water	1,000m^3/10h/once	1 time/year	2 - 6	50 - 10,000	500 - 1,500	100-150	1,000	-
Waste water from chemical cleaning	Demineralized water	1,500m^3/2 days	1 time/ 3 - 4 years	2 - 12	50 - 6,000	2,000 - 4,000	10 - 50	50 - 6,000	-
Waste water from waste water treatment area	Raw water	5 m^3/day	daily	3 - 10	30 - 50	10 - 15	2 - 10	50	-

4.2.3 DESIGN DATA

(1) Main building mechanical drainage system

(a) Turbine room sump pump and motor

o Pump

Type	Vertical shaft, not clogging type
Number	Two (2) sets each unit
Capacity	To be decided by the Contractor However not loss than 15 m^3/H
Head	20 m
Design temperature	90^oC
Motor	Indoor, vertical type

o Control panel

Number	Two (2) sets each unit
Type	Wall hanging, indoor
Size	500 m/mW x 250 m/mD x 700 m/mH

(b) Condenser pit sump pump and motor

o Pump

Type	Submerged
Number	Two (2) sets each unit
Capacity	To be decided by the Contractor However, not less than 25 m^3/H
Head	20 m
Design temperature	90^oC
Motor	Submerged type

o Control panel

Number	One (1) set each unit
Type	Wall hanging, indoor

Size	500 m/mW x 250 m/mD x 600 m/mH

(c) Turbine oil sump pump and motor

o Pump

Type	Vertical shaft, non clogging
Number	Two (2) sets each unit
Capacity	To be decided by the Contractor However, not less than 15 m^3/H
Head	20 m
Design temperature	90°C
Motor	Indoor, vertical

o Control panel

Number	One (1) set each unit
Type	Wall hanging, indoor
Size	500 m/mW x 250 m/mD x 600 m/mH

(d) Machine drainage and floor drain piping

Place of installation	Under floor
Pipe material	Carbon steel pipe with asphalt jute cloth
Pipe diameter	80 mm minimum

(2) Unit neutralizing equipment

(a) Unit neutralizing pit

Type	Underground reinforced concrete with acid and alkaliproof coating
Number	One (1) set each unit
Capacity	150 m^3 (Tentative)
Effective depth	3,000 mm

(b) Pit pump and motor

Type	Outdoor, vertical shaft
Number	Two (2) sets each unit
Capacity	150 m^3/H each (Tentative)
Material	Stainless steel or equivalent
Design temperature	90°C
Motor	Outdoor, vertical type

(c) Control panel

Type	Cubicle, outdoor
Number	One (1) each unit
Size	500 m/mW x 450 m/mD x 1700 m/mH

(d) Agitating blower

Number	One (1) each unit
Type	Root's blower
Capacity	2.0 Nm^3/min.
Delivery head	0.3 kg/cm^2G
Motor	Totally enclosed outdoor type induction motor 3.7 kW x 4 poles x 440 V x 50 Hz Insulation Class B

(3) Waste water storage pond equipment

(a) Waste water storage pond

Type	Underground reinforced concrete with acid and alkali-proof lining type
Number	One (1) set
Capacity	1,500 m^3 (Tentative)

(b) Pump and motor

Type	Outdoor, vertical shaft
Number	Two (2) sets
Capacity	40 m^3/H (Tentative)
Head	20 m
Pit depth	4,250 mm
Design temperature	90°C
Motor	Outdoor, vertical type

(c) Agitating blower

Type	Rotary type (with silencer)
Number	Two (2) sets
Capacity	To be decided by the Contractor For waste water storage pond For pH control oxidation pit

(4) pH control oxidation pit and mixing pit equipment

(a) pH control oxidation pit

Type	Reinforced concrete with acid and alkali-proof coating
Number	One (1) set
Capacity	20 m^3
Effective depth	2,500 mm

(b) Agitating blower

The agitation blower shall also be used as the waste water storage pond agitating blower.

(c) Mixing pit

Type	Reinforced concrete with acid and alkali-proof coating

Number	One (1) set
Capacity	10 m^3
Effective depth	2,500 mm

(d) Mixing pit agitation and motor

Type	Puddle type
Number	One (1) set
Motor	Outdoor, vertical type

(3) Coagulation sedimentation tank equipment

(a) Coagulation sedimentation tank

Type	Reinforced concrete, center drive Center drive type
Number	One (1) set
Capacity	190 m^3
Up flow rate	0.7 m/hr or less
Main dimension	9,000 mmø x 3,000 mmH (Effective depth)
Driving unit	Motor, reduction gear, turn table

(b) Sludge pump and motor

Type	Outdoor, slurry, horizontal
Number	One (1) set
Capacity	To be decided by the Contractor
Motor	Outdoor, horizontal type

(6) Clear water pit equipment

(a) Clear water pit

Type	Reinforced concrete
Number	One (1) set
Capacity	40 m^3

	Effective depth	2,500 mm

(b) Filter feed pump and motor

Type	Outdoor, vertical shaft
Number	Two (2) sets
Capacity	40 m^3/H
Head	To be decided by the Contractor
Design temperature	90°C
Motor	Outdoor, vertical type

(7) Filter equipment

(a) Filter

Type	Vertical, pressure filter
Number	Two (2) sets
Capacity	40 m^3/Hr
Filters	Sand + anthracite
Filtration rate	8 m/Hr or less
Washing rate by backwashing	35 m/Hr or over
Cleaning rate by air scrubbing	70 m^3/m^2/Hr or over
Net washing and cleaning time per one time	5 min. by air scrubbing and 15 min. by water backwashing

(b) Air scrubbing blower

Type	Rotary (with silencer)
Number	One (1) set
Capacity	6 Nm^3/min.

(8) Neutralizing pit equipment

(a) Neutralizing pit

Type	Reinforced concrete with acid and alkali-proof coating

	Number	One (1) set
	Capacity	20 m^3
	Effective depth	2,500 mm

(b) Pit pump and motor

Type	Outdoor, vertical shaft
Number	Two (2) sets
Capacity	40 m^3/H
Head	To be decided by the Contractor
Design temperature	90°C
Motor	Outdoor, vertical type

(c) Agitator and motor

Type	Puddle
Number	One (1) set
Motor	Outdoor, vertical type

(9) Purified waste water pit equipment

(a) Purified waste water pit

Type	Reinforced concrete
Number	One (1) set
Capacity	100 m^3
Effective depth	2,500 mm

(b) Filter back washing pump and motor

Type	Outdoor, horizontal, centrifugal
Number	One (1) set
Capacity	250 m^3/Hr
Motor	Outdoor, horizontal type

(10) Sludge enrichment tank equipment

(a) Sludge enrichment tank

Type	Reinforced concrete center drive

type

Number — One (1) set

Capacity — 59 m^3

Up flow rate — 0.5 m/Hr or less

Effect of sludge enrichment

Average SS concentration at inlet — 1.5%

Average SS concentration at outlet — 4.0%

Main dimensions — 5,000 mmϕ x 3,000 mmH (Effective depth)

Driving unit — Motor, reduction gear turntable

(b) Sludge pump and motor

Type — Outdoor, slurry, horizontal

Number — One (1) set

Capacity — To be decided by the Contractor

Motor — Outdoor, horizontal type

(11) Chemical injection equipment

(a) Concentrated HCl tank

Type — Horizontal, cylindrical

Number — One (1) set

Capacity — 12 m^3

Density — 35% as HCl

(b) Concentrated NaOH tank

Type — Horizontal, cylindrical

Number — One (1) set

Capacity — 12 m^3

Density — 45% as NaOH

(c) Dil. HCl tank

Type — Vertical, cylindrical, natural

		rubber coating
	Number	One (1) set
	Capacity	1 m^3
	Density	10% as HCl
(d)	HCl gas seal tank	
	Type	Vertical, cylindrical, natural rubber coating
	Number	One (1) set
	Capacity	To be decided by the Contractor
(e)	Dil. HCl dosing pump and motor	
	Type	Outdoor, horizontal, diaphragm (Natural rubber coating)
	Number	Two (2) sets
	Capacity	To be decided by the Contractor
	Motor	Outdoor, horizontal type
(f)	Dil. HCl tank agitator and motor	
	Type	Puddle
	Number	One (1) set
	Motor	Outdoor, vertical type
(g)	Dil. NaOH tank	
	Type	Vertical, cylindrical epoxy resin coating
	Number	One (1) set
	Capacity	1 m^3
	Density	10% as NaOH
(h)	Dil. NaOH dosing pump and motor	
	Type	Outdoor, horizontal, diaphragm (Epoxy resine coating)

	Number	Two (2) sets
	Capacity	To be decided by the Contractor
	Motor	Outdoor, horizontal type
(i)	Dil. NaOH tank agitator and motor	
	Type	Puddle
	Number	One (1) set
	Motor	Outdoor, vertical type
(j)	Coagulant tank	
	Type	Vertical, cylindrical, natural rubber coating
	Number	One (1) set
	Capacity	1 m^3
	Density	80% as $FeCl_3$, $6H_2O$
(k)	Coagulant dosing pump and motor	
	Type	Outdoor, horizontal, diaphragm (Natural rubber coating)
	Number	Two (2) sets
	Capacity	To be decided by the Contractor
	Motor	Outdoor, horizontal type
(l)	Coagulant aid tank	
	Type	Vertical, cylindrical, epoxy resin coating
	Number	One (1) set
	Capacity	2 m^3
	Density	0.1% as high molecular coagulant aid
(m)	Coagulant aid tank agitator and motor	
	Type	Puddle

	Number	One (1) set
	Motor	Outdoor, vertical type
(n)	Coagulant aid dosing pump and motor	
	Type	Outdoor, horizontal, diaphragm (Epoxy resin coating)
	Number	Two (2) sets
	Capacity	To be decided by the Contractor
	Motor	Outdoor, horizontal type
(o)	Concentrated HCl transfer pump and motor	
	Type	Outdoor, horizontal, diaphragm (Natural rubber coating)
	Number	Two (2) sets
	Capacity	2 m^3/hr
	Motor	Outdoor, horizontal type
	Density	35% as HCl
(p)	Concentrated NaOH transfer pump and motor	
	Type	Outdoor, horizontal, diaphragm (Epoxy resin coating)
	Number	Two (2) set
	Capacity	2 m^3/hr
	Motor	Outdoor, horizontal type
	Density	45% as NaOH
(q)	Chemical storage area pit pump and motor	
	Type	Submerged, with acid and alkali-proof coating
	Number	One (1) set
	Capacity	5 m^3/hr
	Motor	Outdoor, submerged type

(r) Concentrated HCL unloading pump and motor

Type	Outdoor, horizontal, diaphragm type (Natural rubber coating)
Number	One (1) set
Capacity	To be decided by the Contractor
Motor	Outdoor, horizontal type
Density	35% as HCL

(s) Concentrated NaOH unloading pump and motor

Type	Outdoor, horizontal, diaphragm type (Natural rubber coating)
Number	One (1) set
Capacity	To be decided by the Contractor
Motor	Outdoor, horizontal type
Density	45% as NaOH

(12) Dehydrator equipment

Type	Multi pressed dehydration type
Number	One (1) set

(13) Control unit system

(a) pH meter

Type	Glass electrode type
pH detector	Three (3) sets
pH indicator	Three (3) sets
pH recorder	Three (3) sets
Alarm setter (double pin type)	One (1) set
pH metering range	pH = 2 - 14
pH detection spots	pH control and oxidation pit, Neutralizing pit

(b) Flow integrating meter

Type	Orifice type
Flow detector	One (1) set
Flow indicator	One (1) set
Flow integrating meter	One (1) set
Flow metering range	0 - 100 m^3/hr
Flow detection spots	Neutralizing pit pump

(14) Stack drainage pit equipment

(a) Pit pump and motor

Type	Outdoor, vertical shaft
Number	One (1) set
Capacity	30 m^3/H (Tentative)
Material	Stainless steel or equivalent
Motor	Outdoor, vertical type

(b) Control panel

Type	Cubicle, outdoor
Number	One (1)

4.2.4 PERFORMANCE AND GUARANTEES

(1) Quality of treated water

(a)	pH	6.5 - 8.5
(b)	Suspended solid	Less than 10 mg/litre
(c)	Chemical oxygen demand	Less than 80 mg/litre
(d)	N-hexane extract (mineral oil)	Less than 10 mg/litre
(e)	Iron	Less than 4 mg/litre

(2) Waste water treatment capacity

$40\ m^3/hr. \times 23\ hr./day = 920\ m^3/day$ (Maximum)

(3) The drainage and waste water treatment equipment shall be guaranteed for the items specified in the "Tenderer's Data Sheet".

(4) Even though the performance of the respective equipment should meet the "Tenderer's Data Sheet", if any equipment, accessories or other materials should be incomplete as a total waste water treatment equipment, the said equipment, accessories or other materials shall be repaired. Replaced or added at the expense of the Contractor.

4.2.5 TESTING

(1) Shop test

The Contractor shall execute the following shop test and shall submit the test results to the Owner and Engineer for approval.

(a) Material test

(b) Dimension check and visible inspection

(c) Hydrostatic test

(d) Performance test

(e) Vibration check for rotary machine

(f) Noise check

(g) Pinhole test (for rubber lining)

(2) Field test

The Contractor shall execute the following field tests and shall submit the test results to the Engineer for approval.

(a) Alignment check

(b) Vibration check

(c) Noise check

(d) Performance check

4.3 TECHNICAL INFORMATION

4.3.1 MAIN BUILDING MECHANICAL DRAINAGE SYSTEM

(1) Sump pump

(a) The material of sump pumps shall be cast iron.

(b) Stop valves, check valves and pressure gauges shall be provided at the delivery of each pump.

(c) The foundation bolts and nuts of pumps shall be supplied.

(d) Automatic lubricator (magnet type) shall be provided on the pumps.

(2) Level control

(a) Float type dial level guage shall be installed at each sump pit.

(b) Sump pump shall be automatically started up and shut down by the level controller in the pit.

(c) Summarized alarm of high level of sump pits shall be alarmed at BTG board in the central control room.

(3) Drainage piping

(a) Drain funnel for equipment and floor drain shall be provided, and the drain shall be led to the sump pit. Drainage piping shall be installed under floor level between mat foundation and floor concrete slab, and outside surface of the pipe shall be covered with asphalt jute cloth.

Drainage piping shall have a blind flanges for Unit 2 construction.

(b) Overflow pipings from the turbine oil sump pit and turbine room sump pit to the condenser sump pit shall

be provided, and the piping shall be covered with asphalt jute cloth.

(c) The discharge of sump pumps shall be led to the unit neutralizing pit. The pipes shall be installed above the floor level.

(d) The drainage pipings for the boiler furnace, economizer hopper and air preheater washing shall be directly led to the unit neutralizing pit. The inside surface of the above piping shall be provided with acidproof lining, and outside surface of the piping buried in earth shall be covered with asphalt jute cloth.

(e) Drainage piping for oil seperator constructed by the Contractor of Lot II-A shall be connected by the Contractor, and the drain shall be led directry to road drainage line.

4.3.2 UNIT NEUTRALIZING EQUIPMENT

One (1) neutralizing system shall be installed each unit.

The neutralizing capacity shall be decided based upon the water amount needed to wash the two (2) air preheaters of one (1) unit.

(1) Air blower for the air agitators shall be installed on the pit.

Air agitating piping shall be installed in the pit.

The piping materials shall be acidproof.

(2) Float type level dial indicator shall be equipped on the pit.

(3) The pump shall be started up and shut down automatically in accordance with the water level in the pit.

(4) The outdoor type control panel shall be installed on the pit. The control switches, lamps and alarms shall be provided on the panel. The summarized alarm shall be indicated on the BTG board in the central control room.

(5) The foundation bolts and nuts of pumps, blower and panel shall be provided.

(6) The future drain connections as spear nozzle shall be provided at the neutralizing pit wall.

The size of connection shall be 200 mm in diameter.

(7) The receptacle of waste water to be discharged during boiler chemical cleaning shall be provided at the unit neutralizing pit pump piping outlet.

(8)

4.3.3 WASTE WATER STORAGE POND EQUIPMENT

This pond is used to temporarily store waste water to be treated. In this pond, an agitator shall be installed so as to prevent sedimentation of SS contained in the waste water to be treated and to agitate waste water by ejecting air from the air diffuser tube on the bottom of the pond to make the quality of waste water uniform.

(1) The pump shall be started up and shut down automatically in accordance with the water level in pond.

(2) Float type level dial indicator shall be furnished on the pond.

(3) The summarized alarm shall be indicated on the board in the waste water treatment equipment control room.

(4) The foundation bolts and nuts of pumps shall be supplied by the Contractor.

(5) The materials to be used for the air spray piping for agitator shall be acidproof and alkaliproof.

(6) The blower for air agitation shall be installed in the waste water treatment equipment control room.

(7) The air spray pipe for the agitator shall also be laid in the No. 1 waste water storage pond and in the pH control oxidation pit.

(8) The sequence control for discharge pump shall be incorporated in the total system of the new waste water treatment system.

4.3.4 pH CONTROL OXIDATION PIT AND MIXING PIT EQUIPMENT

(1) pH control and oxidation pit

This pit is provided in order to allow metallic hydroxides mainly consisting of $Fe(OH)_3$ settle through control of pH of waste water to be treated and, at the same time, to control the pH value into an optimum range for the coagulation - sedimentation process.

(a) The blower for air agitation to be used in this pit shall be used as the blower for the waste water storage pond.

The air spray pipe to be attached in this pit shall be arranged so as to ensure uniform agitation of air.

(b) pH control shall be made by injecting dilute HCl and dilute NaOH.

The optimum pH shall be controlled between 5.0 to 11.0 and changed automatically in conformity with the volume and quality of waste water and the type of coagulant.

(c) The surface of the pH control and oxidation equipment that comes into contact with waste water shall be made

of materials suitable for the quality of waste water or shall be corrosionproof finished.

(2) Mixing pit

This pit is installed to ensure easy and sufficient sedimentation and separation of SS contained in the waste water to be treated. By quantitatively injecting the coagulant and coagulant aid, large flocs are formed and the SS are captured in the flocs. As oil and other contents are included in the flocs, it will be possible to sediment and separate the oil and other contents. The coagulant and coagulant aid shall be injected into the pH control oxidation pit.

(a) The surface of the mixing pit that comes into contact with waste water shall be made of materials suitable for the quality of waste water or shall be corrosion-proof finished.

4.3.5 COAGULATION-SEDIMENTATION TANK EQUIPMENT

This tank is installed for sedimentation and removal of flocs formed in the mixing pit through separation by gravitational force.

In this tank, solids and liquids are separated and the clear water is introduced into the clear water pit by gravity. The sedimentated flocs are collected into the center of the tank bottom and sent to the sludge enrichment tank.

(1) All SS shall be sedimented sufficiently in the coagulation - sedimentation tank, and SS in supernatant liquid shall be made less than 30 ppm.

(2) The discharge capacity of sludge shall be sufficient for treatment of the planned volume of waste water or even at the maximum load in view of the quality of waste water. The sludge pump shall be operated automatically by setting a timer.

(3) The surface of this tank that comes into contact with waste water shall be made of the materials suitable for the quality of waste water or shall be corrosionproof finished.

4.3.6 CLEAR WATER PIT EQUIPMENT

This pit shall be installed to introduce waste water flowing down by gravity from the coagulation - sedimentation tank into the filter.

(1) The final neutralizing pit shall be used as the clear water pit.

(2) A clear feed pump shall be installed in this pit.
This pump shall be started and stopped in conformity with the water level of the pit and the differential pressure of the filter.

4.3.7 FILTER EQUIPMENT

This filter equipment shall be installed to improve the quality of treated waste water by making fine SS being carried over from the coagulation - sedimentation tank pass through the filter medium (sand + anthracite coal) so as to remove the SS.

(1) Backwashing of this filter shall be carried out by using water and air.

(2) Backwashing of this filter shall be carried out once a day by means of timer as well as through detection of differen-

tial pressure, and the waste water discharged through backwashing shall be recovered into the waste water storage pond.

(3) The air scrubbing blower shall be installed in the waste water treatment equipment control room.

4.3.8 NEUTRALIZING PIT EQUIPMENT

This pit equipment shall be installed to control the pH value of treated waste water from the filter to the pH value applicable to the standards for waste water to be discharged into the sea.

(1) pH control in this pit shall be carried out automatically through interlocked operation of the pH gauge. In case the pH value of treated water is not within the range of 6.5 - 8.5, discharge of such water into the sea shall be suspended automatically and such water shall be returned to the waste water storage pond.

The pH value shall be indicated and recorded on the panel in the waste water treatment equipment control room.

(2) The neutralizing agents to be used for pH control shall be 10% HCl and 10% NaOH.

(3) The surface of the equipment that comes into contact with the neutralizing agents shall be made of acidproof and alkaliproof materials.

(4) The pit pump shall automatically be started and stopped in conformity with the water level of the pit.

(5) The flow integrating meter shall be attached at the pit pump outlet, and any indication and recording therefrom shall be made on the panel in the waste water treatment equipment control room.

4.3.9 PURIFIED WASTE WATER PIT EQUIPMENT

This pit equipment shall be installed to check the quality of treated waste water flowing from the neutralizing pit prior to discharging into the sea.

This pit shall also be used to wash the filter by reversing clear water.

(1) The oil separator shall be used as this pit.

(2) The filter backwashing pump to be installed in this pit shall automatically be started and stopped in conformity with the water level in this pit or by means of timer or through transmission of signal of differential pressure of the filter.

4.3.10 SLUDGE ENRICHMENT TANK EQUIPMENT

This tank shall be installed to enrich the sludge separated in the coagulation - sedimentation tank.

(1) The sludge pump shall be designed and constructed so as to sufficiently and smoothly discharge the sludge enriched in the sludge enrichment tank into the sludge storage pond.

(2) The sludge pump shall be automatically operated through setting of timer.

(3) Any water flowing over from the sludge enrichment tank shall be recovered into the waste water storage pond.

4.3.11 DEHYDRATOR EQUIPMENT

This equipment is installed to dehydrate sluge from the sludge enrichment tank. This equipment shall be used to separate dehydrated sluge and enriched waste water. Dehydrated sluge will be abandoned as industrial wastes. Enriched waste water shall be

recovered into the waste water storage pond.

(1) Type Multi pressed dehydration type

(2) Capacity 2 Ton/h

(3) Water content 80% (After dehydration)

4.3.12 CHEMICALS INJECTION EQUIPMENT

This equipment is installed to inject hydrochloric acid (including diluted hydrochloric acid) and caustic soda (including diluted caustic soda) into the pH control oxidation pit and the neutralizing pit so as to control the pH value of treated waste water at the optimum level.

This equipment shall be used to inject the coagulant and coagulant aid so as to ensure formation of large flocs through coagulation and smooth sedimentation of flocs.

(1) Concentrated hydrochloric acid

The liquid state hydrochloric acid is received into the concentrated hydrochloric acid tank from a tank lorry through unloading pump.

The HCl tank for the final neutralizing pit shall be used as the consectrated hydrochloric acid tank, and located in the chemicals storage yard.

(2) Diluted hydrochloric acid

The liquid state hydrochloric acid is pumped into the diluted hydrochloric acid tank from the concentrated hydrochloric acid tank and diluted.

Preparation of 10% HCl solution shall be made automatically in conformity with the level of the diluted hydrochloric acid tank.

(3) Concentrated caustic soda

The liquid state caustic soda is received into the concentrated caustic soda tank from a tank lorry through unloading pump.

The NaOH tank for the unit neutralizing pit for Unit shall be used as the concentrated caustic soda tank and located in the chemical storage yard.

(4) Diluted caustic soda

The liquid state caustic soda is pumped into the diluted caustic soda tank from the concentrated caustic soda tank and diluted.

Preparation of 10% NaOH solution shall be made automatically in conformity with the level of the diluted caustic soda tank.

(5) Coagulant

Ferric chloride (liquid $FeCl_3$) shall be used as the coagulant.

(6) Coagulant aid

High molecular coagulant aid (powder state) shall be used as the coagulant aid.

Dissolving of this coagulant aid shall be made easy so as to achieve uniform concentration.

(7) Operation and control system

(a) The chemical injection equipment shall be interlocked with the master switches, etc., for the pH control and oxidation pit equipment, the mixing pit equipment, coagulation sedimentation tank equipment and neutralizing pit equipment.

(b) The quantity of chemicals to be injected shall be controlled by changing the stroke of the pump, and chemical injection shall be carried out continuously by using the control valve.

(c) pH control shall be carried out automatically through interlocked operation of the pH gauge, and injection quantities of coagulant and coagulant aid shall be able to be controlled by the controllers on the control panel in the waste water control room.

4.3.13 OPERATION SYSTEM

To ensure laborsaving and safety as well as to facilitate operation and control, an automatic operation system shall be adopted wherever practicable. In other words, the waste water treatment system shall be placed in automatic operation if the control switches of the respective equipment have been set to AUTO and the master switch has been turned ON.

The operation and control of the waste water treatment system shall, in principle, be carried out according to the waste water treatment system monitor and control panel installed in the control room.

The monitor and control instruments shall be furnished on the control and monitor panel, and the operating conditions of the respective equipment shall be displayed on the graphic panel so as to ensure easy operation and control of the waste water treatment system.

4.3.14 CONTROL MECHANISM

(1) Pumps and similar equipment shall be controlled through

ON/OFF operation of the level switches.

(2) pH control of waste water shall be carried out through ON/OFF operation of control valves by signal from pH analyzer.

(3) The instruments and control units to be used shall be either of an electrical or a pneumatic type.

(4) Alarm shall be issued should any trouble arise in the instruments or equipments or all processes variable such as water level, pH value, etc. All alarms to be issued shall be indicated in the central control room.

4.3.15 PIPING

(1) All portions of piping required to be washed, replaced in view of the construction or to be dismantled at the time of inspection of the equipment shall be connected with flange joints.

(2) The portions of the sludge line, etc., which might be subjected to clogging shall be provided with washing water lines.

(3) The internal surface of the piping which comes into contact with hydrochloric acid shall be lined with rubber, and the piping of caustic soda shall be made of stainless steel. All appropriate measures shall be taken against possible leakage of hazardous chemicals.

(4) The sludge line piping shall be of stainless steel pipe.

(5) The portions of the piping penetrating into the respective tanks shall be made of stainless steel, and the pipes to be laid for the agitators inside the tanks shall be of PVC.

(6)

4.3.16 VALVES

(1) All valves shall be of anticorrosive material, and shall be mounted at positions permitting convenient operation.

(2) The valves to be installed outdoors shall be of such a construction so as not to cause malfunction.

(3) The valves to be used for any acidic or alkali chemical line shall be of such a construction so that all glands will not directly contact external air.

(4) All stop valves of the sludge line shall be of diaphragm type.

(5) Nameplates indicating the number (No.) and names of the respective valves shall be attached accordingly.

4.3.17 PANEL

Further information regarding the panel shall be referred to Clause 9.6 of "Panel and Board" in Section I of Part II.

(1) Control panel for waste water treatment equipment

Type Self-standing, steel plate

Number One (1) set

a. The control panel which shall consist of indicator, control switches, alarm indicator lamps and graphic panel shall be installed in the waste water treatment equipment control room. The control panel shall be designed and constructed so as to ensure easy centralized supervision and operation.

b. The Contractor shall submit the drawing of graphic panel to the Engineer for approval.

(2) Control panel for unit neutralizing pit equipment

Type Self-standing, waterproof, steel plate

steel plate

Number One (1) set

This control panel shall be installed outdoors in the vicinity of the unit neutralizing pit.

4.3.18 PAINTING

The painting shall be in conformity with Clause 1.13 of "Painting" in Section II of Part I.

4.3.19 MOTOR

Further information regarding the motor shall be referred to in Clause 9.7 of "Standards of Electric Motor" in Section I of Part II.

4.3.20 CABLES

(1) The Contractor shall furnish the power cables, control cables, cable ducts, trays, conduits and grounding wires for the drainage and waste water treatment equipment.

(2) Further information regarding scope of works and material supply for all items in (1) shall be in accordance with Clause 10 of "Erection" in Section V of Part II.

4.3.21 SCAFFOLD, HANDRAIL AND LADDER

The scaffolds, handrails and ladders shall be provided at the places as required for operation and control, patrol, inspection and maintenance of the respective equipment while taking into account the safety of the above works.

4.3.22 SPECIAL TOOLS AND STANDARD TOOL SETS

The Contractor shall provide the special tools and standard tool sets for the drainage and waste water treatment equipment.

4.3.23 LIGHTING

The Contractor shall execute wiring for the lighting system as required for inspection and maintenance for both indoor and outdoor equipment.

5. FUEL OIL SYSTEM

5.1 GENERAL INFORMATION

The fuel oil system shall consist of heavy oil transfer system including modification work of existing PSO's tank area and natural gas system.

Heavy oil to be used as main fuel for Units 1 and 2 will be supplied to the proposed power station from Pakistan State Oil using existing heavy oil storage tanks as new storage facilities in West Wharf Thermal Power Station.

Natural gas as auxiliary fuel, which will be used as ignition and warm up fuel of steam generator and as fuel of house boiler, will be supplied from existing SUI gas station in West Wharf Thermal Power Station.

Natural gas are going to be supplied continuously to the existing "BX" Station until it is dismantled during Unit 1 construction. However, if need arises that natural gas can not be made available for the "BX" Station, the Contractor of Lot I shall consider to install temporary heavy oil piping for the existing "BX" Station from PSO tanks to the existing fuel oil pumps.

5.1.1 APPLICABLE STANDARDS AND CODES

The fuel oil system shall be designed and constructed in accordance with the requirements of "Applicable Standards and Codes" specified in Clause 6 of Part I.

5.1.2 DESIGN DATA

Qualities of fuel oil shall be as follows.

(1) Heavy oil analysis

(a) Residual oil

Specific gravity	at 15/4°C	max. 0.99
Viscosity at 50°C	cst	max. 400
Pour point	°C	max. 35
Flash point	°C	max. 66
Sulphur content	%wt	max. 3.5

(2) Natural gas analysis

	% by volume	
	Use for perf. Caluculations	Variation
Methane (CH_4)	93.5	90 - 96
Ethane (C_2H_6)	0.9	0.5 - 1.5
Propane (C_3H_6)		
Butane (C_4H_{10})	0.4	0.2 - 1.0
Complex (C_nH_{2n+2})		
Carbon dioxide (CO_2)	2.0	0.0 - 5.0
Nitrogen (N_2)	3.2	3.0 - 5.0
Net Calorific Value kJ/m^3 (STP)	34,740	33,000 - 35,000

5.2 HEAVY OIL STORAGE TANK

5.2.1 SCOPE OF SUPPLY

Existing two 2476 kl heavy oil storage tanks will be used for new West Wharf Thermal Power Station, however, the following items shall be included in the scope of supply of the Contractor.

(1) All heavy oil piping including steam trace piping. From the terminal points located the first flanged joint of raised point of heavy oil supply pipline to new heavy oil transfer pump

inlet pipe header shall be installed.

(2) New tank nozzle for heavy oil transfer pump minimum flow line shall be installed for each tank.

(3) Supply and installation of heavy oil suction heaters.

(4) Air foam extinguishing equipment for heavy oil storage tanks.

(5) Fire detector for the heavy oil storage tanks.

(6) Supply and installation of necessary tank nozzles for ensure operation of fuel oil system.

(7) Overhaul inspection of existing tanks shall be carried out before modification work.

5.2.2 INFORMATION OF HEAVY OIL STORAGE TANK

(1) Type — Cone roof, steel welded structure

(2) Installation — Outdoor

(3) Number — Two (2)

(4) Capacity — 2,476 kl (each)

(5) Dimension

Shell diameter	approx. 15.24 m
Shell height	approx. 14.63 m

(6) Tank nozzle (existing)

	No. 1	No. 2
8B nozzle (as outlet)	1	1
6B nozzle (as inlet)	1	1
3B nozzle (as outlet)	1	1

5.3 HEAVY OIL TRANSFER SYSTEM

5.3.1 SCOPE OF SUPPLY

Two (2) sets of heavy oil suction heaters of outdoor type shall be installed in heavy oil storage tanks.

The heavy oil suction heaters shall include the following items.

(1) Heavy oil suction heater

(2) Piping and valves including heating steam control valve and drain piping including level control valve.

(3) Insulation for heater, heavy oil pipe downstream from the heater and heating steam.

(4) Painting

(5) All necessary instrumentation

(6) Special tools and standard tool sets

Two (2) sets of heavy oil transfer pumps shall be provided.

The heavy oil transfer pumps shall include the following components with accessories.

(1) Heavy oil transfer pump

  (a) Pump and motor

  (b) Common base plate

  (c) Coupling and coupling guard

  (d) Foundation bolts and nuts

(2) Suction strainer

(3) Piping and valves (including minimum flow)

(4) Pressure control system (pneumatic type)

(5) Control panel

(6) Instrumentation

(7) Cables

(8) Painting

(9) Special tools and standard tool sets

5.3.2 GENERAL INFORMATION

5.3.2.1 OUTLINE

(1) The heavy oil suction heater shall be used when heavy oil in the respective heavy oil storage tanks is insufficient to be transfered at normal temperature.

(2) The heavy oil suction heater shall be installed in dike of heavy oil storage tanks.
The piping shall be installed from the battery point to the heavy oil transfer pump.

(3) The heavy oil transfer pump shall be used to transfer heavy oil from heavy oil storage tank to the heavy oil service tank.

(4) The control panel for the pump operation shall be supplied for the heavy oil transfer system.

(5) The start and stop of the pump shall be operable on the control panel.

(6) Two (2) transfer pumps shall be supplied, one (1) pump for normal operation and the other for stand-by.

(7) The pressure control valve shall be provided at the delivery piping of the transfer pumps.
The return piping to heavy oil storage tank and the pressure control valve shall have ample flow capacity.

(8) Oil drain or oily water from heavy oil storage tanks and heavy oil heater area shall be led to the oil separator. Drain from the oil separator shall be led directory to road drain.

The Contractor shall provide all necessary piping, etc. for the above drainge piping.

Oil separator shall have handrails with stanchions around it, vertical ladders for access to the bottoms of the oil separator before weir and after weir, and walkway of grating across the separator.

5.3.2.2 DESIGN DATA

(1) Heavy oil suction heater

(a)	Type	Horizontal, U tube
(b)	Fluid	Shell side (Steel plate) Residual oil Cover side (Tube ... Carbon steel) ..... Steam
(c)	Number of set	Two (2) sets
(d)	Heating surface	To be decided by the Contractor
(e)	Heavy oil flow	The same capacity as that of residual oil pump
(f)	Heavy oil temperature	Inlet 20°C Outlet 50°C
(g)	Heating steam source	3 kg/cm^2g (Saturated)

(2) Accessories of heavy oil suction heater

(a) Plug

(b) Name plate

(c) Installation bolts, nuts and gaskets

(3) Heavy oil transfer pump and motor

(a)	Type	Motor driven, screw or gear type
(b)	Installation	Outdoor

(c) Number — Two (2) sets

(d) Capacity — The same capacity as that of heavy oil pump

(e) Head — 7 kg/cm^2g

(f) Motor — Outdoor, horizontal

(g) Oil temperature — $20^{\circ}C$ - $50^{\circ}C$

(4) Accessories of heavy oil transfer pump

(a) Suction strainer

Type — Simplex, air motorized with mechanical cleaning device

Screen — Stainless steel wire, 60 mesh

Number — Two (2) sets

(b) Control panel

Type — Outdoor, self-standing

Number — One (1) set

5.3.2.3 PERFORMANCE

The heavy oil suction heater shall have the capacity to keep heavy oil outlet temperature at $50^{\circ}C$ under the conditions given in 5.3.2.2 of Design Data.

The heavy oil transfer pump shall have a steady discharge capacity.

The Contractor shall submit performance curves showing head, horsepower, required NPSH and efficiency to the Engineer for approval.

5.3.2.4 TESTING

(1) Shop test

The Contractor shall execute the hydrostatic test on the

tube side of the residual oil suction heater, and shall submit the results to the Owner and the Engineer for approval. The Contractor shall execute the following shop tests for residual oil transfer pumps and oil separator transfer pump, and shall submit the test results to the Owner and the Engineer for approval.

(a) Material test

(b) Dimension check and visual inspection

(c) Hydrostatic test

(d) Performance test under actual operating condition

(e) Vibration check

(f) Overhaul inspection

(2) Field test

The Contractor shall execute the operation test for residual oil suction heaters in the presence of the Owner and the Engineer, and shall submit the test results to the Owner and the Engineer for approval.

The Contractor shall execute the following field tests for residual oil transfer pumps and oil separator transfer pump during and after construction, and shall submit the test results to the Owner and the Engineer for approval.

(a) Alignment check

(b) Trial operation test

(c) Vibration check

(d) Noise check

5.3.3 TECHNICAL INFORMATION

5.3.3.1 HEAVY OIL SUCTION HEATER

(1) The heavy oil suction heater shall be of the shell and

tube type.

(2) Heating steam shall be taken from the secondary steam line of steam converter or house boiler and the heating steam drain shall be returned to steam converter feedwater tank or drain recovery tank for house boiler.

(3) The Contractor shall provide a fuel oil temperature control valve on each heating steam line so as to maintain fuel oil outlet temperature at 50°C when fuel oil quality is not sufficient to transfer it without heating. An automatic level control valve shall be provided for each residual oil suction heater to maintain constant drain level of the residual oil suction heater.

5.3.3.2 HEAVY OIL TRANSFER PUMP AND MOTOR

(1) The pump and motor shall be installed on the common base.

(2) All parts shall be designed for long lasting use.

(3) The mechanical seal shall be provided for the gland of pump to prevent leakage.

(4) The coupling cover shall be provided.

(5) The oil pan with a drain valve shall be provided at the pump to receive leaked oil.

(6) Further details regarding motor shall be referred to in Clause 2.2 of "Electric Motor" in Section II of Part I.

5.3.3.3 STRAINER FOR HEAVY OIL TRANSFER PUMP

(1) The duplex strainer shall be of air motorized type with mechanical cleaning device.

(2) The strainer shall be constructed to allow easy overhaul.

(3) The top cover of strainer shall be able to be removed by

one person.

One piece of eye plate for overhauling shall be fitted to the structual member or an addition member of the sunshade above the strainer.

(4) The oil pan with drain valve shall be provided to prevent oil spilling during cleaning the strainer.

(5) Air source for the strainer air motors and for cleaning the strainer shall be taken from the service air compressor.

5.3.3.4 PIPING AND VALVES

(1) The piping of heavy oil transfer system shall cover the following piping.

From the battery point (first flanged joint of heavy oil supply pipe from PSO) to the bypass branch point at inlet side of heavy oil service tank.

From the discharge side of heavy oil transfer pump to heavy oil storage tanks through a pressure regulating valve.

Safety valve outlet piping, oil drain piping, air vent valves, etc.

Heating steam from fuel oil temperature control valve to residual oil suction heater and steam drain from heavy oil suction heater to level control valve.

Steam trace piping of all heavy oil piping.

(2) The material of piping shall be STPG 38 Schedule 40, and the piping shall be of welded joints except at connections of equipment and facilities such as pump, strainer, etc.

(3) Double valves shall be provided in series for vent and

drain valves.

(4) The piping shall, as a rule, be installed on the ground. Where the pipe runs from dike inside to dike outside or vice-versa, the pipe shall be arranged over the dike.

(5) The Contractor shall carry out stress analysis for the fuel oil piping and submit the results to the Engineer for approval.

(6) Piping supports and accessories, etc., shall be supplied by the Contractor.

(7) All drainage of oil and water shall be led to oil separator. One oil sampling station shall be provided at the heavy oil transfer pump discharge side.

(8) Heavy oil transfer piping for Unit 2 heavy oil service tank shall have a connections with isolating valves and blind flanges for Unit 2 construction.

(9) Further information regarding piping and specification of valves shall be referred to in Clause 1.1 and 1.3 in Section II of Part I.

5.3.3.5 ACCESSORIES

Operating platforms, supporting structures and their foundation bolts, etc., necessary for installation, operation and maintenance shall be provided.

5.3.3.6 INSTRUMENTATION

(1) Pressure gauges shall be installed at the following locations.

(a) Inlet and outlet of strainer

(b) Delivery of pumps

(c) Outlet of pressure control valves, etc.

(2) Differential pressure switch and indicator for strainer shall be provided.

(3) Control air for pressure control valves shall be led from piping of yard instrument air system.

(4) Low pressure switch shall be installed on the pump discharge pipe line to enable alarm on BTG board.

(5) The necessary thermometers shall be fitted to the heavy oil suction heaters to indicate temperatures of heavy oil inlet and outlet, heating steam and drain.

5.3.3.7 MOTORS

The motor shall be in conformity with Clause 2.2 of "Electric Motor" in Section II of Part I.

5.3.3.8 CONTROL PANEL

The control panel shall be provided at the residual oil transfer pump area and oil separator transfer pump area.

(1) The following components shall be equipped on the control panel.

(a) Operating switches and operation indicating lamps for pumps

(b) Ammeters

(c) Alarm signal lamp for the following.

Differential pressure of strainers

Motor overload

(2) The above summarized alarm shall be transmitted to the BTG board in the central control room.

(3) The control panel shall be of the outdoor type.

(4) Further information regarding panel shall be referred to in Clause 2.1 of "Standards of Panels and Boards" in Section II of Part I.

5.3.3.9 INSULATION

The heavy oil suction heater and the outlet piping shall be insulated in accordance with Clause 1.12 of "Insulation for Piping and Equipment" in Section II of Part I.

5.3.3.10 PAINTING

The painting shall be in conformity with Clause 1.13 of "Painting for Piping and Equipment" in Section II of Part I.

5.3.3.11 CABLES

(1) The Contractor shall furnish the power cables, control cables, cable ducts, trays, conduits and grounding wires for the heavy oil transfer pumps and oil separater drain pump.

(2) Further information regarding cabling and cable material shall be in accordance with Clause 2.3 of "Standards of Cable and Wire" in Section II of Part I.

5.3.3.12 SPECIAL TOOLS AND STANDARD TOOL SETS

The Contractor shall provided the special tools and standard tool sets including chain block with geared trolley for the heavy oil transfer pump, oil separater drain pump and heavy oil suction heater.

5.4 NATURAL GAS SYSTEM

5.4.1 SCOPE OF SUPPLY

Natural gas from the existing lines shall be used for new West Wharf Thermal Power Station.

The following items shall be included in the scope of supply of the Contractor.

(1) The modification works for the gas reducing station.

(2) Piping and valves

(3) Natural gas leakage detecting system

(4) Control panel

(5) Instrumentation

(6) Cables

(7) Painting

(8) Special tools and standard tool sets

5.4.2 GENERAL CONDITION

5.4.2.1 INFORMATION OF NATURAL GAS

(1) Conditions for gas lines

Inlet gas pressure 130 - 170 psig.

(2) Flow diagram of existing gas reducing station is shown in attached sheet.

5.4.2.2 OUTLINE

The Contractor shall state the operating and design data of the gas reducing station taking into account following items.

(1) All motor valves shall be operated in the central control room and the local control panel.

(2) Design and determination of piping and valves size shall have sufficient capacity considering requirements of the boiler design.

(3) All necessary instrumentation shall be provided.

(4) Gas leakage detectors shall be provided, and alarms located effective place for gas detecting shall be transmitted and indicated to the gas alarm panels nearby central control room, and summarized alarm signals shall be transmitted to the fire protection control panel.

(5) The unit shut off valves shall be provided at the branch piping of each unit.

(6) The electrical equipment applicable to the corresponding hazardous area shall be adopted if installed inside it inside the said area.

5.4.2.3 TECHNICAL INFORMATION

(1) The material of piping shall be STPL 39 Schedule 40 or ASTM A333/A933M equivalent, and the piping shall be of welded joints.

(2) The Contractor shall carry out stress analysis for the natural gas piping and submit the results to the Engineer for approval.

(3) Piping supports and accessories, etc., shall be supplied by the Contractor.

(4) Operating platforms, supporting structures and their foundation and foundation bolts, etc., necessary for installation, operation and maintenance shall be provided.

(5) Control air to be used for instrumentation shall be led from piping of yard instrument air system.

(6) The pipe support shall be in conformity with Clause 1.1 of "Power Plant Piping" and Clause 1.2 of "Hangers, Anchors and Supports" in Section II of Part I.

(7) The painting shall be in confirmity with Clause 1.13 of "Painting" in Section II of Part I.

(8) Regarding panel shall be referred to in Clause 2.1 of "Standards of Panels and Boards" in Section II of Part I.

(9) Regarding cabling and cable material shall be in accordance with Clause 2.3 of "Cable and Wire" in Section II of Part I.

(10) The Contractor shall provide the special tools and standard tool sets.

6. FIRE PROTECTION SYSTEM

6.1 SCOPE OF SUPPLY

The scope of supply shall include, but shall not be limited to, the following components with accessories, for Units 1 and 2.

(1) Fresh water extinguishing equipment

(a) One (1) emergency fresh water fire pump, motor driven and diesel engine driven

(b) Turbine room hydrant

(c) Boiler room hydrant

(d) Administration building and warehouse hydrant

(e) Plant outdoor hydrant

(f) Piping and valves

(g) Instrumentation

(h) Control panel

(i) Spray nozzle set for transformers

(2) Air foam extinguishing equipment

(a) Air foam concentrate tank

(b) Air foam proportioning controller

(c) Piping and automatic valves for air foam chambers of heavy oil service tanks and heavy oil storage tanks.

(d) Air foam hydrants for heavy oil storage tanks, heavy oil pump and heater area and house boiler area

(e) Piping and valves

(f) Instrumentation

(g) Control panel

(4) Dry chemical extinguishing equipment

(a) Dry chemical storage tank with accessories

(b) Piping and valves

(c) Control box (starting devices)

(d) Instrumentation

(5) Fire detecting equipment

(a) Push buttons and thermoswitch for fire alarm

(b) Automatic fire alarm

(c) Wiring

(6) Fire protection panel, fire alarm control panel for administration building and local panel for 132 kV and 220 kV substation

(7) Portable fire extinguisher

(8) Wheel cargo extinguisher

(9) Explosion-proof electric equipment

(10) Gas alarm system

(a) Gas leakage detecting equipment

(b) Gas alarm panel

(c) Wiring

(11) Pipings, valves and specialities

(12) Cables

(13) Foundation bolts, nuts, etc.

(14) Painting

(15) Special tools and standard tool sets

6.2 GENERAL INFORMATION

6.2.1 APPLICABLE STANDARDS AND CODES

The fire protection system shall be designed and constructed in accordance with the requirements of Clause 6 of "Applicable Standards and Codes" in Part I.

6.2.2 OUTLINE

The fire protection system shall consist of fresh water extinguishing equipment, air foam extinguishing equipment, dry chemical extinguishing equipment, fire alarm system, portable and wheel cargo fire extinguisheres.

(1) Fresh water extinguishing equipment

The fresh water extinguishing equipment shall be used for extinguishing fire at boiler, turbine, generator, transformers, administration building, warehouse, other auxiliary houses.

For the above purposes, fresh water hydrants with hoses and nozzles shall be furnished at the proper places for extinguishing fire indoors and outdoors.

The equipment shall be used to extinguish fire at main transformer and auxiliary transformer by adopting a spray nozzle system.

The fresh water fire piping from the branch point of main piping to the spray piping for new substation transformers which is constructed by Lot II-A Contractor shall be installed including installation of solenoid valves.

Fresh water for fire system commonly used as service water shall constantly be pressurized by one of two service water pumps.

If the water pressure drops further, the emergency fresh water fire pump shall start automatically to maintain the water pressure.

(2) Air foam extinguishing equipment

The air foam extinguishing equipment shall be used for extinguishing fire at heavy oil service tanks, heavy oil

storage tanks and heavy oil transfer pump area.

Total five (5) air foam hydrants for heavy oil pump and heater areas and heavy oil transfer area, and one (1) for house boiler area shall be provided with hoses, nozzles and fire alarm push buttons on hose boxes.

Air foam solution shall be produced by mixing fresh water and air foam concentrate, which shall be supplied by emergency fresh water fire pump and air foam proportioning controller, respectively.

(3) Dry chemical extinguishing equipment

The dry chemical extinguishing equipment shall be provided for extinguishing fire at the turbine main oil tank and at the boiler burner areas.

The capacity of equipment shall be sufficient to fight any fire which may break out simultaneously at the oil tank and the boiler burner area.

Local application system shall be adopted for the dry chemical extinguishing system.

(4) Fire alarm system

The fire alarm system shall consist of fire alarm detecting equipment and fire protection panel.

The signal from fire detecting equipment shall be transmitted to fire protection panel in the central control room.

The air foam fire extinguishing equipment shall be capable of operating at the fire protection panel by selecting the fire zone.

The solenoid valves of spray nozzle sets for Units 1 and 2

transformers and 132 kV and 220 kV substation transformers shall be capable of operating at the fire protection panel and local control panel located control room of substation.

(5) Portable and wheel cargo fire extinguishers

The portable and wheel cargo fire extinguishers are intended as a first line of defense to cope with fires of limited size.

One pair of portable fire extingushers shall be provided for the main building, boiler area, outdoor area, warehouse, etc.

One wheel cargo fire extingusher shall be provided for heavy oil pump and heater areas.

The portable and wheel cargo fire extinguishers shall be of the multipurpose powder chemical type having a capacity of 8 kg and 48 kg in powder chemical weight, respectively.

(6) Gas alarm system

Flammable gas leakage detecting system, which consists of gas leakage detectors and a flammable gas alarm panel, will be adopted in consideration of further safty measures for using natural gas in the West Wharf Thermal Power Plant Units 1 and 2.

(7) The following lines shall be branched for fire protection from the service water main piping.

(a) Washing water for air preheater

(b) Connections for fire protection system for Unit 2

(c) Substation transformers for spraing line

(d) Administration Building

(e) Main power house

(f) Other requirements

(8) The Contractor shall provide trolley and chain block for overhauling motor and diesel driven emergency fresh water fire pump.

(9) The Contractor shall include in his scope of work any and all equipment, materials and accessories as required for the making of a complete set of fire protection system.
The Contractor of Lot I shall inform Lot II-A Contractor to concern the connection work of fresh water fire piping and fire alarm system, moreover, the design of such connection work shall be carried out by the Contractor of Lot I.

6.2.3 DESIGN DATA

(1) Fresh water extinguishing equipment

(a) Emergency fresh water fire pump

Installation	Indoor
Type	Horizontal, centrifugal pump
Number	One (1) set
Capacity	about 200 m^3/h (Tentative)
Discharge pressure	8.0 kg/cm^2
Prime mover	Motor and Diesel engine driven
Control panel	Indoor self standing type
Fuel for engine	Diesel oil
Fuel oil tank	To have a capacity corresponding to full oil consumption for ten (10) hours

(b) Main power house hydrant

Type	40 mm diameter, 90^o angle valve with hose coupling

	Number	Twenty (20) sets, ten sets for Unit 2
	Hydrant box	Twenty (20) sets, ten sets for Unit 2
	Accessories for each box	Hose : 40 mm diameter, 15 m length Two (2) sets
		Nozzle: One (1) set, 130 liters per minute (minimum capacity)
(c)	Boiler area hydrant	
	Type	40 mm diameter, 90° angle valve with hose coupling
	Number	Fourteen (14) sets, seven sets for Unit 2
	Hydrant box	Fourteen (14) sets, seven sets for Unit 2
	Accessories for each box	The same as turbine room hydrant
(d)	Administration building and wearhouse hydrant	
	Type	40 mm diameter, 90° angle valve with hose coupling
	Number	Twelve (12) sets (Four for wearhouse)
	Hydrant box	Twelve (12) sets (Four for wearhouse)
	Accessories of each	Hose : 40 mm diameter, 15 m length Two (2) sets

		Nozzle: One (1) set, 130 liters per minute (minimum capacity)

(e) Plant outdoor hydrant

Type	Outdoor, self stand, two-way hydrant
Number	Fourteen (14) sets, seven sets for Unit 2
Hydrant box	Fourteen (14) sets, seven sets for Unit 2
Accessories for each box	Hose : 65 mm diameter, 20 m length Four (4) sets
	Nozzle: Two (2) sets 400 liters per minute (minimum capacity)

(f) Spray nozzle sets for transformers

Number	Five (5) sets, two sets for Unit 2
Object	Main transformer and auxiliary transformers for Units 1 and 2 and starting transformer

(3) Air foam extinguishing equipment

(a) Air foam concentrate tank

Type	Horizontal, cylindrical rubber back type
Number	One (1) set
Capacity	Not less than 3 m^3.

	Chemical	Air foam concentrate for 3% air foam chemical solution

(b) Air foam proportioning controller

Installation	Outdoor
Injection ratio	3%
Injection method	Automatic pressure side proportioning

(c) Air foam hydrant for outdoor fuel oil facilities

Type	Outdoor, self stand two-way air foam hydrant
Number	Five (5) sets, two sets for Unit 2
Hydrant box	Five (5) sets, two sets for Unit 2
Accessories for each box	Hose : 65 mm diameter, 20 m length, Four (4) sets Nozzle: Two (2) sets, 400 liters per minute (each)

(4) Dry chemical extinguishing equipment

(a)	Installation	Indoor (main power house mezzanine floor)
(b)	Type	Remote and local actuation
(c)	Number	Two (2) sets, one for Unit 2
(d)	Chemical storage capacity	About 2000 kg (Tentative)
(e)	Delivery ratio	50 kg/sec

(f) Object — Units 1 and 2 Boiler burner floor and turbine main oil tank

(5) Fire alarm system

(A) Fire detecting equipment

(a) Automatic fire alarm for heavy oil tanks

Location	Heavy oil service tanks and storage tanks
Type	Thermostat
Number	Two (2) sets per each tank

(b) Automatic fire alarm

Location	Mainpower house Administration building warehouse
Type and Number	Automatic fire detector To be decided by the Contractor

(c) Push button type fire alarm

Location	All hydrant boxes of turbine room .... $10 \times 2^{unit} = 20$ All hydrant boxes of administration building and wearhouse .... 12 All air foam hydrant boxes for outdoor fuel facilities .... 5 Dry chemical for Burner area ... $6 \times 2^{unit} = 12$ (each boiler)

4-505

Dry chemical for Turbin main oil tank .... 2 (each unit)

The following locations .. 3 (PB only)

- . Chlorination equipment room
- . Water treatment control room
- . Substation

Type: Manual push button

Number: Total Fifty-four (54) sets

(B) Fire protection panel

Installation: Indoor (in central control room)

Type: Self-standing

Number: One (1) set

(C) Fire alarm control panel for administration building

Installation: Indoor

Type: Wall mounted

Number: One (1) set

(D) Local panel for 132 kV and 220 kV substation

Installation: Indoor (in control room)

Type: Wall mounted

Number: One (1) set

(6) Portable fire extinguisher

(a) Type: Powder chemical

(b) Number: Thirty (30) sets for Units 1 and 2

(c) Capacity: 8 kg (powder chemical weight)

(d)	Box	Fifteen (15) sets (each box accommodates 2 extinguishers)

(7) Wheel cargo extinguisher

(a)	Type	Wheeled, powder chemical
(b)	Number	Four (4) sets
(c)	Capacity	48 kg (powder chemical weight)

(8) Gas alarm system

(a) Gas leakage detecting equipment

Measuring system and number of detector	To be decided by The Contractor
Objective gas	Methane gas contained in the air
Detecting points	Natural gas station Units 1 and 2 boiler area Other requirements
Measuring range	0 to 100% LEL (Lower explosion limit)
Accuracy	± 5% of full scale range
Alarm level	30% LEL
Alarm operation	Gas lamp (continual) Failure lamp (continual)
Output signal	to ext. alarm panel (BTG Board) Gas alarm contact 1a (individual)
Temperature	Normal Detector max. 60°C
Pressure	Atomospheric pressure
Power source	AC 100 V ± 10%

		(Uninterruptible power supply)
	Alarm indication	Alarm lamp (alarm unit)
	Explosion-proof construction of detector head	YES
	Dripproof construction	IP 23
(b)	Gas alarm panel	
	Installation	Indoor
		(Nearby cenral control room)
	Type	Self-standing
	Number	Two (2) sets
		One for Unit 2

6.2.4 PERFORMANCE

The fire protection equipment shall have the performance specified in the "Tenderer's Data Sheet".

6.2.5 TESTING

(1) Shop test

The Contractor shall execute the following shop test and shall submit the test results to the Engineer for approval.

(a) Dimension check and visible inspection

(b) Hydrostatic test

(c) Performance test of pumps with prime mover

(d) Tests of diesel engine including performance test, noise check and vibration check

(2) Field test

The Contractor shall execute the following field test and shall submit the test results to the Engineer for approval.

(a) Hydrostatic test

(b) Performance test

(c) Operation test for air foam and dry chemical system

6.3 TECHNICAL INFORMATION

6.3.1 FRESH WATER EXTINGUISHING EQUIPMENT

(1) Service water pipline and fresh water fire pipeline shall be common pipe, so that the service water pump will be operated automatically by the low pressure of the discharge pipe and able to start and stop at fire protection panel and local control panel.

Start and stop indications for the service water pumps shall be provided on the fire protection panel.

The fire water pump shall be started and shut down at the local control panel. The pump shall have sufficient capacity to supply water to outdoor hydrant and general service.

(2) Emergency fresh water fire pump shall be started and shut down at the fire protection panel and/or the local control panel, and shall be started automatically by low pressure signal of the service water line.

The actuated emergency fresh water fire pump shall continue operation even if the line pressure is restored.

(3) Emergency fresh water fire pump shall have ample capacity to supply water to five indoor hydrants and and four outdoor hydrants, air foam supply to the objective heavy oil storage tanks and two air foam hydrants. Fresh water fire main piping in main power house shall have connections with isolating valves and blind flanges for Unit 2.

(4) Emergency fresh water fire pump is capable of operating by

K-509

electric motor.

Battery charger shall be provided.

(5) Diesel oil shall be used as fuel for the diesel engine.

Fuel oil tank for the diesel engine shall have a capacity of more than that of 10 hours' pump operation.

Refer to 1.2.3.1 of Section II in Part II for diesel oil analysis.

(6) Local control panel shall be provided with necessary instruments and control equipment.

(7) Necessary protection devices shall be provided for the diesel engine.

(8) If the sealing or cooling water for diesel engine is required, the self-cooling system shall be provided, and the cooling water shall be branched from the service water line located nearby.

Necessary valves and piping shall be provided for the above.

(9) Protection measures shall be provided for operator's safety when the diesel engine pump starts automatically.

(10) Silencer shall be attached to the engine to reduce the noise level to within the acceptable range.

(11) Adequate measures for preventing excess vibration of the piping and base plate due to engine operation shall be provided.

(12) Main power house hydrant

(a) Twenty (20) sets of 40 mm diameter, ten (10) sets for Unit 2, 90^{o} angle valve type hydrant with hose and nozzle shall be provided.

(b) The number and location of hydrants for each Unit shall be

as follows.

Three (3) sets on ground floor

Three (3) sets on mezzanine floor

Three (3) sets on operating floor

One (1) set on 4th floor

(c) Fire boxes, including a fire alarm push button and fire hydrants, shall be provided.

Installation height of the hose box shall be 0.8 to 1.2 meters above the floor.

(d) Water for hydrant shall be supplied from the main fire water piping in the main power house.

(13) Boiler area hydrant

(a) 40 mm diameter, 90° angle valve type hydrant with hoses and nozzle shall be provided.

(b) Fourteen (14) sets of the hydrants, seven (7) sets for Unit 2, shall be provided on platforms of the steam generator.

(c) Hydrant and fire box shall not obstruct passageways.

(d) Water for hydrant shall be supplied from the main fire water piping in the boiler room.

(e) Water washing piping for boiler furnace and air preheater shall be branched from the boiler fire water piping.

(14) Administration building and warehouse

(a) Twelve (12) sets, eight for administration building and four for warehouse, of 40 mm diameter, 90° angle valve type hydrant with hose and nozzle, which shall be the same as those of main power house

11-5-11

hydrants, shall be supplied and installed by the Contractor.

(b) Fire boxes with fire alarm push buttons shall be included in the scope of supply of the Contractor.

(15) Plant outdoor hydrant

Fourteen (14) sets of 65 mm diameter hydrants with hoses and nozzle, six (6) sets for Unit 2, shall be provided.

(16) Spray nozzle sets for the main transformer and auxiliary transformer, starting transformer shall be provided.

The spray water rate at transformers shall be not less than 10.2 liters/min.m^2.

(17) The Contractor shall design and construct all necessary fresh water fire extinguishing piping for existing No.1 and No.2 heavy oil storage tanks as new storage tanks including material supply.

(18) The Contractor shall connect on the battery point for spray water pipeline of substation transformers furnished by Lot II-A Contractor.

6.3.2 AIR FOAM EXTINGUISHING EQUIPMENT

(1) Air foam extinguishing equipment shall be started by pushing the button on the fire protection panel in the central control room.

(2) The motor operating valve at air foam proportioning controller suction side shall be capable of operating at fire protection panel and/or local control panel.

(3) Automatic valves shall be provided on the air foam extinguishing piping.

(4) The air foam extinguishing piping shall be sloped to

facilitate drainage of air foam solution after operation.

The drain valve shall be furnished at the bottom of piping.

(5) Air foam hydrant for outdoor fuel oil facilities

(a) Five (5) sets, two sets for Unit 2, 65 mm diameter hydrants with hoses and nozzles shall be provided.

(b) Alarm push button shall be provided on each hose box.

(c) The alarm signal shall be transmitted to the fire protection panel in the central control room.

(6) Air foam pipe lines shall have the connections with isolating valves and blind flanges for Unit 2 construction.

6.3.3 DRY CHEMICAL EXTINGUISHING EQUIPMENT

(1) The main starter of the extinguishing equipment shall be installed outside of the central control room, and the individual starter shall be placed locally near the objectives.

(2) The service zone of each starter shall be divided and clearly indicated.

Starters shall be kept in boxes to prevent operation mistake.

(3) Dry chemical piping shall be installed for tournament system so as to uniformly eject dry chemical from each nozzle.

The piping shall be steel pipe of A120 ASTM or equivalent, and shall have screw joints.

(4) Chemical vessel and pressure tank with accessories shall be compactly installed in one place.

(5) Alarm push button shall be located at a place nearby the objectives.

The alarm signal shall be transmitted to the fire protection

4-5-13

panel in the central control room.

(6) Dry chemical control panel shall have fire indication lamps and discharge buttons. Internal wiring and necessary electric equipment shall be included in the control panel so as to complete the connection work with the external wiring to the terminal points of the control panel.

(7) Dry chemical of sodium bicarbonate ($NaHCO_3$) shall be used as the principal ingredient.

(8) The weight of dry chemical per unit area of the fire extinguishing object shall be 8.8 kg/m^2.

The minimum quantity of dry chemical shall be obtained by 1.1 times the calculation result based on the surface area of the object to be extinguished and weight of the dry chemical per unit area of the fire extinguishing object.

The surface area to be extinguished for one boiler burner shall be 9 m^2.

The surface area of turbine main oil tank shall be obtained by calculating the tank external surface area minus the surface area of the tank bottom.

6.3.4 FIRE ALARM SYSTEM

(1) Fire alarm system shall be provided for main power house, boiler area, administration building, auxiliary buildings and outdoor fuel oil facility area.

Fire alarms of the said areas shall be transmitted to the fire protection panel in the central control room.

The Contractor shall provide for all necessary fire alarm system of 132 kV and 220 kV substation including interfacing to fire protection panel.

(2) Fire alarm push buttons shall be installed on the air foam hydrant boxes, near dry chemical nozzles and fresh water hydrant boxes in main power house, administration building and warehouse.

The Contractor shall provide and install fire detectors on the existing heavy oil storage tanks as new storage tanks.

(3) Fire alarm push buttons for water treatment control room, chlorination control room and 132 kV and 220 kV substation, shall be provided and mounted on the outside wall near the entrance.

Alarm signal from push button located 132 kV and 220 kV substation shall be transmitted to fire protection panel and local control panel located control room of substation.

(4) Fire alarm system shall consist of alarm push button, bell, pilot lamp, etc.

By pushing the button, the bell shall be rung and the pilot lamp shall flicker. All hand operated push buttons and starters shall be installed in glass covered box to prevent operation mistake.

(5) All necessary devices such as switches, lamps, alarm windows, push buttons, etc., to supervise and start the fire protection system shall be provided on the fire protection panel.

(6) The Contractor shall design the fire protection system in accordance with the following drawings.

(a) Summarized functional diagram for fire protection system

(b) Fire detecting method, alarm indication and start up

method of fire extinguishing equipment.

(7) The fire protection panel shall have the following fire location indicators and push buttons for air foam control device.

The scope of supply shall include, but not be limited to the followings.

(a) ANN x 5 for air foam outdoor hydrants

(b) ANN x 14 for dry chemical (Units 1 and 2 boiler and Turbin

(c) ANN x 8 for main power house for Units 1 and 2

(d) ANN x 5 for administration building, warehouse water treatment control room, cholorination control room 132 kV and 220 kV substation

(e) ANN x 4 for fire detection of heavy oil storage tanks and heavy oil service tanks.

(f) ANN x 2 for summarized alarm of Units 1 and 2 gas alarm panel.

(g) ANN x 6 for automatic fire alarm of Units 1 and 2 main powerhouse.

(h) Push buttons x 4 air foam solenoid valves for Units 1 and 2

Internal wiring and necessary electric equipment shall be included in the panel so as to complete the connection work with the external wiring to the terminal points of the panel including Unit 2 construction.

(8) The Contractor shall arrange the fire protection panel in consideration of the following items.

(a) Annanciators for fire protection system.

(b) Graphic panel which indicates the location of the system to be considered and the operation condition.

(c) Operation and control switches, for example, push buttons for air foam solenoid valves and air foam injection system, fresh water fire pump, service water pumps, solenoid valves for transfermer's spraying system and so on.

(d) Interface between fire protection panel and local panels, for example, air foam local control panel, dry chemical local control panel, local control panel for fire water pump and service water pumps, local panel for 132 kV and 220 kV substation and so on.

In addition to the above, internal wiring and necessary electric equipment for 132 kV and 220 kV substation conducted by Lot II-A Contractor shall be included in the panel so as to complete the connection work with the external wiring to the terminal point of the panel.

(9) Further information regarding panel shall be referred to in Clause 2.1 of "Panel and Board" in Section II of Part I.

6.3.5 PORTABLE AND WHEEL CARGO FIRE EXTINGUISHERS

(1) All extinguishers shall be located in a place readily accessible to and immediately available in the event of fire.

Preferably, they shall be located along normal paths of travel, including exits from an area.

(2) Extinguishers shall not be obstructed from view.

(3) Extinguishers shall be installed on the hangers or in the brackets supplied, mounted in cabinets, or set on shelves unless the extinguishers are of the wheeled type.

(4) Portable extinguishers shall have only operating

instructions and classifications on the outward face of the extinguisher.

6.3.6 Explosion-proof electric equipment

Explosion-proof electrical equipment in hazardous area shall be provided in consideration of futher safty measures for using natural gas in West Wharf Thermal Power Plant Units 1 and 2.

(1) Hazardous area (minimum requirement)

(a) Burner area (each unit)

(b) Natural gas station

(c) Valves, flange joints, pressure gauges and other instruments attached directry to natural gas pipelines.

(2) Classification of explosion-proof

The Contractor shall submit the report to Engineer for approval.

6.3.7 GAS ALARM SYSTEM

(1) Gas alarm system shall be provided for boiler area, natural gas station and other requirements. Gas alarms of the said areas shall be transmitted to the gas alarm panel nearby central control room, futhermore, shall be interfaced extension alarm panel on the BTG board.

(2) Gas alarm system shall consist of flammable gas leakage detector equipment and gas alarm panel.

The Contractor shall design and arrange the gas alarm system in consideration of the following items.

(a) Design concept is as shown in "SUMMARIZED FUNCTIONAL DIAGRAM FOR GAS ALARM SYSTEM".

(b) Arrangement of gas alarm panel, such as annanciators,

alarm unit and so on.

(c) Internal wiring and necessary electric equipment shall be included in the panel so as to complete the connection work with the external wiring to the terminal points of the panel including Unit 2 construction.

6.3.8 PIPING, VALVES AND SPECIALITIES

(1) The Contractor shall provide all necessary piping, valves and specialities for the fire protection system.

(2) The piping shall, as a rule, be placed above the ground, and the bottom of piping shall be 500 mm above the ground level.

(3) The buried pipings shall be covered with two (2) layers of asphalt jute cloth.

(4) The piping joints shall, as a rule, be welded.

(5) Flexible expansion joints shall be installed at the connections of the heavy oil tanks.

(6) Further information regarding piping shall be referred to in Clause 1.1 of "Power Plant Piping" in Section II of Part I.

(7) The specification of valves shall be referred to in Clause 1.3 of "Valves and Specialities" in Section II of Part I.

6.3.9 ELECTRIC MOTOR

The electric motor shall be in conformity with Clause 2.2 of "Electric Motor" in Section II of Part I.

6.3.10 PAINTING

The painting for the system shall be in conformity with Clause 1.13 of "Painting" in Section II of Part I.

6.3.11 CABLE

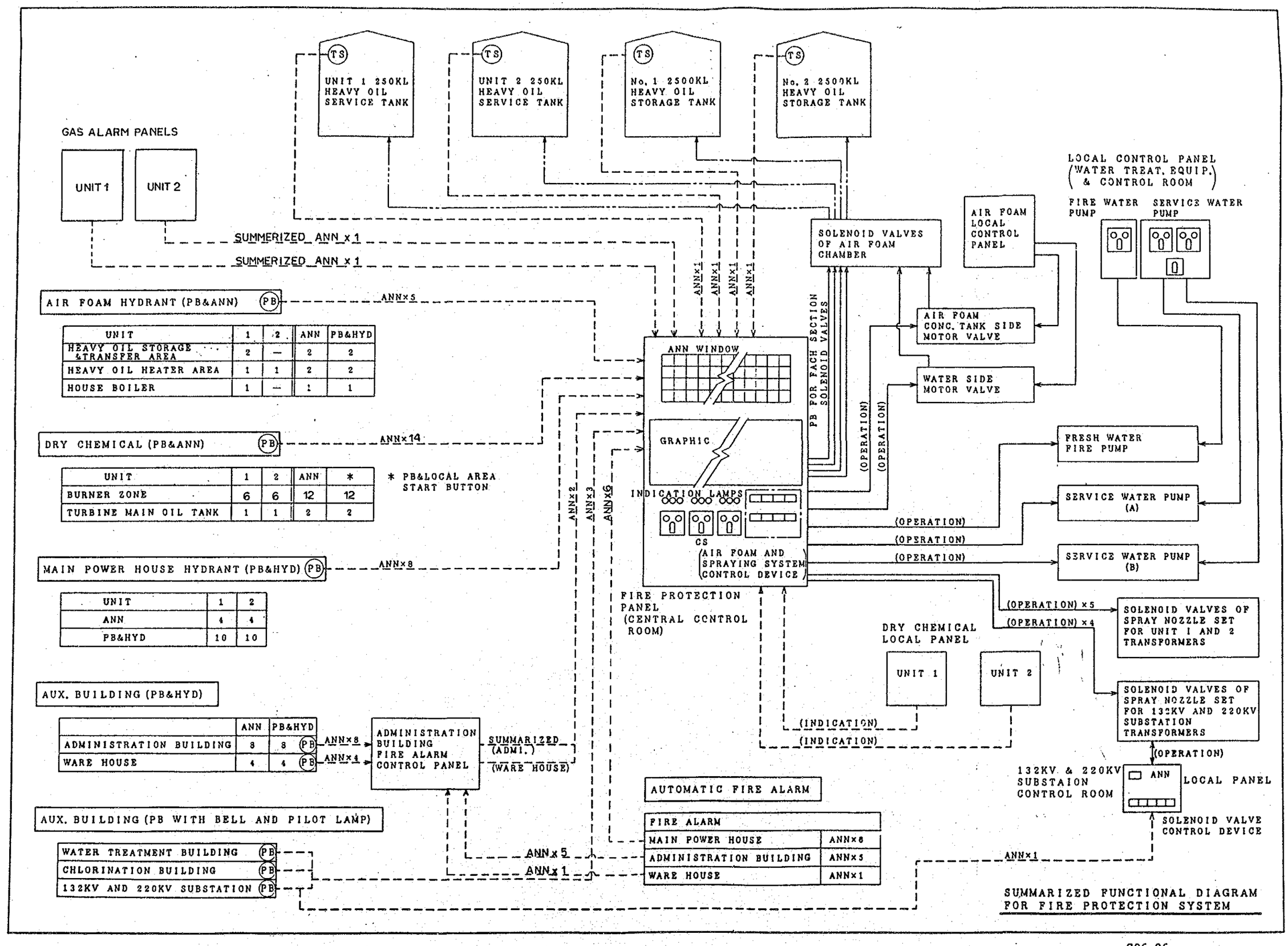
(1) The Contractor shall furnish the power cables, control

cables, cable ducts, trays, conduits and grounding wires for the fire protection system.

(2) Further information regarding cabling and cable materials shall be in accordance with Clause 2.3 of "Cable and Wire" in Section II of Part I.

6.3.12 SPECIAL TOOLS AND STANDARD TOOL SETS

The Contractor shall provide the special tools and standard tool sets for the fire protection system.



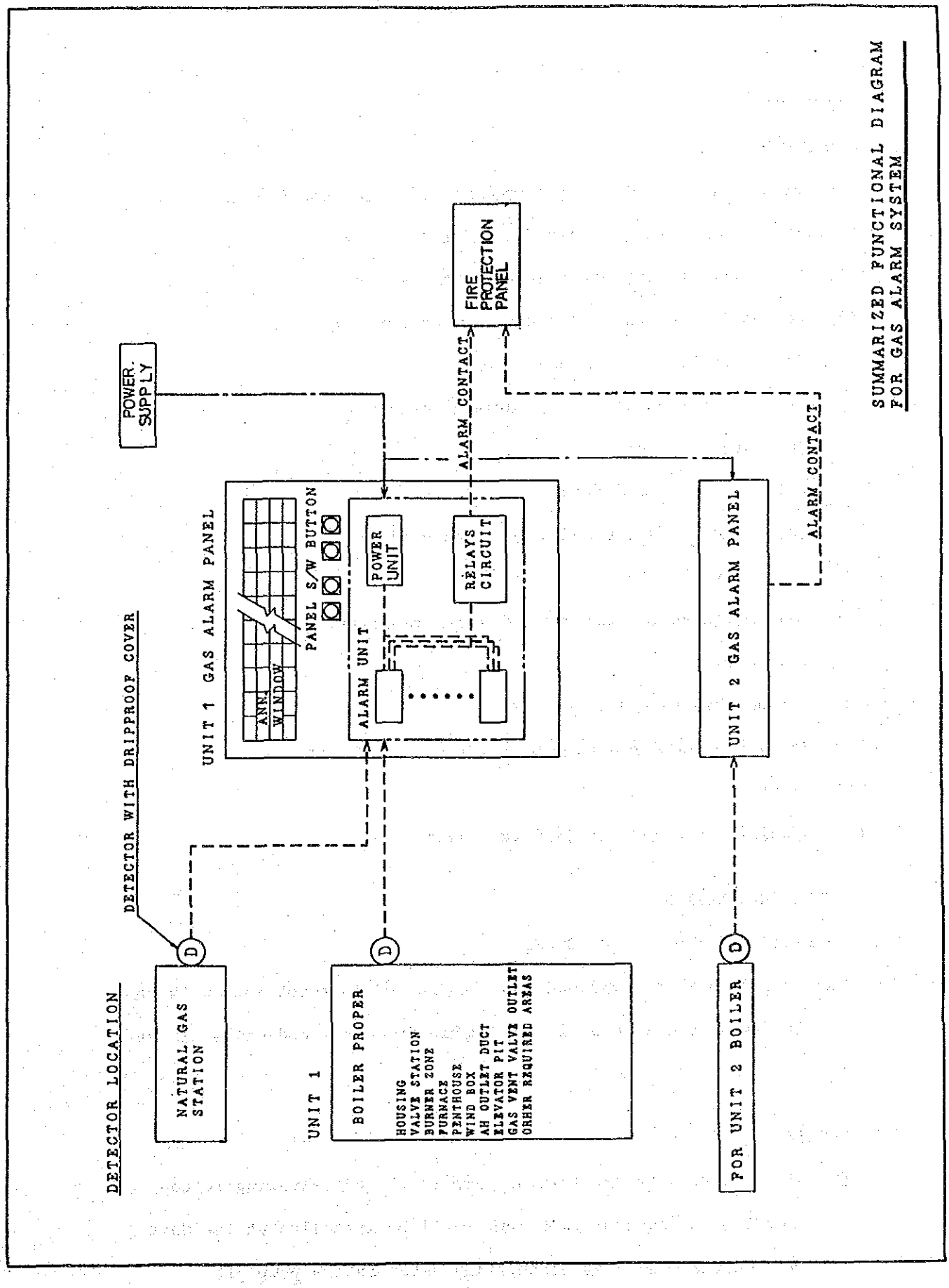
SUMMARIZED FUNCTIONAL DIAGRAM FOR FIRE PROTECTION SYSTEM

NAME OF FIRE EXTINGUSHING EQUIPMENT (1/2)

NAME OF FIRE EXTINGUSHING EQUIPMENT	OBJECT TO BE PROTECTED BY EXTINGUISHING EQUIPMENT	FIRE DETECTING METHOD			ALARM INDICATION AT		START UP METHOD OF FIRE EXTINGUISHING EQUIPMENT
		THERMO. SWITCH	PUSH BUTTON	AUTOMATIC FIRE DETECTOR	CENTRAL CONTROL ROOM	LOCAL PANEL	
FRESH WATER FIRE EXTINGUISHING EQUIPMENT	1. MAIN POWER HOUSE						1. When the water pressure of main pipe drops below the predetermined pressure, the stand by service water pump starts automatically. If the water pressure drops further, emergency fresh water fire pump starts automatically to maintain the water pressure of main pipe.
	GROUND FL		o		o	o	
	MEZZA. FL		o		o	o	
	OPERATION FL		o		o	o	
	4TH FL		o		o	o	
	2. ADMINISTRATION BUILDING				SUMMARIZED ONE SIGNAL		2. The emergency fresh water fire pump shall be designed to enable remote control either from the fire control panel in the central control room or from the local control panel. Moreover, the emergency fresh water fire pump shall be designed to start up together with air foam extinguishing system if required.
	GROUND FL		o		FROM FIRE	o	
	1ST FL		o		ALARM	o	
	2ND FL		o		CONTROL	o	
	3RD FL		o		PANEL(FACP)	o	
	3. WARE HOUSE					INDICATES FACP	
	GROUND FL		o		- DITTO -	o	
	1ST FL		o			o	
AIR FOAM EXRINGUISHING EQUIPMENT	1. No.1 Heavy oil storage tank	o			o	o	1. Air foam extinguishing equipment shall be conducted the following functions when the selection button is selected for extinguishing object according to the alarm indication. a. Air foam pressure proportion inlet valve (fresh water side) and air foam injection valve open. b. The solenoid valve for the fire extinguishing object opens. c. Emergency fresh water fire pump starts.
	2. No.2 - ditto -	o			o	o	
	3. UNIT 1 Heavy oil service tank	o			o	o	
	4. UNIT 2 - ditto -	o			o	o	
	5. Each outdoor hydrant		o		o	o	7. Air foam pressure proportion inlet valve (fresh water side) and air foam injection valve shall be designed to operate automatically and manually from the fire protection panel and local control panel.

NAME OF FIRE EXTINGUSHING EQUIPMENT (2/2)

NAME OF FIRE EXTINGUSHING EQUIPMENT	OBJECT TO BE PROTECTED BY EXTINGUISHING EQUIPMENT	FIRE DETECTING METHOD			ALARM INDICATION AT		START UP METHOD OF FIRE EXTINGUISHING EQUIPMENT
		THERMO. SWITCH	PUSH BUTTON	AUTOMATIC FIRE DETECTOR	CENTRAL CONTROL ROOM	LOCAL PANEL	
DRY CHEMICAL EXTINGUISHING EQUIPMENT	1. Boiler Burner Area Each Boiler Firing Aisle		o		o	o	1. Dry chemical shall be automatically sprayed onto the fire extinguishing object by selecting the zone and pushing the button on the start up device mounted outside the central control room.
FIRE ALARM FOR AUXILIALY BUILDING	1. Water Treatment Control Room 2. Chlorination Control Room 3. 132 KV and 220 KVSubstation		o o o		o o o	 o	1. Fire alarm push button with bell and pilot lamp shall be provided and mounted on outside wall near by each aux. building entrance. 2. Fire alarms shall be transmitted to the fire protection panel in the central control room.
AUTOMATIC FIRE ALARM	1. Main Power House Computer Rooms Battery Room Units 1 and 2 Control Equip. Room PABX Room Conference Room Air Conditioning Machine Room 2. Administration Building Air Conditioning Machine Room Electric Room Conference Room Battery Room Library & Storage Room 3. Ware house			o o o o o o o o o o o		o o o o o o o o o o o	1. The Contractor shall design and furnish the automatic fire detectors in accordance with NFPA Standards. 2. The selection of the automatic fire detectors as fire sensor shall be determined by the character of fires anticipated, the structures and occupancy conditions of individual property, protection against hazards and other factors.


SUMMARIZED FUNCTIONAL DIAGRAM
FOR GAS ALARM SYSTEM
FIRE PROTECTION PANEL
ALARM CONTACT
POWER SUPPLY
UNIT 1 GAS ALARM PANEL
ANN. WINDOW
PANEL S/W BUTTON
POWER UNIT
RELAYS CIRCUIT
ALARM UNIT
ALARM CONTACT
UNIT 2 GAS ALARM PANEL
DETECTOR WITH DRIPPROOF COVER
DETECTOR LOCATION
NATURAL GAS STATION
UNIT 1
BOILER PROPER
HOUSING
VALVE STATION
BURNER ZONE
FURNACE
PENTHOUSE
WIND BOX
AH OUTLET DUCT
ELEVATOR PIT
GAS VENT VALVE OUTLET
OTHER REQUIRED AREAS
FOR UNIT 2 BOILER

7. INTAKE SCREEN

7.1 SCOPE OF SUPPLY

The screen and the following components with accessories and auxiliaries shall be provided for units 1 and 2.

(1) Bar screen at sea water inlet on KPT wharf

(2) Screen for condenser circulating water intake

  (a) Traveling screen and motor

  (b) Bar screen with motor driven rakes

  (c) Spray system

  (d) Wash pump and motor

  (e) Guide channels and foundation bolts

  (f) Control panel

  (g) Differential water level relay facility

  (h) Cables

(3) Screen mesh in the trash pit

(4) Removable submerged sump pump for the trash pit

(5) Painting

(6) Special tools and standard tool sets

7.2 GENERAL INFORMATION

7.2.1 APPLICABLE STANDARDS AND CODES

The screen shall be designed and constructed in accordance with the requirements of Clause 6 of "Applicable Standards and Codes" in Part I.

7.2.2 OUTLINE

(1) Two (2) sets of bar screens with rakes and traveling screens and two (2) sets of wash pump shall be installed at the Unit 1 and Unit 2 condenser circulating water intake pump pit

respectively, and one (1) set of control and differential water level panel for each Unit shall be installed in the chlorination equipment area & control room.

(2) The water level transmitter shall be installed at each traveling and bar screen for each Unit to operate screen automatically.

(3) The traveling and bar screen shall be able to be operated by manually and automatically for start up and shutdown.

(4) The water tray for bar screen shall be provided with washing pipes.

(5) The screen equipment shall be provided with the Aluminium cathodic protection bar.

(6) One (1) set of removable submerged sump pump with accessories shall be equipped in the Unit 1 and Unit 2 screen trash pit. Screen mesh with a slope shall be provided in the trash pit.

(7) The bar screen for the sea water intake culvert (3 feet square) shall be provided and installed at the sea water inlet on the KPT wharf.

The bar screen shall be a type similar to those existing at the inlet openings for the "BX" Station intake pipes, and shall have a structure so as to prevent incoming of foreign matter such as branches, wooden sticks, polyvinyle bags, sheets, etc.

The bar screen shall be designed for sufficient strength and easy removal for maintenance.

7.2.3 DESIGN DATA

(1) Screen for condenser circulating water intake

(a) Traveling screen

Installation	Outdoor
Type	Vertical, front spray type
Number	Four (4) sets, two sets for Unit 2
Screen mesh	2.0 mmϕ, 10 mm square
Width of screen pit (face to face)	4,500 mm
Level	
Operating floor level	EL + 5,000 mm
Bottom level of pit	El - 4,000 mm
Maximum water flow	4.75m^3/sec. each screen
Screen rotation speed	
High speed	3 m/min.
Low speed	1.5 m/min.
Operation	Manual operation for starting and stopping, and automatic operation by water level diference and timer

(b) Bar screen with motor driven rake

Number	Four (4) sets, two sets for Unit 2
Pitch of bars (face to face)	Approx. 40 ~ 45 mm
Width of screen pit and level	The same as traveling screen
Rake rotation speed	The same as traveling screen

(c) Wash pump

Number	Four (4) sets, two sets for Unit 2
Type	Vertical shaft type
Discharge pressure	Minimum 6 kg/cm^2g each
Capacity	Minimum 300 m^3/h each

7.2.4 PERFORMANCE AND GUARANTEE

The screen shall be guaranteed for the items specified in the "Tenderer's Data Sheet".

7.2.5 TESTING

(1) Shop test

The Contractor shall execute the following shop tests and shall submit the test reports with procedures to the Owner and Engineer for approval.

(a) Inspection for construction and dimension

(b) Material test for principal parts

(c) Performance test

(2) Field test

The Contractor shall execute the following field tests and shall submit the test reports to the Owner and Engineer for approval.

(a) Performance test

(b) Interlock test

7.3 TECHNICAL INFORMATION

7.3.1 TRAVELING AND BAR SCREEN

(1) All parts of traveling and bar screens shall be designed to fulfill the needs and conditions which may be imposed during

handling, shipping and erection, as well as the actual operation.

(2) All traveling and bar screens when operating shall be free from excessive noise and vibration.

(3) All traveling and bar screens shall be so constructed that dismounting and repairing is easy.

(4) All traveling and bar screens shall be suitable for all weather outdoor service and sea water service.

(5) All traveling and bar screens shall be designed to start and operate under the load caused by 750 mm differential in head at conditions of maximum water depth.

(6) The structural design of all parts of the traveling and bar screens, where applicable, shall be adequate to withstand a differential head of 1,500 mm of water across the screen without bending or distorting.

(7) All traveling and bar screens shall be of two speed type, and speed changing shall be manually possible.

(8) The screen trays shall be of sturdy construction.

(9) Screen unit shall be effectively sealed at boot, side and joints between successive baskets so that running clearance at these points shall not exceed the size of mesh opening.

(10) The principal parts, such as chains, screen mesh wire, baskets with rakes rollers, pins, bolts and nuts shall be made of SUS 316L or equivalent, and shall be designed for used under uniform loading and to minimize the wear of parts for long time service. Other parts shall be constructed or protected by corrosion proof materials.

(11) The shear pins to prevent the excess loading shall be

furnished, and the pins shall be made easily replaceable. The limit switch shall be provided to alarm when share pin breaks.

(12) Screen housings shall be able to be easily removed for inspection of the inside.

(13) Inspection windows protected by splash-proof plates shall be furnished on back sides of screen housing.

(14) Motors and gears shall be of the weather-proof type. The motor shall be in conformity with Clause 2.2 of "Electric Motor" in Section II of Part I.

(15) Dirt shall be washed out by screen jet washing water, and shall be collected by screen plate located at the end of pit. Guide plates shall be installed to prevent dirt from falling into the downstream of the screen.

(16) The construction of traveling screen and bar screens shall be easily divided into several parts so as to enable transport, assembly and repair.

(17) Ladder and grating with handrail shall be installed for the maintenance of the motor and gear.

(18) The non-clogging spray nozzles shall be within the enclosure, and shall be arranged to direct fan shaped overlapping sprays across the width of the screen trays for washing on the ascending side.

(19) Spray nozzles for traveling screens shall be of removable type.

7.3.2 WASH PUMP, PIPING AND EQUIPMENTS IN THE TRASH PIT

(1) One (1) set of wash pump shall be installed for one (1) set of traveling screen.

Flow capacity of wash pump shall be sufficient for washing two (2) traveling water screens and trays for two (2) bar screens.

(2) Materials of major parts shall be corrosion-proof.

(3) Required valves, strainers, pressure gauges and pressure switches shall be furnished on the discharge piping of wash pump.

The valves for future extension wash pump shall be furnished on the pump discharge header.

(4) All necessary piping supports and motor for supports shall be provided by the Contractor.

(5) The capacity of the sump pump shall be sufficient at the time of cleaning for the trash pit.

(6) The material of sump pump and screen mesh in the trash pit shall be of stainless steel (SUS 316).

7.3.3 BAR SCREEN WITH RAKE

Bar screens shall be of inclined type and made of steel. Rakes shall be of motor driven type and shall be of SUS316L.

7.3.4 GUIDE CHANNEL AND FOUNDATION BOLTS

Embedded materials, such as guide channel and foundation bolts for screens and pump shall be provided by the Contractor. The guide channel shall be of cast iron with tar epoxy resin coating.

7.3.5 OPERATING SYSTEM OF TRAVELING SCREEN AND BAR SCREEN

(1) When screen is started, the wash pump shall be started automatically.

(2) The screens and wash pump shall be started automatically by the signal relay of differential water level of 200 mm at the upstream and downstream of screen.

(3) The screen shall be started automatically by the timer and stopped automatically after the set time elapses.

(4) The pump and screens shall be able to operate independently of each other.

7.3.6 CONTROL PANEL

(1) Control panel to control bar and traveling screens and wash pump shall be installed in the chlorination equipment area & control room.

(2) Operation switches, signal lamps, timers and alarms shall be furnished on the control panel.

(3) The summarized alarm shall be transmitted to the BTG board in the central control room.

(4) Control panel shall be in conformity with Clause 2.1 of "Panel and Board" in Section II of Part I.

7.3.7 DIFFERENTIAL WATER LEVEL RELAY FACILITY

(1) Two (2) sets of differential water level relay facilities shall be provided for Unit 1 and Unit 2 bar and traveling screens.

(2) Water level indicator shall be installed at the screen control panel in the chlorination equipment area 2 control room.

(3) Large outer piping for protection of instrument pipings to detect the differential water level shall be provided. All pipings and supporting materials shall be corrosion-proof materials.

(4) The air for differential water level relay facility shall be led from piping of yard instrument air system, and the air receiver for the facility shall be provided.

7.3.8 CABLES

(1) The Contractor shall furnish the power cables, control cables, cable ducts, trays, conduits and grounding wires for the screen

equipment.

(2) Further information regarding scope of works and material supply for all items in (1) shall be in accordance with Clause 10 of "Erection" in Section V of Part II.

7.3.9 PAINTING

(1) Screens shall be coated with epoxy resin of sea water proof type.

(2) Other painting shall be in conformity with Clause 1.13 of "Painting" in Section II of Part I.

7.3.10 SPECIAL TOOLS AND STANDARD TOOL SETS

The Contractor shall provide the special tools and standard tool sets for the intake screen.

8. CHLORINATION EQUIPMENT

8.1 SCOPE OF SUPPLY

The chlorination equipment with the following components and accessories shall be provided for Units 1 and 2.

(1) Chlorination equipment

(a)	Chlorination feed pump	Three (3) sets, one for Unit 2
(b)	Electrolyzer	Three (3) sets, one for Unit 2
(c)	Deaerator column	Three (3) sets, one for Unit 2
(d)	Injection diffuser	Eight (8) sets, four for Unit 2
(e)	Strainer	Three (3) sets, one for Unit 2
(f)	Instrumentation	
(g)	Piping and valves	

(2) Rectifier equipment

(a)	High tension, incoming	Three (3) sets, one for Unit 2
(b)	Transformer	Three (3) sets, one for Unit 2
(c)	Rectifier	Three (3) sets, one for Unit 2

(3) Screen for chlorination pump pit

(a)	Bar screen	Two (2) sets, one for spare
(b)	Guide channels and foundation bolts	One (1) set

(4) Control panel

(5) Foundation bolts and nuts

(6) Cables, grounding wire and conduits

(7) Painting

(8) Special tools and standard tool sets

8.2 GENERAL INFORMATION

8.2.1 APPLICABLE STANDARDS AND CODES

The chlorination equipment shall be designed and constructed in accordance with the requirements of Clause 6 of "Applicable Standards and codes" in Part I.

8.2.2 OUTLINE

(1) This equipment shall be designed to be operated and controlled locally.

(2) This equipment shall be installed within the site proposed for this equipment as shown in drawing No. WMT-1015 "Flow Diagram Chlorination System (Sea Water Electrolysis Method)".

(3) Consideration shall be given to design of the equipment in view of preventing pollution.

(4) This equipment shall be designed to permit easy operation and maintenance.

(a) The operating conditions of pumps and any other equipment shall be controlled and monitored from the control panel.

(b) Should there be any possibility of trouble in operation and control due to trouble of equipment, such equipment shall be furnished with standby equipment when necessary.

(c) The equipment shall be designed to cope with any change in the quality and quantity of sea water for the sea water electrolysis chlorine injection equipment.
The equipment shall be designed to permit start up through normal operation even after a long period of shutdown.

(d) The equipment shall be designed so that the entire equipment can be tripped in sequence in the event of abnormal decrease in the sea water volume and/or abnormal rise of electrolysis current.

(5) In order to ensure labor saving and safty as well as facilitate operation and control, an automatic operation system shall, to the extent possible, be adopted.

(6) The flow rate of electrolysis sea water shall be measured at the equipment inlet, and the flow rate of hypochlorite shall be measured at the inlets of the injection diffusers for the respective units.

(7) The respective equipment and piping shall be designed by fully taking into account corrosion, particularly due to hypochlorite.

(8) Hypochlorite shall be injected directly into CWP pit in front of bar screen.

(9) Hydrogen (H_2) generated in the electrolysis cell shall be reduced to 1.0 vol. % or less by the deaerating system, which shall be installed by the Contractor, before releasing it into the atmosphere.

(10) All safety devices required for protection of the equipment and safety of personnel shall be installed.

8.2.3 DESIGN DATA

(1) Chlorination equipment for condenser circulating water

(a) Condenser circulating water conditions

Sea water flow	9.5 m^3/sec
Sodium hypochlorite injection (as Cl_2)	1.4 ppm to be injected continuously

Quality of sea water

Refer to Clause 3.7 of "Plant Water Source" in Section I.

(b) Sea water feed pump

Type	Vertical shaft
Number	Three (3) sets, one set for Unit 2
Capacity	60 m^3/hr each (Tentative)
Delivery head	70 m (Tentative)
Material	Anticorrosive
Casing:	Cr.Ni alloy cast steel
Impeller:	Stainless steel
Shaft:	Stainless steel

(c) Strainer

Type	Auto cleaning
Quantity	Three (3) sets, one set for Unit 2
Capacity	100% each
Screen	40 mesh
Material	Carbon steel with inside rubber lining
Basket	Stainless steel
Screen	Stainless steel

(d) Electrolizer

Type	Closed flat plate
Quantity	Three (3) sets, one set for Unit 2
	Composed of 16 modules (Tentative)
Capacity	50 kg/hr (as Cl_2)
Material	
Anode	Titanium plate with platinum metal coating

	Cathode	Stainless steel
	Cell body	Carbon steel with inside rubber lining
(e)	Deaeration column	
	Type	Cylindrical, vertical
	Quantity	Three (3) sets, one set for Unit 2
	Material	Carbon steel with inside rubber lining
	Body	Carbon steel with inside rubber lining
	Valve housing	Carbon steel with inside rubber lining
	Other parts	Anticorrosive material
(f)	Injection diffuser	
	Type	Multi nozzle
	Quantity	Eight (8) sets, four sets for Unit 2
	Material	Reinforced PVC
(2)	Transformer and rectifier	
	Type	Outdoor, thyristor controlled
	Quantity	Three (3) sets, one set for Unit 2
	Cooling system	
	Transformer	Oil cooled
	Rectifier	Oil cooled
	AC main power source	50 Hz, 4,160 V
	DC output	100 V
	Rated current	3,700 A (Tentative)
	Regulating range	10 - 100%
	Input capacity	370 KVA (Tentative)

(3) Screen for chlorination pump pit

(1) Bar screen

Number	Two (2) sets, one for spare
Pitch of bars	Approx. 80 mm
Width of screen pit (face to face)	3,000 mm
Level	
Operating floor level	EL + 5,000 mm
Bottom level of pit	EL - 2,900 mm

8.2.4 PERFORMANCE AND GUARANTEE

The chlorination equipment shall be guaranteed for the items specified in the "Tenderer's Data Sheet".

8.2.5 TESTING

(1) Shop test

The Contractor shall execute the following shop tests and shall submit the test results to the Owner and the Engineer for approval.

(a) Dimension check and visible inspection

(b) Hydrostatic test

(c) Performance test

(d) Lining thickness test

(e) Material test for principal parts

(2) Field test

The Contractor shall execute the following field tests and shall submit the test results to the Owner and the Engineer for approval.

(a) Leak test

(b) Hydrostatic test

(c) Pump running test

(d) Performance test

8.3 TECHNICAL INFORMATION

(1) The chlorination equipment shall comprise a train of 100% capacity equipment including electrolyzer, rectifier, transformer, indicated voltage regulator, etc.

(2) Sodium hypochlorite shall be injected continuously and controlled automatically in proportion to the sea water flow rate.

(3) The chlorination equipment shall be designed for continuous service and shall be automated to minimize the number of operators.

(4) Maximum prefabrication and compactness of the unit at the manufacturer's shop shall be considered.

(5) Injection point shall be provided in the circulating water pump pit.

(6) The following instrumentation shall be provided on the control panel, but these shall not be limited to the items below.

(a) Flow indicator for cell

(b) Control switches, indicating light alarm window, etc.

(c) Current meter

(7) The chlorination equipment shall be able to be operated manually and automatically for start up and shut down on the chlorination control panel located in the chlorination equipment area & control room.

(8) Alarm shall be issued should any trouble arise in the instruments

or equipments or all processes. Any alarm to be issued shall be indicated on the local control panel, and a summerized alarm shall be indicated in the central control room.

(9) The control panel shall be in conformity with Clause 2.1 of "Panel and Board" in Section II of Part I.

(10) The connecting terminal including valves shall be furnished on the hypochlorite discharge pipe.

(11) The connection terminals including valves shall be furnished at the chlorination feed pump discharges header and injection headers for Unit 2 installation of chlorination system.

(12) The connection piping between No. 1 and No. 2 booster pump discharge pipes shall be furnished so that either of the two pumps can supply sea water to either the No. 1 or the No. 2 chlorination equipment.

(13) The spare valves shall be provided on the each hypochorite discharge line.

(14) All necessary pipings, valves, fittings and supports between chlorination equipment and condenser circulating water intake channel shall be provided.

(15) The distribution piping for condenser circulating water shall be securely fixed so as to withstand the intake flow velocity. All fixtures shall be of corrosionproof material.

(16) Bar screen

(a) The principal parts, screen mesh wire, pins, bolts and nuts shall be made of SUS 316L or equivalent, and shall be designed for used under uniform loading and to minimize the wear of parts for long time service. Other parts shall be constructed or protected by corrosion proof materials.

(b) Ladder and grating with handrail shall be installed.

(c) Bar screen shall be of inclined type and made of steel.

(d) Embedded materials, such as guide channel and foundation bolts shall be provided by the Contractor.

The guide channel shall be of cast iron with tar epoxy resin coating.

(e) Two sets of bar screen, one for spare, shall be used alternately so that bar screen shall be made easily replaceable.

(17) The interlock between the chlorination equipment and the sea water circulating water pump shall such that it will not be able to start the equipment when the pump is not operating.

(18) Material for valves and pipings shall be as follows.

Pipings

Sea water circulating pump to sea water booster pump

SGP, with inside rubber lining

Chlorination feed pump to electrolyzer

SGP, with inside rubber lining

Electrolyzer to deaerator column

SGP, with inside rubber lining

Deaerator to intake channel

SGP, with inside rubber lining

Drain piping

Corrosionproof material

Valves

Corrosionproof material

(19) Three strainers, one for Unit 2 shall be installed on the sea water feed pipe at chlorination feed pump discharge side.

(20) The strainers shall be of the auto cleaning type and shall be made of anticorrosion material.

(21) Alarm signal of differential pressure detected from the inlet and outlet of the strainer shall be transmitted to the control panel.

(22) Electrolysis cell

(a) The electrolysis cell shall be of a construction permitting stable and continuous operation without causing adhesion of magnesium hydroxide, etc., over the electrode surface even if no chemical washing is carried out.

(b) In no case shall a drift of electrolysis current arise.

(c) The electrolysis cell shall be lined with rubber, etc., protected from cathodic corrosion, and have a construction causing no sea water leakage.

(d) The electrolysis cell shall be so constructed that generated chlorine which has undergone perfect absorption reaction in the electrolysis cell shall be leak from the electrolysis cell.

(e) The electrolysis cell shall be designed so that the volume of generated NaClO can be regulated depending upon the volume of sea water to be used (for example, number and capacity, etc., of circulating water pumps in operation).

(f) The electrolysis cell shall be insulated from the ground, and all measures shall be taken to prevent leakage of electric current. The same measures shall be taken for the auxiliary working floors, stairs, etc.

(23) Electrode plate

(a) The electrode shall be constructed of such materials as to permit continuous operation without necessitating interpole adjustment.

(b) Suitable materials and thickness shall be selected for anodic plate coating, and the coating shall be rigid and have uniform bonding force so that the coating will not separated.

(c) The electrode plate for the chlorination equipment shall be designed so as to be used for a minimum of five years.

(24) Deaerator

(a) A deaeration column shall be installed to reduce H_2 content in hydrogen generated according to electrolysis into 1 vol. % or less before safely releasing it into atmosphere.

(b) The deaeration tank shall be designed by giving sufficient consideration to the shape, capacity, safety and other factors.

(25) Pumps

(a) The seawater booster pumps shall be directly coupled to the motors.

(b) Gland packing or mechanical seal shall be applied to the sealing system for the shaft seal section of the pumps.

(c) The materials to be used for the casing, impellers, etc., shall be sufficiently corrosionresistant.

(d) The motor shall be in conformity with Clause 2.2 of "Electric Motor" in Section II of Part I.

(26) Working platform, working floor and stairs

The working platform, working floor and stairs shall be installed at all places required in view of safety and ease of operation and maintenance.

(27) Lifting equipment

The monorail and chain block with geared trolley shall be installed for maintenance of machinery and equipment such as electrode plates, etc.

(28) Others

Overflow water and drain water from the equipment shall be discharged into the drain pit through the provided piping. No overflow shall arise during normal operation of the equipment.

(29) The chlorination equipment in the above is of minimum requirements.

If the Contractor wishes to offer on alternate type, the Contractor shall propose chlorination equipment (with detailed information) of an equivalent or higher grade.

(30) Foundation bolts, etc.

All necessary foundation materials, such as hangers, supports, piping sleeves, foundation bolts, etc., shall be provided.

(31) Cables

(1) The Contractor shall furnish the power cables, control cables, cable ducts, trays, conduits and grounding wires for the chlorination system.

(2) Further information regarding scope of works and material supply for all items in (1) shall be in accordance with Clause 10 of "Erection" in Section V of Part II.

4-545

(32) Painting

The painting shall be in conformity with Clause 1.13 of "Painting" in Section II of Part I.

(33) Special tools and standard tool sets

The Contractor shall provide the special tools and standard tool sets for the chlorination system.

9. YARD INSTRUMENT AIR SYSTEM

9.1 SCOPE OF SUPPLY

The yard instrument air system shall be provided with the following components and accessories, but these shall not be limited to the items below.

(1) Suction air filters

(2) Compressors and driver motors

(3) Loading control equipment for compressors

(4) After coolers

(5) Air receiver

(6) Air dryer

(7) Drain traps, safety valves, check and stop valves, solenoid valve, flow relay, glass sights, pressure gauges and other instruments

(8) Piping

(a) Between suction filter and air compressor

(b) Between air compressor and after cooler

(c) Between after cooler and air receiver

(d) Between air receiver and air dryer

(e) Between the main piping and outlet piping of the dryer

(f) Between instrument air line and yard instrument air line

(g) Yard instrument air piping

(to raw-water pretreatment system, water treatment system, drainage and waste water treatment equipment, chlorination equipment, heavy oil transfer pump, inside dike of heavy oil storage tanks, inside dike of Limits 1 and 2 heavy oil service tanks etc.)

(h) Drain piping and others

(9) Control panel for compressors

(10) Foundation bolts and nuts

(11) Installation

(12) Cables

(13) Painting

(14) Special tools and standard tool sets

9.2 GENERAL INFORMATION

9.2.1 APPLICABLE STANDARDS AND CODES

The yard instrument air system shall be designed and constructed in accordance with the requirements of Clause 6 of "Applicable Standards and Codes" in Part I.

9.2.2 OUTLINE

(1) Two (2) sets of instrument air compressor shall be installed for the control air source of yard equipment: one (1) set shall be for normal operation, and the other for stand-by. The stand-by compressor shall be automatically started up by the low pressure signal from the pressure switch of the air receiver.

(2) The instrument air compressor shall be operated automatically.

(3) The delivery air pressure of compressor shall be controlled in the range of 5.6 to 7 kg/cm^2g.

(4) The compressor shall be of the oilfree type to keep instrument air clean.

(5) The compressed air shall be sent to instrument air receiver through the air aftercooler.

(6) Instrument air shall be dehumidified in the dryer.

(7) Installation and trial operation of the yard instrument air system shall be carried out by the time the hydrostatic test of the steam generator is carried out, and the system shall be ready for operation at that time.

9.2.3 DESIGN DATA

(1) Compressor

(a) Type	Vertical, belt driven, oilless, reciprocating, water cooled
(b) Installation	Indoor (water treatment equipment & control room)
(c) Number	Two (2) sets
(d) Discharge air pressure	7 kg/ cm^2g
(e) Capacity	To be decided by the Contractor
(f) Ambient air temperature	33^oC
(g) Loading-unloading control	0% and 100%, two step type

(2) Motor

(a) Type	Indoor use, horizontal
(b) Number	Two (2) sets

(3) Control panel

(a) Type	Self-standing, indoor
(b) Number	One (1)

(4) After cooler

(a) Type	Horizontal pipe line Tube side : air Shell side: cooling water

	(b) Number	Two (2) sets
(5)	Air receiver	
	(a) Type	Vertical welded, cylindrical, steel construction
	(b) Capacity	1.0 m^3
	(c) Number	One (1) set
(6)	Cooling water	Bearing cooling water
(7)	Air dryer	
	(a) Type	Refregerative, fully automatic package type
	(b) Installation	Indoor (water treatment equipment control room)
	(c) Number	Two (2) sets
	(d) Pressure	7 kg/cm^2g
	(e) Capacity	Each 100% of compressor capacity at free air
	(f) Dew point of discharge air	-15°C or less

9.2.4 PERFORMANCE

(1) The capacity of compressor shall be decided by the Contractor.

(2) The air temperature leaving the aftercooler shall be less than 45°C.

(3) The sound pressure level shall not exceed 85 dB (A) at one (1) meter distance when the center line frequency is 1000 cycles.

(4) The Contractor shall submit the performance curves which show the pressure, horsepower, capacity and efficiency of the compressors to the Engineer for approval.

9.2.5 TESTING

The Contractor shall execute the following tests, and shall submit the results to the Owner and the Engineer for approval.

(1) Shop test

(a) Dimension check and visual inspection

(b) Performance test

(c) Safety valve setting

(d) Hydrostatic test for compressor cylinder, aftercooler, air receiver and air dryer

(e) Dew point test for dryer

(2) Field test

(a) Operation test including measurements of noise level and vibration

(b) Safety valve setting for air compressor and air receiver

(c) Leak test for the piping system

(d) Dew point test for dryer

9.3 TECHNICAL INFORMATION

(1) The compressor shall be free from excessive vibration, cavitation, noise and leaks under all conditions of operation.

(2) The compressor shall be a heavy duty, single stage machine, and shall be designed to deliver, to the extent possible, air free from any oil or oily vapors due to lubrication.

(3) The compressor shall be factory assembled and provided with suitable base plate, as required, with provisions for mounting on the foundations.

(4) All electrical wiring and piping integral to the compressor shall be factory installed, and shall have convenient terminal points for connection to the external wiring and piping systems.

(5) Yard instrument air line shall be connected to instrument air line at the suitable place.

(6) The compressor shall be provided with integral air piping and cooling water piping, and shall include thermometers, flow relay, flow glass, pressure gauges, pressure switches, etc.

(7) The stuffing box where the piston rod passes through the cylinder shall be deepened and fitted with nonlubricated carbon or teflon packing to assure tightness without excessive pressure or piston rod wear.

(8) Frame of the compressor shall be completely sealed and absolutely dusttight. The openings shall be sealed by lightweight covers to permit easy access to the frame interior.

(9) Window type of glass gauge type oil level indicator shall be mounted on the frame.

(10) The suction filter shall be of the cartridge type.

(11) The compressor cylinder shall be automatically unloaded during starting and stopping.

(12) The compressor shall include 0 and 100% load-unload control by automatic operation of inlet and outlet valves on the cylinder during compressor operation.

(13) The compressor shall be furnished with solenoid operated cooling water valve on the cooling water inlet line, and flow relay and flow glass on the outlet line.

If the supply of cooling water fails, the flow relay shall be actuated and this shall be alarmed. The cooling water supply shall be stopped automatically when the compressor stops.

(14) The compressor shall be provided with an appropriate belt cover for human protection.

(15) The after cooler shall be furnished with a drain separator, drain chamber, level glass gauge, automatic drain trap, safety valve and thermometer.

(16) The check valve shall be provided on the pipe line between the after cooler and air receiver.

(17) The air receiver shall be of the vertical cylinder type with manhole, supporting legs, inlet and outlet nozzles, drain and instrument taps.

(18) The air receiver shall be provided with an automatic drain trap.

(19) The pressure switch for annunciator indication shall be provided on the receiver.

(20) The Contractor shall furnish the base frame, anchor bolts, nuts, sleeves and other pertinents for the compressor, after cooler, air receiver and air dryer.

(21) The drain trap for the air dryer shall have sufficient capacity to discharge the drain and oil mist from the air line.

(22) The dryer shall utilize inert gas as its cooling medium.

(23) The dryer shall be provided with integral inert gas piping, air piping, and electrical wiring and all necessary instruments.

(24) The material of instrument air piping shall be galvanized carbon steel (SGPW). The outlet air piping of air dryer shall be provided with antisweat insulation.

(25) The instrument air piping shall be in conformity with Clause 1.1 of "Power Plant Piping" in Section II of Part I.

(26) The motor shall be in conformity with Clause 2.2 of "Standards of Electric Motor" in Section II of Part I.

(27) Control switch, indicating lamps, pressure gauges and pressure switches shall be provided on the control panel of the compressor.

(28) Painting shall be in conformity with Clause 1.13 of "Painting for Piping and Equipment" in Section II of Part I.

(29) The Contractor shall furnish the power cables, control cables, cable ducts, trays, conduits and grounding wires for the yard instrument air system.

(30) Further information regarding scope of works and material supply for all items in (28) shall be in accordance with Clause 10 of "Erection" in Section V of Part II.

(31) The Contractor shall provide the special tools and standard tool sets for the yard instrument air system.

10. PIPING, PIPE SUPPORT AND STRUCTURE FOR YARD PIPING SYSTEM

10.1 SCOPE OF SUPPLY

(1) The Contractor shall supply and install the following materials for yard piping system for Units 1 and 2.

- (a) Piping
- (b) Valves and specialities
- (c) Insulation
- (d) Pipe supporting structure
- (e) Pipe slippers
- (f) Pipe supports (individual support)
- (g) Foundation bolts, nuts, sleeves, etc.
- (h) Walkway, platform, ladder, etc.
- (i) Painting
- (j) Temporary piping

(2) All materials necessary for support of the yard piping system shall be provided.

(3) The foundations for pipe supporting structures, pipe sleepers and pipe supports shall be provided by the Contractor.

10.2 GENERAL INFORMATION

10.2.1 APPLICABLE STANDARDS AND CODES YARD PIPING SYSTEM

The piping, pipe support and structure for yard piping shall be designed and constructed in accordance with requirements of Clause 6 of "Applicable Standards and Codes" in Part I.

10.2.2 OUTLINE

Yard piping system shall consit of necessary piping system for the Units 1 and 2. Yard piping system to be constructed for Unit 1 shall be designed to connect ensurely for Unit 2 construction.

10.2.3 TESTING

The Contractor shall execute the following field tests and shall submit the test results to the Owner and the Engineer for aprroval.

(a) Leak test

(b) Hydrostatic test

(c) X-ray for welded point

(d) Color check

(e) Flashing

10.3 TECHNICAL INFORMATION

(1) The span between pipe supports shall be designed suitably considering piping arrangement.

The Contractor shall submit the design data and calculation sheet of the span between pipe supports to the Engineer for approval.

(2) The height of the supporting structure serving as the main pipe rack will be 6 meters or more, however, at the crossing of main road shall be 8 meters.

(3) The main pipe rack shall have two pipe support stages due to the limited utilization area of the pipe route.

The spacing between pipe support stages shall be 1,200 mm or more in consideration of piping installation.

(4) The pipe support shall be in conformity with Clause 1.1 of "Power Plant Piping" and Clause 1.3 of "Hangers, Anchors and Supports" in Section II of Part I.

(5) Painting shall be in conformity with Clause 1.3 of "Painting for Piping and Equipment" in Section II of Part I.

(6) The pipe supports and structure shall be designed in accordance with Clause 9 of "Design Condition" in Part I.

(7) The yard piping to be connected for Unit 2 construction shall have connection with the isolating valve and blind flang. However, the following piplings shall be considered to install as temporary piping for house boiler and Unit 1 operation due to Unit 2 construction.

(a) Natural gas piping

(b) Raw water piping

(c) Service/Fire water piping

(d) Demineralized water piping

(e) Auxiliary steam piping

(f) Instrument and service air piping

(g) Cooling water piping

(h) Other requirement

(8) The piping system must have sufficient flexibility so as to prevent thermal expansion that could cause failure of piping and over straining of anchors.
Therefore, fuel oil piping, steam piping, etc. shall be designed so as to possess the required flexibility.

(9) All of individual pipe supports and foundation for outdoor piping shall be provided by the Contractor.

(10) The Contractor shall connect the city water receiving piping constructed by the Contractor of Lot II-A.

11. LABORATORY AND LABORATORY INSTRUMENTS

11.1 LABORATORY

11.1.1 SCOPE OF SUPPLY

The Contractor shall provide the laboratory and laboratory instruments which shall comprise, but not be limited to, the following fixtures, apparatus and other necessary devices.

(1) Fixtures specified in Clause 11.1.4, Fixtures List.

(2) Instruments specified in Clause 11.1.5, 11.1.6, 11.1.7, 11.1.8, Instrument List.

(3) Apparatus specified in Clause 11.1.9, Apparatus List.

(4) Reagents Specified in Clause 11.1.10, Reagents List.

(5) The Contractor shall furnish and install the items mentioned above, and shall design the laboratory room and gas cylinder storage room which shall serve as the fuel oil analysis, water analysis and analytical instruments.
The laboratory shall be located in the main power house adjacent to the battery room.

(6) Piping and valves

(7) Painting

(8) Cables and grounding wire

(9) Special tools and standard tool sets

11.1.2 GENERAL INFORMATION

11.1.2.1 APPLICABLE STANDARDS AND CODES

The laboratory and laboratory instruments with complete accessories shall be in conformity with the requirements of Clause 6 of "Applicable Standards and Codes" in Part I of Section II.

11.1.2.2 OUTLINE

(1) Basic plan of the laboratory shall be referred to in the attached drawings "General Arrangement of Laboratory".

(2) The laboratory shall consist of the following two (2) rooms.

(a) Fuel oil analysis room

(b) Water analysis and analytical instrument room

(3) Testing

The Contractor shall execute the following tests and shall submit the test results to the Engineer.

(A) Shop test

(a) Material test

(b) Dimension check and visible inspection

(c) Operation test

(B) Field test

(a) Operation test

11.1.3 TECHNICAL INFORMATION

(1) Though the types and names of fixtures, apparatus and instruments described herein are specified, equivalent articles which can meet the specifications will be acceptable, providing the proposed manufacturer's equipment is equal or superior in quality, function, etc.

(2) The water analysis instruments and apparatus shall be supplied, and shall have a minimum capacity required in view of steam power plant water control. Further information shall be referred to in the following.

JIS B8224 or equivalent	Testing Methods for Boiler Feed Water and Boiler Water
JIS K0101 or equivalent	Testing Methods for Industrial Water
JIS K0102 or equivalent	Testing Methods for Industrial Waste Water

(3) Oil analysis instruments and apparatus corresponding to JIS or ASTM shall be provided, and shall be capable of analyzing the following items.

(a)	High heating value	(F.O.)
(b)	Specific gravity	(F.O. and L.O.)
(c)	Viscosity	(F.O. and L.O.)
(d)	Pour point	(F.O.)
(e)	Flash point	(F.O.)
(f)	Sulfur content	(F.O.)
(g)	Water content	(F.O. and L.O.)
(h)	Total acid value	(L.O.)
(i)	Oil sludge	(F.O. and L.O.)
(j)	Color phase	(L.O.)

(k) Conradson carbon residue (F.O. and L.O.)

(l) Asphalt (F.O.)

Note: F.O. indicates heavy oil use; L.O. indicates lubricating oil use.

(4) In case analyzing instruments with specified JIS numbers are requested, a complete set of glass, reagent and articles of consumption prescribed in JIS shall be included in the said instruments.

(5) All accessories required for measurement shall be supplied.

(6) The Contractor shall also be responsible to indentify all equipment which requires controlled environmental conditions for their proper functioning.

(7) The Contractor shall design, furnish and install the respective laboratory rooms

(8) The receptacles with earth connection for AC 110 volt and AC 220 volt electric power sources shall be installed on walls and tables through the electric distribution panel which shall be installed in the respective laboratory rooms.

(9) Material such as drainge pipes (corrosionproof), gas piping and demineralized water pipes (stainless steel) pipings shall be supplied by the Contractor.

(10) Ventilation system for respective laboratory rooms shall have sufficient capacity so as to ensure personnel safety and prevent enviromental polloution.

(11) One (1) set each of draft chamber for fuel oil analysis room and water analysis and analytical instrument room shall be installed with all necessary pertinents.

(12) Gas piping for analytical instruments shall be installed from gas bottle storage room to respective analytical instruments located on tables in the laboratory rooms.

(13) Materials to be used for floor of laboratory room shall be of the antialkali and acidproof type.

(14) Drainage water discharged from respective laboratory rooms shall be sent to Unit 1 and Unit 2 unit neutralizing pit by gravitically force.

(15) The Contractor shall execute the site training of the Owner's engineers for testing method of all laboratory instruments in accordance with applicable standards, and shall provide JIS and ASTM testing method textbooks for water analysis, fuel oil and flue gas.

11.1.4 FIXTURES LIST

All fixtures of the best quality shall be procured and provided by the Contractor.

11.1.4.1. Fuel oil analysis room

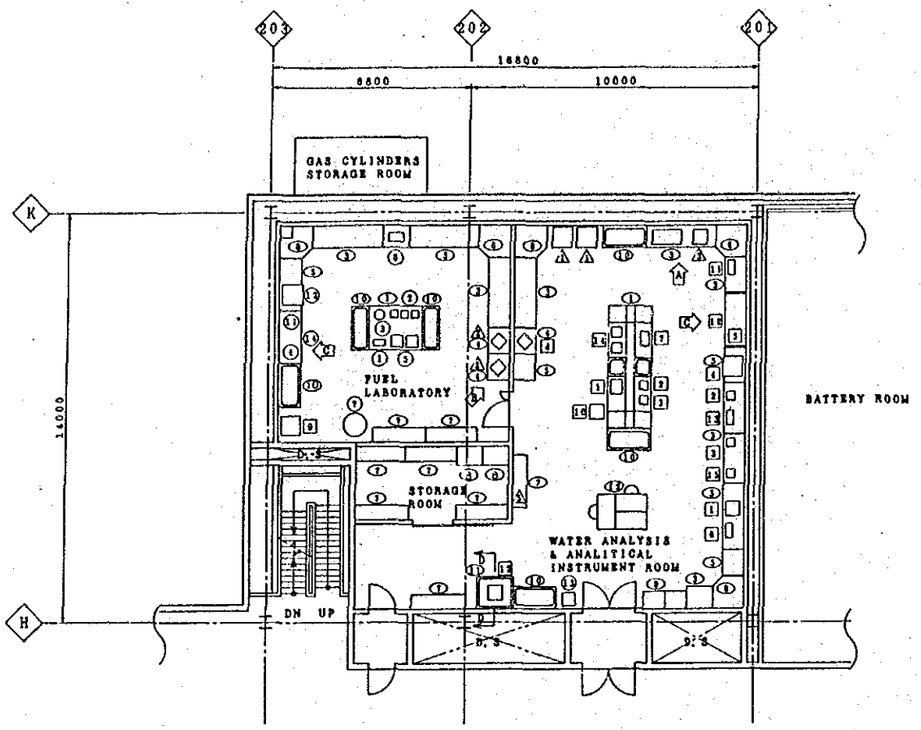
	Item	Dimension (L x W x H)	Quantity
(1)	Storage cupboard	1800x750x1800	Two (2) sets
(2)	Wall table	2400x750x800	Two (2) sets
(3)	Drawer cupboard	2400x750x800	One (1) set
(4)	Drawer cupboard	1500x750x800	One (1) set
(5)	Corner unit	1100x1100x800	Two (2) sets
(6)	Sink unit	1500x750x(800+160)	One (1) set
(7)	Center table with sink unit	3000x1500x800	One (1) set
(8)	Viblation proof balance table	900x750x750	Two (2) sets

11.1.4.2 Water Analysis and Analytical Instrument Rooom

	Item	Dimension (L x W x H)	Quantity
(1)	Storage cupboard	1760x400x970	Two (2) sets
(2)	Wall table	2400x750x800	Three (3) sets
(3)	Wall table	1500x750x800	One (1) set
(4)	Wall table	1200x750x800	One (1) set
(5)	Wall table	900x750x800	One (1) set
(6)	Drawer cupboard	1200x750x800	One (1) set
(7)	Drawer cupboard	900x750x800	Two (2) sets
(8)	Corner unit	1100x1100x800	Three (3) sets
(9)	Sink unit	1500x750x(800+160)	Three (3) sets
(10)	Vibration proof balance table	900x750x750	One (1) set
(11)	Center table with sink unit and bottle cabinet	4200x1500x800	One (1) set
(12)	Office desk and chair		Three (3) sets
(13)	Bottle cabinet	680x620x750	Two (2) sets

11.1.4.3 Storage room

	Item	Dimension (L x W x H)	Quantity
(a)	Storage cupboard	1500x500x1800	Two (2) sets
(b)	Storage cupboard	1800x500x1800	Two (2) sets
(c)	Wooden shelf	1065x610x1830	Two (2) sets



LIST OF LABORATORY EQUIPMENT

FOR FUEL ANALYSIS

ITEM	DISCRIPTION
1	FLASH POINT TESTER
2	GRAVITY HYDROMETER
3	VISCOSITY WATER BATH
4	CONRADSON CARBON-YESIDUE APPARATUS
5	WATER CONTENTS NEASURING APPARATUS
6	POUR POINT TESTER
7	CENTRIFUGE
8	HOT PLATE
9	ELECTRIC REFRIGERATOR
10	SULFUR CONTENTS EQUIPMENT
11	MUFFLE FURNACE
12	DRYING OVEN
13	WATER COOLER
14	DRAFT CHAMBER

FOR ANALITICAL INSTRUMENT

ITEM	DISCRIPTION
A1	CALORIMETER
A2	DIRECT READING BALANCE
A3	ATOMIC ABSORPTION FLAME SPECTROPHOTOMETER
A4	ORSAT APPARATUS

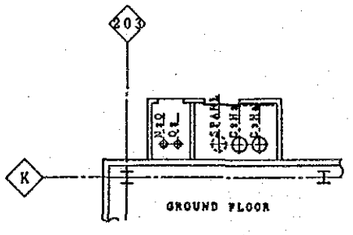
FOR WATER ANALYSIS

ITEM	DISCRIPTION
1	SPECTROPHOTOMETER
2	PH METER
3	CONDUCTIVITY METER
4	DRYING OVEN
5	MUFFLE FURNACE
6	MAGNETIC STIRRER
7	WATER BATH
8	DIRECT READING BALANCE
9	ELECTRIC REFRIGERATOR
10	SHAKER
11	HOT PLATE
12	DEMINERALIZER
13	JER TEST APPARATUS
14	FILTERATION EQUIPMENT
15	INDIGO CARMINE APPARATUS
16	DRAFT CHAMBER

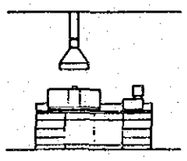
FIXTURES LIST

ITEM	DISCRIPTION
①	CENTER TADLE
②	WORK TABLE
③	WALL TABLE
④	VIBRATION PROOF BALANCE TABLE
⑤	DRAWER CUPBOARD
⑥	CORNER UNIT
⑦	STORAGE CUPBOARD
⑧	SUPER SHELF
⑨	BOTTLE CABINET
⑩	SINK UNIT
⑪	BUILT IN SINK UNIT
⑫	OFFICE DESK AND CHAIR

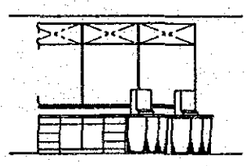
NOTE : ITEMS IN THE ABOUE LIST THAT IS INDICATED IN THE LEFT SHOWS MAJOR EQUIPMENT ONLY.



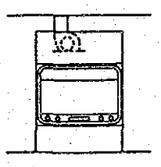
GAS CYLINDERS STORAGE ROOM



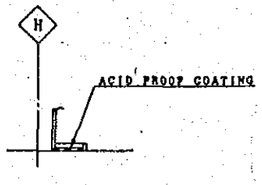
VIEW A-A



VIEW B-B



VIEW C-C



SECTION D-D

PAKISTAN
KARACHI ELECTRIC SUPPLY CORPORATION
WEST WHARF THERMAL POWER PLANT PROJECT
UNITS NO. 1 AND NO. 2

GENERAL ARRANGEMENT OF LABORATORY

JAPAN INTERNATIONAL COOPERATION AGENCY

APPROVED BY	REVIEWED BY	CHECKED BY	DRAWN BY
DWG NO.		SCALE 1:100	DATE

11.1.5 WATER ANALYSIS EQUIPMENT

(1) Spectrophotometer

The Contractor shall provide the spectrophotometer which shall be electrically operated for accurate routine colorimetric analysis, and shall be complete with accessories, full set of slits, graduated test tubes and the full range of cells and dust covers.

The general specification of the spectrophotometer shall be as follows.

(a)	Number	One (1) set (Digital display)
	Wave length range	195 nm - 870 nm
	Photometric accuracy	±0.003 at 0.5 Abs,
		±0.005 at 1 Abs
	Optics	Symmetrical double beam
	Light source	W lamp for VIS region
		D2 lamp for UV region
		(One touch changeover)
	Power supply	AC 110V, 50Hz
(b)	Number	One (1) set (meter)
	Wave length range	325 nm - 1000 nm
	Wave length accuracy	± 2nm
	Light source	Tungsten lamp
	Photometric repeat-ability	±0.003 Abs (at 1.0 Abs)
	Photometric range	Transmittance: 0 - 100%T
		Absorbance : 0-1,0-2 Abs
		Concentration: All scales to be linear

K-647

(c) Accessories and spare parts

(i)	Standard	One (1) set for each spectrophotometer
(ii)	Lamp	Ten (10) sets each
(iii)	100 mm Cell	Five (5) sets each
	50 mm Cell	Five (5) sets each
	10 mm Cell	Five (5) sets each

(2) pH meter

pH meters shall be provided, and shall be complete with cells, automatic temperature compensation and spare electrodes.

The general specifications of pH meter shall be as follows.

(a) Number	Two (2) sets (Digital display)
Measuring range	0 - 14 PH, 0 to 1999 mV
Minimum scale	0.01 pH mv 1mV
Accuracy	PH:0.01 PH $\pm$1 digit
	mV:0.1% of rdg = 1 digit
Power	AC 110V
Temperature compensation	0^{o}C to 60^{o}C

The following accessories shall be supplied.

(i) Spare electrodes	(a) Glass	10 sets
	(b) Reference	5 sets
	(c) Combination	10 sets

(ii) Standard accessories

K-568

(3) Conductivity meter

Conductivity meters shall be provided to measure the conductivity of river water, service water, feed water, boiler water, demineralized water and condensate water. The meters shall be direct reading digital type instruments.

The general specification of meter shall be as follows.

Measuring range		0.1 us/cm to 1000 ms/cm
		1.00 us/cm - 100.0 ms/cm
		0.100 us/cm - 10.00 ms/m
		10.0 us/cm - 1000 ms/cm
Accuracy	10us-10mv rang :	0.2% rdg ±2 digit
	100mv range	0.5% of rdg ±2 digit
Temperature compensation		0°C to 60°C
Compensation accuracy		±1.5°C
Power		AC 110V, 50 Hz

The following accessories shall be supplied.

(a) Standard cells with constant K=1.0 5 pieces

(b) Special cells with constant K=0.1 2 pieces

(c) Special cells with constant K=10 2 pieces

(d) Standard accessories

(4) Drying Oven

The drying oven shall be provided to enable water determination of substances.

The general specification shall be as follows.

Number	Two (2) sets
Operating temperature range	40°C to 250°C
Temperature control accuracy	±1.0°C

Time to reach max. temperature	80 minutes
Inner wall	Stainless steel SUS-304
Inner capacity	150 l
Power	AC 110V, 50 Hz
Power consunption	1.5 kw
Accessories	Standard accessories
	One (1) set

Two (2) sets of drying oven shall be supplied.

One set shall be provided in the water analysis room and the other in the fuel oil analysis room.

(5) Muffle furnace

The electricity heated muffle furnace shall be provided, and shall have an adequate zone which can be maintained at a uniform temperature of 1150°C.

The general specification shall be as follows.

Number	One (1) set
Operating temperature range	100°C to 1150°C
Temperature control accuracy	±10°C
Temperature controller	Indicating controller (0°C to 1200°C 2 position control system, with thermocouple use)
Power	Single phase AC 110V, 50 Hz 2 KVA

One (1) set of muffle furnaces shall be supplied.

One set shall be provided in the water analysis room and the other in the fuel oil analysis room.

The muffle furnaces shall be complete with accessories

including thermocouple, lead wire, power supply cord, grounding wire, connecting cord, etc.

(6) Magnetic stirrer

The magentic stirrer shall be supplied, and shall be capable of handling up to six sample containers at one time to efficiently stir and mix samples.

Six (6) built-in motors shall be provided and shall operate individually.

The general specification shall be as follows.

Number	One (1) set
Stirring speed	Approx. 300 - 2500 rpm.
Stirring capacity	100 ml - 1000 ml
Motor, S shading coil type	2 pole

The following accessories shall be provided.

Stirring bar	Eight (8) pieces
Grounding wire	One (1) piece
Rubber sheets	Six (6) pieces

(7) Water bath

The constant temperature water bath shall be provided.

The general specifications shall be as follows.

Number	One (1) set
Operating temperature range	Room temperature +5°C to boiling point
Temperature control accuracy	±0.6°C
Temperature distribution accuracy	±1°C
Number of openings	6, 82 mm in diameter each
Inside capacity	approx. 6.5 lit.

The water bath shall be complete with accessories including

4-571

thermometer, stand, clamp, etc.

(8) Direct reading balance

(a) The analytical electronic balance shall be provided and shall have a capacity of 200 g maximum load.

Number	One (1) set
Capacity	200 g/max load
Indication	Fully digital
Readability	0.1 mg
One division of projection scale	10 mg
	AC 110 V, 50 Hz
Standard accessories	One (1) set

(b) One (1) set of top loading electronic balance with vibrationproof desk shall be provided.

Number	One (1) set
Capacity	1 kg load (max.)
Indication	Digital
Readability	0.1 g
Standard accessories	One (1) set
Power	AC 110 V, 50 Hz

(9) Electric refrigerator

One (1) set of electric refrigerator to be used for storage of reagents and samples shall be supplied.

Number	One (1) set
Total capacity	225 lit.
	(Freezer cap:
	52 lit.)
Temperature range	(at 30°C ambient)
Freezing room	-18°C

Refrigerating room	3°C

(10) Shaker

The shaker to be used for agitating, mixing and extracting of samples shall be supplied.

The shaking speed shall be operated by freely selecting speeds from low to high (40 to 300 times/min).

Number	One (1) set
Number of sample	3 pieces (1000 mlit.)
Horizontal shaking	Approx. 40-280 times/min
Vertical shaking	Approx. 40-300 times/min
Timer range	0 to 60 mm
	(minimum 5 min)
Power	AC 110 V 50 Hz

All accessories for this equipment shall be supplied.

(11) Hot plate

One (1) set of hot plate with complete accessories shall be supplied.

The general specification shall be as follows.

Number	One (1) set
Range of temperature	300°C to 400°C
Power	AC 100 V, 1 kw
Size	350 L x 300 W (mm), minimum requirement

(12) Demineralizer

The potable demineralizer shall be provided and installed in water analysis room.

The general specification shall be as follows.

Number	One (1) set

Capacity	25 liter/hour
Total pure water produced in one cycle	400 liters
Resin volume	Cation resin 0.6 liter
	Anion resin 1.2 liter

All required standard accessories for this equipment shall be supplied.

(13) Jar test apparatus (Laboratory flocculator)

The flocculator shall comprise a multiple stirring machine equipped with variable speed drive. Four stainless steel stirrer paddles with arrangement to vary the speed for each independently from 0 rpm to 200 rpm shall be provided.

The flocculator shall be fitted with a fractional horsepower motor, and shall accomodate jars and beakers of 100 ml capacity having 130 mm diameter. The lighting arrangement shall be provided under the base.

The general specifications for this apparatus shall be as follows.

Number	One (1) set
Speed	0 rpm to 200 rpm
Size	500(W) x 220(D) x 480(H) mm

(14) Filteration equipment

Filteration equipment to be used for filtering of testing water shall be provided.

The general specifications shall be as follows.

(a) Mini pump

Number	Two (2) sets
Type	Oilless, diaphragm

Capacity 15 l/min (minimum)

Accessories One (1) set

(b) Filter holder

Three (3) sets of filter holder shall be provided.

Number Three (3) sets

Type Glass

Size Filter holder 47 mm

(a) Standard 2 sets

(b) Milipore filter 0.45 micron cellulose acetate filter discs

(15) Indigo carmine apparatus

Indigo carmine apparatus shall be provided for easy measurement of dissolved oxygen contained in the condensate water and feed water.

Number One (1) set

Measuring range 0 ppb to 170 ppb

Accessories Indigo carmine reagent

(16) Free chlorine tester

Free chlorine tester shall be provided for measuring free chlorine in cooling tower water, drinking water and service water.

This testing method shall comprise the ortho-trigine method.

Number Two (2) sets

The equipment shall be provided with all standard accessories.