

11.1.6 OIL TESTING EQUIPMENT

The oil testing equipment shall be provided and installed in the oil analysis room in the technical building.

(1) Flash point tester

Pensky-Martens Flash Point Testers of JIS-K2265 or ASTM, complete with electrical heaters, electrical stirrer and igniters shall be provided.

The general specification shall be as follows.

Number	One (1) set
Type	Motor agitator 90 rpm to 120 rpm
Power	AC 110 V, 50 Hz

All required accessories for this equipment shall be provided.

(2) Gravity hydrometers

(a) The Contractor shall provide long type hydrometers having an overall length 335 (max) with torpedo shaped bulbs 25 (max) SP.Gr, in maximum scale length of 125 mm, with a maximum permissible error of 0.0005^oSP.Gr. adjustable for use at 15^oC.

The gravity hydrometers shall be installed in the automatic water bath for measuring the specific gravity at constant temperature.

Range (in degrees)	0.600 - 0.650, 0.650 - 0.700
	0.700 - 0.750, 0.750 - 0.800
	0.800 - 0.850, 0.850 - 0.900
	0.900 - 0.950, 0.950 - 1.000
	1.000 - 1.050, 1.050 - 1.100

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(b) Hydrometer jars made of glass with foot and lip shall be provided. The general specification shall be as follows.

Overall height 360 mm \pm 10

Indicated diameter 55 mm \pm 3

Number Three (3) sets

The following hydrometers and thermometers with accessories shall be provided.

(a) Hydrometer 0.750 - 0.800 Five (5) sets

0.800 - 0.850 Five (5) sets

0.850 - 0.950 Five (5) sets

0.950 - 1.000 Five (5) sets

(b) Thermometer 0°C - 100°C Ten (10) sets

(mercury, 0.02°C divisions)

(3) Viscosity water bath

One (1) set of viscosity water bath with complete accessories shall be provided.

Number One (1) set

Measuring range Room temperature to 100°C

Temperature accuracy \pm 0.01°C

Agitating method Forced circulating

(Induction motor)

Temperature control One touch, automatic control

Accessories

(a) Standard One (1) set

(b) Standard set for Cannon method of JISK2283

Range 50 - 400 cst at 50°C Five (5) sets each

2.2 - 50 cst at 30°C Five (5) sets each

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(c) Stop watch

30 sec/cycle, 0.1 sec division

Four (4) sets, 1 min/cycle

0.2 sec division (2) sets

(4) Conradson carbon residue apparatus

The Contractor shall provide the Conradson carbon residue apparatus to determine the amount of carbon residue left after evaporation pyrolysis of oil under a specified condition. This equipment shall comply to JIS-K2270 or ASTM-D189.

All required accessories for this equipment shall be provided.

Number One (1) set

Type Electro heating method

Temperature range 1100°C (max)

900°C (normal service)

Temperature control system By temperature controller

Accessories (a) Platinum crucible

Two (2) sets

(b) Standard One (1) set

(5) Water content measuring apparatus

The Contractor shall supply the water content measuring apparatus for determining water content in oil. This apparatus shall be furnished complete with distillation vessel condenser and four (4) receivers of 10 ml and 25 ml each.

Number Two (2) sets

Accessories (a) Flask heater two (2) sets

(b) 3 sets of all instruments

including condenser,

flask (500 ml), etc.

(c) Standard One (1) set

(6) Pour point tester

The Contractor shall provide the pour point tester for measuring the pour point of oil. This equipment shall be furnished complete with all required standard accessories.

Number One (1) set

Measuring range -12°C

Vessel Metal bath

(7) Centrifuges

Small laboratory centrifuges of 110 V, 50 Hz single phase with adjustable control of motor speed between 1000 rpm to 4000 rpm shall be provided.

The equipment shall be of angle rotor self-balancing type having buckets which accept 15 ml centrifuge tubes.

The motor and rotor shall be completely enclosed.

The general specification shall be as follows.

Number One (1) set

Speed 4000 rpm

Capacity 100 ml x 4

Size 850(W) x 850(D) x 950(H) mm

All required standard accessories shall be provided.

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(8) 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
Temperature range	300°C to 400°C
Power	AC 110 V, 1 kW
Size	350 L x 300 W (mm) minimum requirement

(9) Electric refrigerator

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

Number	One (1) set
Total capacity	225 lit. (Freezer capacity: 52 liters)
Temperature range	(at 30°C ambient)
Freezing room	-18°C
Refrigerating room	3°C

(10) Sulfur content equipment

This equipment shall be supplied for measuring the sulfur contents in fuel oil, and shall be supplied as complete sets.

This equipment shall comprise fixed furnace voltage controller, voltmeter and ammeter, and shall maintain the temperature of 950°C to 1200°C during normal operation.

This equipment shall be in accordance with JIS-K 2541.

Number Two (2) set

Furnace tube Quartz tube Four (4) sets

All required accessories for this equipment, including that to measure sulfur contents in fuel oil, shall be provided.

(11) Measuring equipment of asphalt contents

The Contractor shall supply the two sets of measuring equipment of asphalt contents with necessary accessories required for ensuring measurement of asphalt contents in residual oil.

11.1.7 ANALYTICAL INSTRUMENTS EQUIPMENT

The Contractor shall supply the analytical instruments equipment, and this shall be installed in the analytical instruments room in the technical building.

(1) Calorimeters

This equipment shall be used for measuring the calorific value in fuel oil and light oil, and shall be furnished complete with required standard accessories. The equipment shall be in accordance with JIS-K2279.

Type Bomb calorimeter

Number Two (2) sets

Power AC 110 V, 50 Hz

Accessories (a) Standard one (1) set

(b) Beckman thermometer Six (6) sets

(c) Pressure reducing valve with gauges

Four (4) sets

(2) Direct reading balance

(a) The analytical electronic balance having the capacity for a maximum load of 200 g shall be supplied. The vibrationproof desk shall be supplied. The general specification shall be as follows.

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

(b) One (1) set of top loading electronic balance shall be supplied.

Number	One (1) set
Capacity	2 kg/max load
Indication	Digital
Power	AC 110 V, 50 Hz
Readability	0.1 g
Standard accessories	One (1) set

(c) Analytical electronic balance having the capacity for a load of 200 g shall be supplied. The vibration-proof desk shall be supplied.

The general specification shall be as follows.

Number	One (1) set
Capacity	200 g/max
Indication	Digital

Power 100 V, 50 Hz

Readability 0.01 mg

Standard accessories One (1) set

- (3) Atomic absorption flame spectrophotometer with -CPU and CRT.

The Contractor shall provide the atomic absorption flame spectrophotometer consisting of, but not limited to, hollow cathodic lamp, burner, adjustable slit, etc.

This equipment shall be provided with -CPU and CRT.

The equipment shall be equipped with all necessary accessories to determine the following elements.

- (a) Ca, Cd, Cu, Fe, Mg, Mn, Na, Zn, Al, V, Ni, Si, Pb, Mo, Cr, Sn

The general specification of the equipment shall be as follows.

Number One (1) set

Wavelength 190 nm - 900 nm

Analytical mode Atomic absorption flame

Slit Four (4) stage changeover function

Measuring mode Direct indication and integration

Zero setting Auto Zero by push button operation

- (b) This equipment shall have the following necessary devices to ensure safe operation.

(i) Flowmeter, control fuel and oxydant

(ii) Interlock to prevent ignition unless burner head is in place

(iii) Automatic extinguishing of burner if pressure in fuel and/or oxydant line is too low or if the

line is lost

(c) Compressor

The oilless compressor to be used for the atomic absorption flame spectrophotometer shall be provided.

Number One (1) set

Exhaust velocity 75 liters/min

Motor AC 110 V, 50 Hz

Size Approx. 300(W) x 600(D) x 370(H) mm

(4) Orsat apparatus for boiler flue gas analysis and adjustment of excess air

The Contractor shall supply the following pertinents.

Absorption pipettes of two compartment type.

The front compartment shall comprise glass tubes to increase the absorption area, and the rear compartment shall comprise the solution reservoir. Each pipette shall have a rubber expansion bag to protect the absorbent from the atmosphere.

The burette shall have a capacity of 100 ml inclusive of the bulb at the top. The lower part of the burette shall be graduated from 0 to 50 ml in 0.2 ml divisions.

The burette shall be surrounded by a water jacket, and shall be connected to levelling bottle through rubber tubing.

Two (2) sets of this equipment shall be provided.

11.1.8 FLUE GAS ANALYZER

(1) Nox, Sox O₂ Analyzer

The Contractor shall provide the flue gas analyzer for measuring Nox, Sox and O₂ in flue gas emitted from the power station.

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The general specification shall be as follows.

Number	One (1) set
Measuring	Nox 0 - 200 ppm, 0 - 500 ppm, 0 - 2000 ppm Sox 0 - 200 ppm, 0 - 500 ppm, 0 - 2000 ppm O ₂ 0 - 5%, 0 - 10%, 0 - 25%
Response	Nox, O ₂ Less than 15 sec SO ₂ Less than 30 sec
Accuracy	±0.5%
Power	220 V, 50 Hz

The gas sampler shall be supplied, and shall comprise drain trap, filter, pump, scrubber, converter, etc.

The gas sampler shall be able to handle sample gas of 200°C.

(2) Dust measuring equipment

The Contractor shall provide the dust measuring equipment for measuring the dust contents in flue gas. The equipment shall be complete with all necessary accessories, and shall be in accordance with JIS-Z8808.

This equipment shall be provided complete with suction pipe, connection tube, SO₂ absorption bottle, mist separator, vacuum pump, manometer oil mist separator, gas meter, etc.

The dust collector shall use filter paper, and shall consist of suction nozzle, filter paper and paper holder.

One (1) set of dust measuring equipment with all standard

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accessories shall be provided.

(3) Flow velocity measuring equipment

The flow velocity measuring equipment shall be provided and shall be used for measuring static pressure and total pressure by calculating the flow velocity of flue gas at the flue gas duct. This equipment shall be complete with measuring tube and inclined manometer.

One (1) set of flow velocity measuring equipment shall be provided, and shall contain all standard accessories.

(4) Sulfur oxides measuring equipment

The Contractor shall provide the sulfur oxides measuring equipment for measuring sulfur oxides in flue gas. The equipment shall be supplied complete with gas sampling tube, adapter, filter materials, heat insulator, absorbing bottle, glass filter, gas drying column, flow rate adjusting cock, closed type suction pump (0.5 to 5 l/ min), pressure gauge, gas meter, etc.

This equipment shall be in accordance with JIS-K0103.

One (1) set of sulfur oxides measuring equipment shall be supplied with all standard accessories.

(5) Nitrogen oxides measuring equipment

The Contractor shall provide the nitrogen oxides measuring equipment for measuring the nitrogen oxides in flue gas.

The equipment shall be supplied complete with gas sampling tube, insulating material, filter medium, heater, three way cock, silicone rubber tube, sampling flask, desiccating agent, suction pump, washing bottle, vacuum manometer, etc.

The material for the gas sampling tube shall be anti-

corrosive so as to withstand corrosive gas contained in exhaust gas.

This equipment shall be in accordance with JIS-K0104.

One (1) set of nitrogen oxides measuring equipment shall be supplied, and shall include all standard accessories.

11.1.9 APPARATUS LIST

All apparatus shall be of SHIBATA manufacture, or equivalent.

	<u>Quantity</u>
(1) Volumetric flasks	
100 ml	75
250 ml	25
500 ml	25
1000 ml	20
(2) Pipettes	
1 ml	20
2 ml	20
5 ml	20
10 ml	20
20 ml	10
25 ml	10
(3) Erlenmayer flasks	
50 ml	30
100 ml	50
250 ml	100
300 ml	50
500 ml	50
(4) Measuring hole pipette	
5 ml	10
10 ml	10
20 ml	10
25 ml	10
50 ml	10

	<u>Quantity</u>
(5) Beakers	
50 ml	50
100 ml	100
200 ml	100
250 ml	100
500 ml	50
1000 ml	25
2000 ml	25
(6) Measuring cylinders	
10 ml	20
25 ml	20
50 ml	20
100 ml	30
250 ml	10
500 ml	10
1000 ml	20
(7) Nickel crucibles	
50 ml	20
100 ml	20
(8) Porcelain crucibles	
20 ml	50
50 ml	100
100 ml	100
200 ml	50

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(9) Burettes		<u>Quantity</u>	
(a) Automatic		(b) Normal	
	<u>Quantity</u>		<u>Quantity</u>
2 ml	10	2 ml	10
5 ml	10	5 ml	10
10 ml	10	10 ml	10
	(4 shall be colored)		
25 ml	20	25 ml	20

(10) Bottles			
(a) Colored		(b) White	
Wide-mouthed		Wide-mouthed	
	<u>Quantity</u>		<u>Quantity</u>
250 ml	30	250 ml	30
500 ml	10	500 ml	10
1000 ml	5	1000 ml	10
5 l	5	5 l	5
		10 l	5
Narrow-mouthed		Narrow-mouthed	
	<u>Quantity</u>		<u>Quantity</u>
250 ml	30	250 ml	30
500 ml	10	500 ml	10
1000 ml	10	1000 ml	10

(11) Distillation apparatus 5
(Pyrex glass with condenser)

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	<u>Quantity</u>
(12) BOD bottle with cap	
Clear 200 ml	20
Clear 300 ml	20
(13) Washing bottle (Polyethylene)	
500 ml	20
1000 ml	20
(14) Bottle (Polyethylene)	
Amber 500 ml	50
Amber 1000 ml	50
Clear 500 ml	50
Clear 1000 ml	50
(15) Winkler flask	
100 ml	20
300 ml	20
500 ml	10
(16) Separate funnel	
250 ml	15
500 ml	15
1000 ml	15
(17) Nessler tube	
50 ml	20
100 ml	20
(18) Flasks (Flat bottom)	
250 ml	20
500 ml	10
1000 ml	10

	<u>Quantity</u>
(19) Plastic squeeze bottles	
500 ml	10
1000 ml	10
(20) Clamps	30
(21) Support clamps (Ring type)	30
(22) Triangles (covered with nickel-chromium wire silica)	30
(23) Bottles (Polyethylene)	
(with friction fitted cap to protect contents)	
500 ml	100
1000 ml	100
(24) Spatulas (Stainless steel)	20
(25) Desiccators	
300 mm	5
(26) Burette stand	5
(with thirty (30) supports)	
(27) Tripod	10
(28) Wire squares	100
(with asbestos centers)	
200 ml	40
(29) Petri dish	
90 x 20 mm	50
(30) pH test paper	
Universal (9 mm)	30

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		<u>Quantity</u>
(31) Filter paper		
	9 cm 11 cm	
Black band	30 pcs.	30 pcs.
Blue band	30 pcs.	30 pcs.
White band	30 pcs.	30 pcs.
(32) Filter (used for suspended solids)		
	30 mm 1 m	
		100 pcs.
(33) Millipore filter		
	0.45 m	
		200 pcs.
(34) Vinyl tube		
5 x 7 mm		40 m
10 x 10 mm		40 m
20 x 28 mm		40 m
(35) Stop cock		
Straight bore 8 mm		20
Three-way 8 mm		20
(36) Three-prong grip clamp		
	50 mm	20
	100 mm	20

	<u>Quantity</u>
(37) Filter paper	
	9 cm
Black band	20
Blue band	20
White band	20
Filter paper (normal)	2 boxes
(38) pH test paper (roll type)	
(39) Beckman thermometer	5 sets
(40) PH buffer powder	
PH 7	10 sets
PH 9	10 sets
(41) Mortars with pestles	
8 cm	1
15 cm	2
20 cm	1
(42) Porcelain capsules	
3 cm	20
4 cm	20
5 cm	20
(43) Glass funnel (with groove)	
8 cm	15
10 cm	15
15 cm	15
(44) Plastic funnel	
4 cm	10
8 cm	10
10 cm	10

				<u>Quantity</u>
(45)	Watch glasses			
	10 cm			25
	12 cm			25
	15 cm			25
(46)	Glass rod			
	0.5 cm	2 kg	0.7 cm	2 kg
(47)	Glass tubing			
	0.5 cm	2 kg	0.7 cm	2 kg
(48)	Rubber tubing			
	0.5 cm			20 m
	1 cm			20 m
	2 cm			20 m
(49)	Thermometer (Mercury)			
	100°C			30
	250°C			10
(50)	Bunsen burner			10
(51)	Tube holders			4
(52)	Test tubes			250
(53)	Crucible tongs (Nickel)			5
(54)	Separating funnels (globe shaped, with stopper at bottom)			
	250 ml			10
	500 ml			10
	1000 ml			10
(55)	Cork borers			1 set

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	<u>Quantity</u>
(56) Measuring cylinder (with cap)	
50 ml	12
100 ml	12
(57) Bottle droppers	
25 ml	20
50 ml	20
(58) Teflon beakers	
200 ml	20
(59) Pipette holder	2
(60) Pincette	20
(61) Pinch cock	100
(62) Carboy (screw neck with spigot, polyethylene)	
25 liters	4
(63) Paper (industrial absorbent tissues, soft, white, non- abrasive, non-linting, for cleaning spectrophotometer cells)	
Size 5 x 9 in	50 boxes
15 x 18 in	50 boxes
(64) Centrifuge tubes with stopper, conical shape	
10 ml, with measure	10
(65) Dishes (evaporating type, round bottom)	
100 mm	10
(66) Dishes (culture)	
90 mm	50

	<u>Quantity</u>
(67) Stopcocks	
Straight bore 8 mm	20
Three-way, T bore 8 mm	20
(68) Clamps (versatile, three prong grips)	
50 mm	10
100 mm	10
(69) Jack (laboratory, stainless steel 200 mm x 200 mm)	2
(70) Electric heater (1200 W, allowing heat control over entire range)	2
(71) Platinum plate	
Number	One (1) set
Capacity	100 ml
(72) Platinum pot	
Number	One (1) set (with cover)
Capacity	30 ml
(73) Sampler	
Number	Two (2) sets
Type	(JIS K2251, JIS K2832)
Capacity	1,000 ml
Accessories	Two (2) sets

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11.1.10 REAGENTS LIST

The grade of all reagents shall be of superior quality.

	<u>Material</u>	<u>Specifications</u>	<u>Chemical Formula</u>	<u>Quantity</u>	
(1)	Sulfuric acid	Concentrated	H ₂ SO ₄	20 l	(GR)
(2)	Phenolphthalein	Indicator	C ₂₀ H ₁₄ O ₄	50 gr	(GR)
(3)	Ethyl alcohol		C ₂ H ₅ OH	20 l	(EP)
(4)	Methyl orange	Indicator	-	50 gr	(GR)
(5)	Hydrochloric acid	Concentrated	HCl	20 l	(EP)
(6)	Strontium chloride		SrCl ₂ ·6H ₂ O	100 g	(GR)
(7)	Barium chloride		BaCl ₂ ·2H ₂ O	1 kg	(EP)
(8)	Sodium hydroxide		NaOH	5 kg	(EP)
(9)	Potassium chromate		K ₂ CrO ₄	2 kg	(GR)
(10)	Silver nitrate		AgNO ₃	2 kg	(GR)
(11)	Sodium chloride		NaCl	4 kg	(EP)
(12)	Mercuric nitrate		Hg(NO ₃) ₂ ·H ₂ O	200 gr	(GR)
(13)	Nitric acid	Concentrated	HNO ₃	10 l	(EP)
(14)	Diphenyl carbazone	Indicator	C ₂₆ H ₂₆ N ₈ O ₂	100 g	(GR)
(15)	Bromophenol blue	Indicator	C ₁₉ H ₁₀ B ₁₄ O ₅ S	100 g	(GR)
(16)	Ammonium oxalate		(NH ₄) ₂ C ₂ O ₄ ·H ₂ O	2 kg	(GR)
(17)	Ammonium hydroxide	Concentrated	NH ₄ OH	30 l	(EP)
(18)	Potassium permanganate		KMnO ₄	1 kg	(GR)
(19)	Sodiumthiosulfate	0.1N	Na ₂ S ₂ O ₃	5 l	(GR)
(20)	Sodiumthiosulfate		Na ₂ S ₂ O ₃ ·5H ₂ O	1 kg	(GR)
(21)	Starch		(C ₆ H ₅ O ₅) _n	1 kg	(EP)

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<u>Material</u>	<u>Specifications</u>	<u>Chemical Formula</u>	<u>Quantity</u>	
(22) Sodium sulfide		$\text{Na}_2\text{S} \cdot 9\text{H}_2\text{O}$	1 kg	(GR)
(23) Potassium sodium tartrate		$\text{KNaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$	3 kg	(GR)
(24) Disodium EDTA		$(\text{H}_2\text{COO})_4\text{N}_2\text{C}_2\text{H}_6\text{Na}_2 \cdot 2\text{H}_2\text{O}$	4 kg	(GR)
(25) Magnesium chloride		$\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$	1 kg	(EP)
(26) Ammonium chloride		NH_4Cl	2 kg	(EP)
(27) Eriochrome black T indicator		$\text{C}_{20}\text{H}_{12}\text{NaO}_7\text{S}$	100 gr	(GR)
(28) Sodium carbonate		Na_2CO_3	2 kg	(GR)
(29) Methyl alcohol		CH_3OH	10 l	(EP)
(30) Calcium carbonate		CaCO_3	1 kg	(GR)
(31) Methyl red Indicator		$\text{C}_{15}\text{H}_{15}\text{N}_3\text{O}_2$	25 gr	(GR)
(32) P-Dimethyl amino benzaldehyde		$(\text{CH}_3)_2\text{NC}_6\text{H}_4\text{CHO}$	100 gr	(GR)
(33) Hydrazine dihydrochloride		$\text{N}_2\text{H}_4 \cdot 2\text{HCl}$	500 gr	(EP)
(34) Glycerin		$\text{C}_3\text{H}_5\text{-(OH)}_3$	3 l	(EP)
(35) Potassium iodide		KI	2 kg	(EP)
(36) Indigo carmine		-	100 gr	(GR)
(37) Potassium hydroxide		KOH	10 kg	(EP)
(38) Dextrose		$\text{C}_6\text{H}_{12}\text{O}_6$	500 gr	(EP)
(39) Cobalt chloride hexa hydrate		$\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$	500 gr	(GR)
(40) Ferric III chloride		$\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$	1 kg	(GR)
(41) Copper sulfate		$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$	1 kg	(GR)
(42) Sodium silicate		$\text{Na}_2\text{SiO}_3 \cdot 9\text{H}_2\text{O}$	500 gr	(EP)

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<u>Material</u>	<u>Specifications</u>	<u>Chemical Formula</u>	<u>Quantity</u>
(43) Buffer tablet for hardness determina- tion with EDTA	-		5 bottles, each contain- ing 1000 tablets. (GR)
(44) Ammonium acetate		$\text{NH}_4\text{C}_2\text{H}_3\text{O}_2$	4 kg (EP)
(45) Acetic acid		CH_3COOH	10 l (EP)
(46) Congo red	Indicator	$\text{C}_{32}\text{H}_{22}\text{N}_6\text{Na}_2\text{O}_6\text{S}_2$	100 gr (GR)
(47) Chloroform		CHCl_3	2 l (EP)
(48) Copper (metal)		Cu	20 gr (GR)
(49) Sodium citrate		$\text{C}_3\text{H}_4(\text{OH})(\text{CO}_2\text{Na})_3 \cdot 2\text{H}_2\text{O}$	2 kg (GR)
(50) Sodium acetate		$\text{NaC}_2\text{H}_3\text{O}_2 \cdot 3\text{H}_2\text{O}$	5 kg (GR)
(51) 1-Amino 2-napthol 4-Sulphonic acid		$\text{H}_2\text{NC}_{10}\text{H}_5(\text{OH})\text{SO}_3\text{H}$	1 kg (GR)
(52) Sodium sulfite anhydrous		Na_2SO_3	2 kg (EP)
(53) Sodim pyrosulfite		$\text{Na}_2\text{S}_2\text{O}_5$	3 kg (GR)
(54) Ammonium meta vanadate		NH_4VO_3	1 kg (GR)
(55) Potassium mono phosphate		KH_2PO_4	2 kg (GR)
(56) Tin chloride		$\text{SnCl}_2 \cdot 2\text{H}_2\text{O}$	2 kg (GR)
(57) Sodium chromate		NaCrO_4	2 kg (GR)
(58) Oxalic acid		$\text{H}_2\text{C}_2\text{O}_4$	4 kg (GR)
(59) Potassium hydrogen phthalate		$\text{KHC}_8\text{H}_4\text{O}_4$	2 kg (GR)

<u>Material</u>	<u>Specifications</u>	<u>Chemical Formula</u>	<u>Quantity</u>	
(60) Disodiumphosphate		Na_2HPO_4	2 kg	(GR)
(61) Hydrofluoric acid		HF	500 gr	(EP)
(62) Perchloric acid		HClO_4	1 l	(EP)
(63) Isopropyl alcohol		$\text{C}_3\text{H}_8\text{O}$	20 l	(GR)
(64) N-Hexyl alcohol		$\text{CH}_3(\text{CH}_2)_4\text{CH}_2\text{OH}$	20 l	(GR)
(65) Iso-amylalcohol		$\text{C}_5\text{H}_{11}\text{OH}$	10 l	(GR)
(66) Baso-phenontroline		-	10 gr	(GR)
(67) Ortephenanthroline		$\text{C}_{12}\text{H}_8\text{N}_2 \cdot \text{HCl} \cdot \text{H}_2\text{O}$	25 gr	(GR)
(68) Iron ammonium sulfate		$\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot \text{H}_2\text{O}$	1 kg	(GR)
(69) Aluminium nitrate		$\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$	1 kg	(GR)
(70) Ammonium thiocyanaide		NH_4SCN	1 kg	(GR)
(71) Potassium chloride		KCl	2 kg	(GP)
(72) Bromocresol green	Indicator	$\text{C}_{21}\text{H}_{14}\text{Br}_4\text{O}_5\text{S}$	100 g	(GR)
(73) Thymol blue	Indicator	$\text{C}_{27}\text{H}_{30}\text{O}_5\text{S}$	"	(GR)
(74) Kaolin		-	1 kg	(GR)
(75) Zinc (metal)		Zn	1 kg	(GR)
(76) Zinc chloride		ZnCl_2	1 kg	(GR)
(77) NN-Indicator		-	100 g	(GR)
(78) Potassium sulfate		K_2SO_4	2 kg	(EP)
(79) Hydroxylamine hydrochloride		$\text{NH}_2\text{OH} \cdot \text{HCl}$	2 kg	(GR)

<u>Material</u>	<u>Specifications</u>	<u>Chemical Formula</u>	<u>Quantity</u>	
(80) Manganium sulfate		$MnSO_4 \cdot 4H_2O$	2 kg	(EP)
(81) Potassium iodate		KIO_3	1 kg	(GR)
(82) Sodium hydrogencarbonate		$NaHCO_3$	1 kg	(EP)
(83) Sodium azide		NaN_3	500 g	(GR)
(84) Barium chloride		$BaCl_2 \cdot 2H_2O$	1 kg	(EP)
(85) Ferric ammonium sulfate		$Fe_2(SO_4)_3 \cdot (NH_4)_2SO_4 \cdot 24H_2O$	1 kg	(EP)
(86) Potassium thiocyanate		$KSCN$	1 kg	(EP)
(87) Bromothymol blue	Indicator	$C_{27}H_{28}Br_2O_5S$	100 g	(GR)
(88) Calcium chloride		$CaCl_2 \cdot H_2O$	1 kg	(EP)
(89) Barium chromate		$BaCrO_4$	1 kg	(GR)
(90) Tartaric acid		$C_2H_2(OH)_2(COOH)_2$	4 kg	(GR)
(91) Mercuric chloride		$HgCl_2$	1 kg	(GR)
(92) Zinc sulfate		$ZnSO_4 \cdot 7H_2O$	1 kg	(EP)
(93) Iodine		I_2	1 kg	(GR)
(94) Basocaproin		$(CH_3)_2(C_6H_5)_2$ $C_{12}H_{14}N_2$	10 g	(GR)
(95) Zincon		$C_6H_3(SO_3H)(OH)N_2$ $OC_6H_5 \cdot NNHC_6H_4(COOH)$	10 g	(GR)
(96) Xylenol orange	Indicator	$C_{31}H_{30}N_2Na_2O_{13}S$	10 g	(GR)
(97) Iso-propylalcohol		$(CH_3)_2CHOH$	10 l	(EP)

	<u>Material</u>	<u>Specifications</u>	<u>Chemical Formula</u>	<u>Quantity</u>	
(98)	Ammonium molybdate		$(\text{NH}_4)_6\text{Mo}_7\text{O}_{24} \cdot 4\text{H}_2\text{O}$	5 kg	(GR)
(99)	Sulfosalicylic acid		$\text{HO}_3\text{SC}_6\text{H}_3(\text{OH})\text{COOH} \cdot 2\text{H}_2\text{O}$	500 g	(GR)
(100)	Ammonium persulfate		$(\text{NH}_4)_2\text{S}_2\text{O}_8$	500 gr	(GR)
(101)	Ammonium citrate		$(\text{NH}_4)_2\text{HC}_6\text{H}_5\text{O}_7$	2 kg	(GR)
(102)	Dimethylglyoxime		$(\text{CH}_3)_2\text{C}_2(\text{NOH})_2$	500 gr	(GR)
(103)	Ammonium nickelsulfate		$\text{NiSO}_4(\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$	500 gr	(EP)
(104)	Silversulfate		Ag_2SO_4	2 kg	(EP)
(105)	Sodium oxalate		$\text{Na}_2\text{C}_2\text{O}_4$	500 gr	(GR)
(106)	Sodium chlorate		NaOCl	500 ml	(EP)
(107)	Aluminium sulfate		$\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$	500 gr	(EP)
(108)	Normal hexane		C_6H_{14}	10 l	(GR)
(109)	Para-phenylendiamine		$\text{NH}_2 \cdot \text{C}_6\text{H}_4\text{NH}_2$	100 g	(GR)
(110)	Aniline		$\text{C}_6\text{H}_5\text{NH}_2$	1 l	(EP)
(111)	-naphthylamine		$\text{C}_{10}\text{H}_7\text{NH}_2$	500 gr	(GR)
(112)	Zinc (powder)		Zn	1 kg	(EP)
(113)	Sodium nitrite		NaNO_2	1 kg	(EP)
(114)	Xylol		$\text{C}_6\text{H}_4(\text{CH}_3)_2$	10 l	(EP)
(115)	Hydroperoxide		H_2O_2	5 l	(EP)
(116)	Sulfamic acid		HOSO_2NH_2	25 gr	(GR)

	<u>Material</u>	<u>Specifications</u>	<u>Chemical Formula</u>	<u>Quantity</u>	
(117)	Methylene blue	Indicator	$C_{16}H_{18}ClN_3S \cdot nH_2O$	100 g	(GR)
(118)	Benzoic acid (for calory test)		C_6H_5COOH	200 gr	(GR)
(119)	Toluene		$C_6H_5CH_3$	5 l	(EP)
(120)	Para-rosaniline hydrochloride		-	100 gr	(GR)
(121)	Formalin		HCHO	1 l	(EP)
(122)	Potassium hydrogen phtholate		$C_8H_4(COOK)(COOH)$	500 g	(GR)
(123)	Sodium bromide		NaBr	500 g	(GR)
(124)	Borax		$Na_2B_4O_7 \cdot 10H_2O$	500 g	(EP)
(125)	Methyl isobutyl ketone		$CH_3COCH_2CH(CH_3)_2$	2 kg	(GR)
(126)	Silver chloride		AgCl	1 kg	(GR)
(127)	N.A.N.A.	Indicator	-	100 g	(GR)
(128)	Lanthanum (III) oxide		La_2O_3	500 g	(GR)
(129)	Magnesium oxide		MgO	500 g	(GR)
(130)	Fluorescein-Na		$C_{20}H_{10}O_5Na_5$	500 g	(GR)
(131)	Sodium acetate (trihydrate)		$CH_3COONa \cdot 3H_2O$	500 g	(GR)
(132)	Ammonium molybdate		$(NH_4)_2MoO_4$	4 kg	(GR)
(133)	Sodium hydrogensulfate		$NaHSO_3$	2 kg	(GR)
(134)	Phenol		C_6H_5OH	500 g	(GR)

	<u>Material</u>	<u>Specifications</u>	<u>Chemical Formula</u>	<u>Quantity</u>	
(135)	Acetone		CH_3COCH_3	2 kg	(GR)
(136)	Cuprizone	Indicator	$\text{C}_6\text{H}_{10}\text{NNHCOCONH}$ $-\text{NC}_6\text{H}_{10}$	10 g	
(137)	Triethanolamine		$\text{N}(\text{CH}_2\text{CH}_2\text{OH})_3$	500 g	(GR)
(138)	D.D.C	Indicator	$(\text{C}_2\text{H}_5)_2\text{NCS}_2\text{Na} \cdot 3\text{H}_2\text{O}$	10 g	
(139)	T.P.T.Z	Indicator	$(\text{C}_5\text{H}_4\text{N})_3\text{C}_3\text{N}_3$	"	
(140)	Nitrobenzene		$\text{C}_6\text{H}_5\text{NO}_2$	1 kg	(EP)
(141)	Sodium perchlorate		$\text{NaClO}_4 \cdot \text{H}_2\text{O}$	1 kg	(EP)
(142)	Sulfanilic acid		$\text{N}_2\text{NC}_6\text{H}_4\text{SO}_3\text{H}$	500 g	(GR)
(143)	3,3'-Dimethyl- benzidine	Indicator	$\text{C}_{14}\text{H}_{16}\text{N}_2$	10 g	
(144)	Potassium dichromate		$\text{K}_2\text{Cr}_2\text{O}_7$	500 g	(GR)
(145)	Sodium phrophosphate		$\text{Na}_4\text{P}_2\text{O}_7 \cdot 10\text{H}_2\text{O}$	500 g	(GR)
(146)	Strontium chloride -		$\text{SrCl}_2 \cdot 6\text{H}_2\text{O}$	500 g	(EP)
(147)	Brucine	Indicator	$\text{C}_{23}\text{H}_{26}\text{N}_2\text{O}_4$	10 g	
(148)	N(1-Naphthyl) ethylenediamine dihydrochloride	Indicator	$\text{C}_{10}\text{H}_7\text{HNCH}_2\text{CH}_2\text{NH}_2 \cdot$ 2HCl	100 g	(GR)
(149)	N.N-Dimethyl- p-phenylenediamine	Indicator	$\text{C}_6\text{H}_4(\text{NH}_2)[\text{N}(\text{CH}_3)_2] \cdot$ 2HCl	100 g	(GR)
(150)	Calcium standard solution		Ca	100 g	

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	<u>Material</u>	<u>Specifications</u>	<u>Chemical Formula</u>	<u>Quantity</u>
(151)	Cadmium standard solution		Cd	100 g
(152)	Copper standard solution		Cu	100 g
(153)	Iron standard solution		Fe	100 g
(154)	Magnesium standard solution		Mg	100 g
(155)	Manganese standard solution		Mn	100 g
(156)	Sodium standard solution		Na	100 g
(157)	Zinc standard solution		Zn	100 g
(158)	Aluminium standard solution		Al	100 g
(159)	Vanadium standard solution		V	100 g
(160)	Nickel standard solution		Ni	100 g
(161)	Silicon standard solution		Si	100 g
(162)	Lead standard solution		Pb	100 g
(163)	Molybdenum standard solution		Mo	100 g

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	<u>Material</u>	<u>Specifications</u>	<u>Chemical Formula</u>	<u>Quantity</u>	
(164)	Chromium standard solution		Cr	100 g	
(165)	Tin standard solution		Sn	100 g	
(166)	Potassium nitrate		KNO_3	500 g	(GR)
(167)	Sulfuric acid, fuming		$H_2SO_4 \cdot XSO_3$	3 l	(GR)

Note: GR: Guarantee reagent

EP: Extra pure reagent

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12. REPAIR ROOM INSTRUMENTS

12.1 SCOPE OF SUPPLY

- (1) The instruments and devices listed in the INSTRUMENTS LIST shall be provided by the Contractor.
- (2) All required installation work and accessories shall be supplied by the Contractor.

12.2 GENERAL INFORMATION

(1) Applicable standards and codes

The instruments and devices shall be in conformity with the requirements of Clause 6 of "Applicable Standards and Codes" in Part I.

(2) Testing

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

(A) Shop test

- (a) Material test
- (b) Dimension check and visible inspection
- (c) Operation test

(B) Field test

- (a) Operation test

(3) Power source

The power source for all instruments and measurement devices shall be 220 V AC or internal battery.

- (4) All furniture and fixtures of the best quality shall be procured and provided locally wherever possible.

- (5) The Contractor shall furnish and install the items mentioned below, and shall design the repair room.
- (6) One (1) set ventilation fan, chamber for hot bath shall be installed with all necessary Pertinents.
- (7) One (1) set draining floor shall be installed at corner of the room with all necessary Pertinents.

12.3 INSTRUMENTS LIST

12.3.1 MECHANICAL/ELECTRONIC INSTRUMENTS

<u>Item</u>	<u>Quantity</u>	<u>Specification</u>	<u>Remarks</u>
(1) Deadweight pressure gauge tester 30K	1	0 - 30 kg/cm ² g	NAGANO PD12-30 or equivalent with *1 accessories
(2) - Ditto - 50K	1	0 - 50 "	NAGANO PD12-50 or equivalent with *2 accessories
(3) - Ditto - 500K with gauge tester table	1	0 - 500 "	NAGANO PD22-500 or equivalent with *3 accessories
(4) Vacuum gauge tester with pump 2K	1	0 - 1,500 m/mHg 0 - 2 kg/cm ² g	NAGANO PM42-231 or equivalent with *4 accessories
(5) Standard pressure gauge set (200 dia) - 76Hg - 350K	2	-76cmHg - 0, 0 - 350 kg/cm ² g 17 Kinds	NAGANO GA21-243 or equivalent
(6) Oxygen analyzer (Portable) 0 - 25%	1	0 - 5, 10, 25% ₂ 0 - 10mV, 1V	NGK SCP-X or equivalent with *5* accessories

1
2
3
1

<u>Item</u>	<u>Quantity</u>	<u>Specification</u>	<u>Remarks</u>
(7) Tool set for mechanical instrument include fitting set, reducing valve, press gauge	5		YOKOGAWA 6925-1000, 5497, 5422, or equivalent
(8) Tool set for electrical instrument	5		YOKOGAWA 6925-2000 & 6925-6000 or equivalent
(9) Maintenance tool set	2		Tool set detail ^{*6}
(10) Digital manometer 20K	1	0 - 10, 20 kg/cm ²	YOKOGAWA, 2654-21-2 or equivalent
(11) - Ditto - 2500 mm aq.	1	0 - 1000, 2500 m/m H ₂ O	YOKOGAWA 2654-24-2 or equivalent
(12) Universal digital meter 7 segment	1	mV, V, Ω, KΩ, MΩ	YOKOGAWA 2501A21 or equivalent
(13) Decade resistance box 0.001/100 Ω x 10	2	0.1 - 1, 111.210Ω	YOKOGAWA 2793-01 or equivalent
(14) Multi-pen recorder 8 pen	1	13 range x 250 mm	YOKOGAWA 3701-82 or equivalent with ^{*7} accessories

<u>Item</u>	<u>Quantity</u>	<u>Specification</u>	<u>Remarks</u>
(15) Portable DC V/A (Standard) 1/100 mA x 10mV/100V	2	0 - 1 - 100mA, 0 - 10 - 100mV - 100V	YOKOGAWA 255400-2 or equivalent
(16) Voltage/current (Standard) 1/100mA X 10mV/10V	2	DC/1 - 100mA, 10 - 100mV, 1 - 10V Power AC 110V 50/60Hz	YOKOGAWA 2553-41-2 or equivalent
(17) Pneumatic pressure (Standard) 2K	2	0 - 2 kg/cm ² g, 0 - 200 Kpa input press 2.8K \pm 0.2K air	YOKOGAWA 2656-23 or equivalent
(18) Revolution meter with discharge tube (Digital) 18,000 rpm	1	4 digit, 18 - 180 rpm x 1, x10, x100 Xenon tube, RFH350F	RIKEN DENKI S2-1 or equivalent
(19) - Ditto - with Photo Probe 20,000 rpm	1	5 digit, 60 - 20,000 rpm	YOKOGAWA 3631 or equivalent
(20) H ₂ gas leakage detector 100 ppm/LEL	1	0 - 100/1,000 rpm H ₂ 0 - 20/100% LEL H ₂ Hydrogen specify	RIKEN KEIKI SP-237-H or equivalent

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<u>Item</u>	<u>Quantity</u>	<u>Specification</u>	<u>Remarks</u>
(21) Vibration meter (Digital) 20 cm/s	2	ACC 0 - 19.99G, Velc 0 - 19.99 cm/s DISP 0 - 1.999 min P-D	SHOWA SOKKI COP. 1332 or equivalent with *6 accessories
(22) Precision temperature calibration bath 300°C	1	Max. 300°C, bath 1800cc AC 110V - 2kW	ISUZU SHOJI 10B-20 or equivalent
(23) Standard thermometer Set 0 - 360°C	2	1/10° div 450 & annealed glass	TOKYO KEIRYOKI CO-0010
(24) Portable calibrator	1	200mA, 100mV - 30V, TC output 5 degit 1V - 30V (measure)	YOKOGAWA 2422-01+B9638CR/BM or equivalent
(25) Portable multi thermometer (Digital) 6ch	1	100mV, 1V, 10V, -200 - 1000°C	YOKOGAWA 2423-01 or equivalent
(26) Oscilloscope 4ch x 100 MHz	1	6" CRT 100MHz - 3db(x1), 50MHz - 3db(x5) Power 100/115/220-240 VAC.	IWATSU Electric Co. SS-7611 or equivalent

<u>Item</u>	<u>Quantity</u>	<u>Specification</u>	<u>Remarks</u>
(27) Portable hybrid recorder 12ch	1	DC/V, TC, RTD, 12ch/5sec Chart 150 m/m x 100 rolls	YOKOGAWA 308723 or equivalent
(28) Portable thickness meter	1	4 digit, 5MHz/1.2 - 200m/m	KETT Electric Co. VTM-100 or equivalent
(29) Electronic digital stopwatch	2	FE type, 1/100 sec Solar cell	SEIKO TBZ
(30) Soldering irons with very low leakage current with accessory	2	25W, 60 W/set each	Hozan tool ind, H545/H-56/H58 or equivalent
(31) Working table with drawer	2	Hardend wood 33t (Top plate) 1,000 kg load 1800W x 750D	UNION DN-1800FL2
(32) Cupboard for instruments	4	SUS/1760W x 400D x 880H	LION JIMUKI CO. 630
(33) Rack for spare parts	3	SUS/1500W x 450D x 1800H	LION JIMUKI CO. 5366P

<u>Item</u>	<u>Quantity</u>	<u>Specification</u>	<u>Remarks</u>
(34) Cupboard for instruction booklets	4	SUS/glass window 1760W x 400D x 880H	LION JIMUKI CO. 635
(35) Desk	3	Top plate 30t, 3 drawer 1800W x 450D x 740H	LION JIMUKI CO. 442-19
(36) Chair	6	405 x 370 m/m seat	LION JIMUKI CO. 440-60
(37) Flare tool set	2	1/8 - 3/4", 6 - 16 m/m	IMPERIAL 227FA+500FBM+350FHA
(38) Air purge gun with air hose	2	Max. pressure 7kg/cm ²	W301-ES
(39) Distance measure	2	0.9 - 45m, 33KHz 4 degit	SONINI50 COATING MS CO
(40) Electric vacuum cleaner	1	AC 100/110V - 1,000W, Code 8 m	HITACHI CV-97A or equivalent

12.3.2 ELECTRICAL/ELECTRONIC INSTRUMENTS

<u>Item</u>	<u>Quantity</u>	<u>Specification</u>	<u>Remarks</u>
(1) DC ammeter 3A	1	0.1/0.3/1/3A	YOKOGAWA 2011-36 or equivalent
(2) - Ditto - 30A	1	1/3/10/30A	ditto 2011-37 "
(3) DC voltmeter 100V	1	3/10/30/100V	ditto 2011-39 "
(4) - Ditto - 1000V	1	30/100/300/1,000V	ditto 2011-40 "
(5) DC ammeter and voltmeter (17 range)	2	50mV 1,000V 1 30A	ditto 2012-00 "
(6) AC ammeter 5A	3	0.5/1/5A	ditto 2013-12 "
(7) - Ditto - 20A	1	5/10/20A	ditto 2013-13 "
(8) - Ditto - 100A	3	10/20/50/100A	ditto 2013-14 "
(9) AC voltmeter 75V	1	30/75V	ditto 2013-16 "
(10) - Ditto - 300V	3	150/300V	ditto 2013-18 "

<u>Item</u>	<u>Quantity</u>	<u>Specification</u>	<u>Remarks</u>
(11) AC ammeter and voltmeter (13 range)	2	0.15 30A 30 750V	YOKOGAWA 2414-00 or equivalent
(12) Watt meter (for 3 phase) 3A/240V	1	120/140V, 1/5A	ditto 2042-02 "
(13) Frequency meter 45-65Hz/240V	1	120/240V, 45 65Hz	ditto 2038-31 "
(14) Shunt	3	100, 300, 500/100mV	YOKOGAWA 2215 and 2216 or equivalent
(15) Current transformer	2	100/300/750/1,500A	YOKOGAWA 2242-00 or equivalent
(16) Potential transformer 6,600V/110V	2	3,300/6,600V	YOKOGAWA 2262-00 or equivalent
(17) Noise level meter 130dB	1	30dB - 130dB 32 - 8,000Hz	YOKOGAWA 3604-00 or equivalent
(18) Revolution meter 20,000 rpm	1	5 digit, 2,000/20,000rpm/ m/min, mm/s	YOKOGAWA 363300/363903/363904 or equivalent

<u>Item</u>	<u>Quantity</u>	<u>Specification</u>	<u>Remarks</u>
(19) Tester	3	DC0.3 - 1,200V/AC3 - 1,200V DC0.01 - 1,200mA, 0 - 20KΩ	YOKOGAWA 3201 or equivalent
(20) Auto megger 250V	2	250 V/50 M ohm	YOKOGAWA 321322 or equivalent
(21) - Ditto - 500V	2	500 V/1,000 M ohm	YOKOGAWA 321323 or equivalent
(22) - Ditto - 1KV	2	1,000 V/2,000 M ohm	YOKOGAWA 321325 or equivalent
(23) Frequency counter (Digital)	1	200 MHz 9 digit	IMATSU ELECTRONIC SC-7201 or equivalent
(24) Ground resistance meter 1K/30V	1	0 - 10 - 100 - 1,000 ohm	YOKOGAWA 323500 or equivalent
(25) Illumination level meter 3000LUX	1	300/1,000/1,000 lx	YOKOGAWA 328100 or equivalent
(26) Variable resistance 4800	2	4,800 ohm, 0.18 A	YOKOGAWA 279101 or equivalent
(27) - Ditto - 170	2	170 ohm, 1 A	YOKOGAWA 279105 or equivalent

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<u>Item</u>	<u>Quantity</u>	<u>Specification</u>	<u>Remarks</u>
(28) Variable resistance	2	100 ohm, 4 A	YAMABISHI ELECTRIC D-11-11 or equivalent
(29) Power factor meter	1	120 V/5 A	YOKOGAWA 2039-02 or equivalent
(30) Var meter	1	120 V/5 A	FUSO ELECTRIC CO. FPWR-36 or equivalent
(31) Digital phase frequency meter 450V/15A	2	0.3 - 450V, 0 - 360° 1mA - 15A, 40 - 70Hz	KEIHIN DENSOOKI DPF-30N or equivalent
(32) Millisecond meter (Digital)	1	0 - 99,999.9 msec	KEIHIN DENSOOKI MCS-2C or equivalent
(33) Hook on meter 350A	2	AC5 - 350A, AC150 - 750V 0 - 1K	YOKOGAWA 234102 or equivalent
(34) - Ditto - 1KA	1	AC10 - 1,000A, AC150 - 750V 0 - 1K	YOKOGAWA 234202 or equivalent

<u>Item</u>	<u>Quantity</u>	<u>Specification</u>	<u>Remarks</u>
(35) Induction voltage regulator (3 phase) 6.5KVA	1	0 - 380V/0 - 10A/6.5KVA	YAMABISHI ELECTRIC CO. 31R-6.5 or equivalent
(36) Phase checker	2	50 - 450 V	KEIHIN DENSOKKI PI-11 or equivalent
(37) Relay testing device with accessories	1		KEIHIN DENSOKKI PRB-12A2 or equivalent
(38) Meter resistance box 0.1/100K	1	6 dial/0.1 - 100M Ω	YOKOGAWA 279303 or equivalent
(39) - Ditto -	2	6 dial/1 - 10K Ω	YOKOGAWA 279301 or equivalent
(40) Digital multi meter (5 digit)	2	5 digit ACV-A, DCV-A, OHM, $^{\circ}$ C f ∞	YOKOGAWA 754101 or equivalent
(41) Photo corder 18ch	1	455 /10div opt-arm 330 m/m WITH CHART 20 ROLLS	YOKOGAWA 2932-21/291603 OR EQUIVALENT

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<u>Item</u>	<u>Quantity</u>	<u>Specification</u>	<u>Remarks</u>
(42) Synroscope with photograph attachment & carrier 60MHz x 4ch	1	DC - 60MHz, 4ch 8 trace	IWASAKI TSUSHIN SS-7607+SK-2201 +MT-600 or equivalent
(43) DC voltage/current (Standard) 100µA/100V x 1-30A	1	100/500/1000V, 10/50/100µA 1/10/30A	YOKOGAWA 256042-2 or equivalent
(44) Portable double bridge	1	1 - 11Ω, 6 div	YOKOGAWA 2769 or equivalent
(45) Rotary for WH (Standard)	1	110/220V, 1/5/10/20/30A	TOSHIBA VP-20 or equivalent
(46) High voltage test set (for oil)	1	110V/50Hz/0 - 25/50kV	KEIHIN DENSOKKI ETP505 or equivalent
(47) Vernier caliper	2	300 & with stop screw	MITSUOTOYO N-300
(48) Drilling machine (desktop) with drill	1	3φ-220V/200W - 2500rpm	ASHINA ADP-360

<u>Item</u>	<u>Quantity</u>	<u>Specification</u>	<u>Remarks</u>
(49) Vice	1	170 x 100	Swivel abride RV-150
(50) Polaroid Camera	1	Charge strobo, fixed focus	Polaroid Super Color 635*600 film 10 packs
(51) Tool box (5 rack)	2	835W x 380D x 880H	OS-NC case C2C8S
(52) Electric bench grinder double shaft	1	220V - 3 ϕ /205 ϕ	TOSHIBA BGB-205T or equivalent
(53) Portable electric drill	2	AC110V/4.2A 1200 rpm	MAKITA 6010N
(54) Battery charger & Rechargeable battery	4	AC100V/DC2.8V 70mA x 2	NATIONAL BQ-300/P-3RS or equivalent

*1. Accessories

ITEM NO. 12.3.1 (1)

1. Pointer Puller : 1 pc
2. Hammer : 1 pc
3. Monkey Wrench : 1 set
4. Piston Packing : 2 pcs (25/13)
5. O Ring : 15(P7...10) (P6...5) pcs
P7...10.6/6.8 P6...9.6/5.8
6. Joint (For Pressure Gauge) : 4(PF3/8...2) (PF1/4...2) pcs
7. Weights & Weight Box : 1 set
8. Setting Bolts & Nuts (M16*85) : 4 sets
9. Machine Oil (Equivalent to JIS K 2238 ISO VG46) : 130ml

*2. Accessories

ITEM NO. 12.3.1 (2)

1. Pointer Puller : 1 pc
2. Hammer : 1 pc
3. Monkey Wrench : 1 set
4. Piston Packing : 2 pcs (25/13)
5. O Ring : 15(P7...10) (P6...5) pcs
P7...10.6/6.8 P6...9.6/5.8
6. Joint (For Pressure Gauge) : 3(PF3/8...2) (PF1/4...1) pcs
7. Weights & Weight Box : 1 set
8. Setting Bolts & Nuts (M6*70) : 4 sets
9. Machine Oil (Equivalent to JIS K 2238 ISO VG7) : 130ml

*3. Accessories

ITEM NO. 12.3.1 (3)

1. Pointer Puller : 1 pc
2. Hammer : 1 pc
3. Monkey Wrench : 1 set
4. Piston Packing : 2 pcs (25/13)
5. O Ring : 15(P7...10) (P6...5) pcs
P7...10.6/6.8 P6...9.6/5.8
6. Joint (For Pressure gauge) : 3(PF3/8...2) (PF1/4...1) pcs
7. Weights & Weight Box : 1 set
8. Setting Bolts & Nuts (M6*70) : 4 sets
9. Machine Oil (Equivalent to JIS K 2238 ISO VG7) : 130ml

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*4. Accessories

ITEM NO. 12.3.1 (4)

No.	Name	Q'ty	Remarks
1	Cross screw driver	1	75 mm No. 1
2	Cross screw driver	1	100 mm No. 2
3	Hex. bar spanner	1	M6
4	Monkey wrench	1	200 mm
5	Hammer for pointer	1	
6	Pointer puller	1	
7	Packing for pressure gauge	20	O-ring JIS B2401-P7
8	Packing for Piston	2	O-ring JIS W1516-44
9	Packing for cylinder	2	O-ring JIS W1516-49
10	Seat packing for valve	5	O-ring JIS B2401-P4
11	Packing for mercury tank	5	O-ring JIS W1516-21 (AN6230)
12	Cu pipe 6φ / 4φ	1	3 m
13	Mercury	1	1.5 kg

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*5. Accessories

ITEM NO. 12.3.1 (6)

- | | |
|---|---------|
| 1. Fuse ... (3A) | : 1 pc |
| 2. Output cable (2m) | : 1 pc |
| 3. Valve for pump | : 2 pcs |
| 4. Diaphragm | : 2 pcs |
| 5. Vinylhose ($\phi 10 \times \phi 6$ 10m) | : 1 pc |
| 6. Hose band | : 4 pcs |
| 7. Transformer (1 ϕ AC220V/110V 200VA) | : 1 pc |
| 8. Cable drum with concentric plug (25m) | : 1 pc |

*6. Accessories

Item No.	12.3.1 (9) Maintenance tool set.	detail
1.	Gear puller	1 GL-4 100φ x 60W
2.	Gear puller	1 GL-10 250φ x 130W
3.	Socket wrench set	1 K-20 8φ - 32, 6 - 27φ
4.	Adjustable angle wrench	1 EM-100 100 ℓ
5.	"	1 EM-200 200 ℓ
6.	"	1 EM-300 300 ℓ
7.	Compression tool	1 AK-15 1.25 - 8 m/m ²
8.	Water pump plier	1 EWPH-300 300 ℓ
9.	Pipe wrench	1 EP-250 6 - 25 m/m
10.	"	1 EP-450 15 - 50 m/m
11.	Hex key wrench set	1 RA-1110 1.5 - 10φ
12.	"	1 AN-070 1.6φ - 7/32"
13.	Side cutting plier	1 6050 185 ℓ
14.	Radio plier	1 MM-15 125 ℓ
15.	Cutting nipper	1 205-150 150 ℓ
16.	Wire stripper	1 P-73 2.6 - 5φ
17.	Precision screw driver set	1 206B 0.9 - 3.5 m/m
18.	Tool box	1 GX-450 450Wx240Dx330H

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*7. Accessories

ITEM NO. 12.3.1 (14)

1. Recording paper (Z-fold chard): 100 sets
2. Pen cartridge (red, green, blue, brown, black, purple, orange,
violet, sky blue): 3 pcs each
3. Lubricating oil : 1 bottle
4. Dust cover : 1 pc
5. Power cord (3-prong type) : 1 set
6. Fuse : 2 pcs
7. Ribbon casset : 5 pcs

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13. TRUCK CRANE

13.1 SCOPE OF SUPPLY

One (1) set of truck crane shall be furnished. The truck crane shall include special and standard tool sets, spare parts and all required accessories.

13.2 GENERAL INFORMATION

13.2.1 APPLICABLE STANDARDS AND CODES

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

13.2.2 DESIGN DATA

(1) Crane

- | | |
|------------------------------------|-------------------------------------|
| (a) Type | Fully-hydraulic truck crane |
| (b) Number | One (1) set |
| (c) Maximum rated lifting capacity | Approx. 40 metric ton x 3.0 m |
| (d) Boom length | Approx. 11 m - 35 m
(4 sections) |
| (e) Jib length | Approx. 9 m - 16 m
(2 sections) |
| (f) Boom derricking angle | Approx. -2° - 80° |

- (2) Carrier
- (a) Type 4 cycle, water cooled, diesel engine
 - (b) Maximum traveling speed 65 km/h or more
 - (c) Maximum output horsepower Approx. 315 ps/2,300 rpm
 - (d) Maximum output torque Approx. 105 kg.m/1,400 rpm

13.3 TECHNICAL INFORMATION

- (1) The truck crane shall be designed in conformity with Clause 9 of "DESIGN CONDITONS" in Part I, and shall be suitable for all weather outdoor service.
- (2) The boom derricking speed of crane shall be of the "high and low" two speed type.
- (3) The hoisting and lowering hook speeds of main and auxiliary shall be of the "high and low" two speed type.
- (4) The oil reservoir capacity for the crane shall be 600 liters or more.
- (5) The crane cab shall be of all steel and welded construction.

- (6) All safety devices for the crane shall be provided, but these shall not be limited to the following items.
- (a) Automatic crane stopper
 - (b) Outrigger lock device
 - (c) Boom derricking safety device
 - (d) Boom retracting and extending safety device
 - (e) Over winding alarm device
 - (f) Boom angle indicator
 - (g) Hydraulic circuit safety valve
 - (h) Drum turning indicator
 - (i) Drum lock device
- (7) The carrier shall have four (4) wheel shafts.
- (8) The gradeability ($\tan \theta$) of carrier shall be 25% or more.
- (9) The minimum turning radius of carrier shall be 13 m or less.
- (10) The carrier shall be provided with, but not limited to, the following systems and equipment.
- (a) Clutch system
 - (b) Transmission system
 - (c) Axles
 - (d) Steering system (right side)
 - (e) Suspension
 - (f) Brake system (service brake, parking brake, auxiliary brake)
 - (g) Electric system
 - (h) Battery
 - (i) Fuel tank (300 liters or more)
 - (j) Outrigger (hydraulically operated)

- (11) The driver's cab of the carrier shall be of all steel and welded construction.
- (12) The recommended spare parts for truck crane shall be provided, and the total price of spare parts shall not be more than 10% of the cost of the truck crane.
- (13) Special tools and standard tool sets for truck crane shall be provided.
- (14) Training for the truck crane operator shall be carried out by the Contractor.
- (15) The Owner's name and symbol shall be indicated on the driver's cab of the carrier and on the crane boom.
- (16) The Contractor shall submit the catalog specifications and recommended spare parts list for truck crane to the Owner and the Engineer for approval.

14. FORK LIFT AND STEPLADDER

14.1 SCOPE OF SUPPLY

The Contractor shall provide one (1) set of fork lift truck and one (1) set of stepladder. The fork lift truck shall include special and standard tool sets, spare parts and all required accessories. The stepladder shall be of portable with four casters and operation platform at the ladder top. Height of the ladder shall be extendable by hand operation.

14.2 GENERAL INFORMATION

14.2.1 APPLICABLE STANDARDS AND CODES

The fork lift truck shall be designed and manufactured in accordance with the requirements of Clause 6 of "Applicable Standards and Codes" in Part I.

14.2.2 DESIGN DATA

1. FORK LIFT

(1) Type	Counter-balance type
(2) Number	One (1) set
(3) Capacity	5,000 kg at 610 mm load center
(4) Lifting height	3,000 mm
(5) Tilting angle (forward-backward)	3° - 10°
(6) Fork length	1,200 mm
(7) Lateral fork adjustment (outside of forks)	300 mm - 1,450 mm
(8) Turning radius	3,400 mm

(9) Drive unit

(a) Type 4 cycle, water cooled diesel engine

(b) Displacement 4.0 liters minimum

(c) Rated output 60 HP/2,150 rpm, or equivalent

2. STEPLADDER

(1) Type Portable type

(2) Number One (1) set

(3) Carrying capacity 100 kg

(4) Height (maximum) 6,500 mm

(5) Height (minimum) 2,300 mm

(6) Weight Approx. 150 kg

14.3 TECHNICAL INFORMATION

14.3.1 OPERATION EQUIPMENTS

(1) Maximum lifting capacity of the truck with side shift carriage shall be 5,000 kg or more at 610 mm load center.

(2) Maximum lifting height shall be 3,000 mm or more.

(3) Maximum lifting speed with rated load shall be 265 mm/sec or more.

(4) Maximum free lifting speed shall be 300 mm/sec or more.

(5) Maximum forward traveling speed shall be 20 km/h or more.

(6) Steering outer turning radius shall be 3,400 mm or less.

(7) Maximum drawbar pull with rated load shall be 4,200 kg.

(8) Overall enclosed mast height shall be 2,600 mm or less.

14.3.2 POWER UNIT

- (1) The fork lift truck shall be powered by one heavy duty industrial diesel engine of a reputable manufacturer, and shall be a completely new model.
- (2) The diesel engine shall have a capacity of 60 horsepower or more at 2,150 rpm under site conditions.
- (3) The engine shall be provided with an oil bath type air cleaner.

14.3.3 TRANSMISSION SYSTEM

The transmission system shall be of the heavy duty torque converter and powershift or hydraulic type.

14.3.4 STEERING SYSTEM

The steering system shall be of the power hydraulic type.

14.3.5 BRAKE SYSTEM

- (1) Service brake shall be of the hydraulic internal expansion, front wheel braked type.
- (2) Parking brake shall be of the mechanical, external contraction propeller shaft braked type.

14.3.6 ELECTRICAL SYSTEM AND GAUGES

All electrical systems and gauges shall be provided, but these shall not be limited to the following items.

- (1) Engine hour meter
- (2) Speedometer (including odometer)
- (3) Fuel gauge
- (4) Ampere meter
- (5) Horn
- (6) Temperature gauge for engine coolant
- (7) Temperature warning light for transmission
- (8) Pressure warning light for engine oil
- (9) Heavy duty 12 volt battery

14.3.7 MAST AND CARRIAGE SYSTEM

- | | |
|----------------------|------------------|
| (1) Type of mast | Three (3) stages |
| (2) Type of carriage | Side shift |
| (3) Fork length | 1,220 mm |
| (4) Headlights | As required |

14.3.8 PROTECTIVE OVERHEAD GUARD

Heavy duty protective overhead guard with weatherproof covering shall be provided.

14.3.9 WHEELS AND TIRES

- (1) The fork lift truck shall have four (4) wheels in the front and two (2) wheels in the rear.
- (2) The tires shall be of the heavy duty pneumatic type.

14.3.10 PAINTING

- (1) Painting shall be as follows.
 - (a) One (1) coat of anticorrosive primer
 - (b) One (1) coat of undercoat
 - (c) One (1) finish coat
- (2) The color of finish paint and marking will be decided by the Owner at a later date.

14.3.11 SPECIAL TOOLS AND STANDARD TOOL SETS

The Contractor shall provide the special tools and standard tool sets for the fork lift truck.

15. MACHINE SHOP EQUIPMENT

15.1 SCOPE OF SUPPLY

The machine shop equipment shall be provided the following equipment.

- (1) Welding machine
- (2) Lathe
- (3) Grinder
- (4) Drill presses
- (5) Welding bench
- (6) Hydraulic press
- (7) Sawing machine
- (8) Threading machine
- (9) Work benches
- (10) Vises
- (11) Chain block with gear trolley
- (12) Control boxes
- (13) Foundation bolts, nuts, sleeves, etc.
- (14) Cables and wire
- (15) Painting
- (16) Special tools and standard tool sets

15.2 GENERAL INFORMATION

15.2.1 APPLICABLE STANDARDS AND CODES

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

15.2.2 OUTLINE

- (1) The machine shop will be located in the administration building. The following items shall be provided by the Contractor.
 - (a) Setting of anchor bolts and grouting for equipment in the machine shop.
 - (b) Supply and installation of power source cables, conduits and grounding wire from main building to the machine shop equipment.
 - (c) Supply and installation of power distribution panel for machine shop equipment.
 - (d) Supply and installation of cables conduits and grounding wire for power distribution panel for machine shop equipment.
- (2) The Construction works for the machine shop equipment shall be completed at least 3 months before the taking over date.
- (3) Monorail and related facilities will be provided.
- (4) The foundation for machine shop equipment will be provided. The Contractor shall submit the necessary drawings for the design of machine foundations to the Engineer.

15.2.3 DESIGN DATA

- (1) Welding machine
 - (a) Type AC arc welder
 - (b) Number Two (2) sets
 - (c) Amper 225 A
 - (d) Accessories Power cables, holders, ground clamps, head shield, eye mask, etc.

(2) Welding machine

- (a) Type Portable diesel engine welder
- (b) Number One (1) set
- (c) Amper DC 200 A
- (d) Diesel engine Water cooled, cell motor type
- (e) Accessories Power cables, holders, ground clamp, head shield, eye mask, etc.

(3) Lathe

- (a) Type JIS Center distance 5100
- (b) Number One (1) set
- (c) Swing over bed 1,000 mm
- (d) Accessories One (1) set

(4) Lathe

- (a) Type JIS Center distance 1500
- (b) Number One (1) set
- (c) Swing over bed 560 mm
- (d) Accessories One (1) set

(5) Grinder

- (a) Type Pedestal grinder
- (b) Number One (1) set
- (c) Wheel diameter 300 mm
- (d) Accessories Safety eye shield, etc.

(6) Grinder

- (a) Type Bench grinder
- (b) Number One (1) set
- (c) Wheel diameter 250 mm
- (d) Accessories Safety eye shield, etc.

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- (7) Drill press
- (a) Type JIS Floor model 540 single spindle
 - (b) Number One (1) set
 - (c) Accessories One (1) set
- (8) Drill press
- (a) Type JIS Radial model 1380 single spindle
 - (b) Number One (1) set
 - (c) Accessories One (1) set
- (9) Press
- (a) Type Hydraulic (oil pump) type
 - (b) Number One (1) set
 - (c) Capacity 60 ton
 - (d) Accessories Adjustable table, pressure gauge, self locking table hoist, two table plates, two V-blocks flat ram nose, etc.
- (10) Sawing machine
- (a) Type JIS 300 mm cutting
 - (b) Number One (1) set
- (11) Threading machine
- (a) Type Portable, power operated
 - (b) Number One (1) set
 - (c) Thread
 - 8 - 50 mm bolt
 - 4 - 50 mm pipe
 - (d) Pipe threading attachment
 - 65 - 150 mm pipe
 - (e) Accessories One (1) set

(12) Vise

- (a) Type 150 mm wide
- (b) Number Three (3) sets
- (c) Accessories Replaceable jaws

(13) Work bench

- (a) Type Steel
- (b) Number Two (2) sets
- (c) Dimension 1.8m x 0.9m x 0.85m height

(14) Welding bench

- (a) Type Steel
- (b) Number One (1) set
- (c) Dimension 1.8m x 0.9m x 0.85m height

(15) Tools

- (a) Cutting tools One (1) set
- (b) Die and die stock One (1) set
- (c) Screw tap One (1) set
- (d) Twist drill One (1) set
- (e) Reamers One (1) set
- (f) File One (1) set
- (g) Grindstone One (1) set
- (h) Other tools required for utilization above machines

15.3 TECHNICAL INFORMATION

- (1) All equipment shall be furnished with complete accessories.
- (2) All equipment shall be furnished with drive motor, motor starter and starting controls.
- (3) The motors shall be in conformity with Clause 2.2 of "Electric Motor" in Section II of Part I.
- (4) The control boxes shall be in conformity with Clause 2.1 of "Panel and Board" in Section II of Part I.
- (5) Painting shall be in conformity with Clause 1.13 of "Painting for Piping and Equipment" in Section II of Part I.
- (6) The Contractor shall furnish the power cables, control cables, cable ducts, trays, conduits and grounding wires for the machine shop equipment.
- (7) Further information regarding scope of works and material supply for all item in (6) shall be in accordance with Clause 10 of "Scope of Electrical Works" in Section V of Part II.
- (8) Special tools and standard tool sets
The Contractor shall provide the special tools and standard tool sets including items specified in Clause 15.1 (16) for the machine shop equipment.
The Contractor shall submit tool list to the Engineer for approval.

16. SPARE PARTS FOR ANCILLARY SYSTEM AND COMMON AUXILIARY EQUIPMENT

The Contractor shall provide the following mandatory spare parts for common auxiliary equipment. In addition, the Contractor shall propose the recommended spare parts for the common auxiliary equipment as stated in Clause PA.14 of "Spare Parts" in Section IV of Volume 1.

16.1 SPARE PARTS FOR UNIT 1

	Number of spare
(1) House boiler	
(a) Tube	3% of each size
(b) Packing for boiler inspection door	200%
(c) Glass for boiler inspection door	200%
(d) Packing for drum manhole	200%
(e) Spring for safety valve	100%
(f) Gland packing, gasket, etc., for valve	1 set each size
(g) Valve	1 set each valve
(h) Diaphragm for control valve	1 set each size
(i) Bearing and mechanical seal for fuel oil pump	2 sets each
(j) Bearing for feedwater pump	1 set
(k) Gland packing for feedwater pump	1 set
(l) Gas burner gun and igniter	3 sets
(m) Relays	1 set each
(n) Lamp for operation and annunciator	30%
(o) Transmitter	1 set each
(p) Control switch	1 set each

	Number of part
(2) Turbine room overhead crane	
(a) Brush and holder for motor	100% each
(b) Brake lining for main and auxiliary hoist	100% each
(c) Coil for magnetic brake	100%
(d) Main contactor tip for controller	100%
(e) Wire rope (for main hoist and auxiliary hoist)	100% each
(f) Fuse	100%
(g) Indicator lamp	200%
(3) Water pretreatment system	
(a) Bearing for all pumps	1 set each
(b) Gland packing for all pumps	1 set each
(c) Shaft sleeve for all pumps	1 set each
(d) Level switch	1 set each
(e) Level gauge	200%
(f) Diaphragm for control valve	1 set each size
(g) Gland packing, gasket, etc. for valve	1 set each size
(h) Solenoid valve	5 pieces
(i) Relay	1 set
(j) Gauge glass	1 set each
(k) Lamp for operation and annunciator	100%
(l) Control switch	1 set each
(m) Standard spare parts for transmitter and controller	1 set.

	Number of part
(4) Filter equipment	
(a) Bearing for back wash water pump	1 set
(b) Gland packing for back wash water pump	1 set
(c) Gauge glass	1 set each
(d) Diaphragm for control valve	2 sets each size
(e) Solenoid valve	5 pieces
(f) Filter element for filter	200%
(g) Gland packing, gasket, etc. for valve	1 set each size
(h) Relay	1 set
(i) Lamp for operation and annunciator	50%
(j) Pressure switch for flow switch	1 set
(k) Control switch	1 set
(l) Transmitter	1 set
(m) Control switch	1 set
(5) Drinking water equipment	
(a) Gauge glass	each 1 set
(b) Diaphragm for control valve	each size 1 set
(c) Solenoid valve	5 pieces
(d) Gland packing, gasket, etc. for valve	each size 1 set
(e) Relay	1 set
(f) Lamp for operation and annunciator	50%
(g) Mercury switch for flow switch	1 set
(h) Control switch	1 set

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	Number of spare
(i) Drinking water pump	
(i) Bearing for pump	1 set
(ii) Gland packing for pump	1 set
(iii) Shaft sleeve for pump	1 set
(6) Raw water tank	
(a) Packing for manhole	1 set
(b) Diaphragm for level control valve	1 set
(c) Gland packing, gasket, etc. for valve	1 set each size
(d) Standard spare parts for level transmitter	1 set
(e) Raw water pump and motor	
(i) Bearing for pump	1 set
(ii) Gland packing for pump	1 set
(iii) Shaft sleeve for pump	1 set
(7) Water treatment system	
(a) Exchange resin (cation and anion)	50% each
(b) Bearing for all pump	1 set each
(c) Gland packing for all pump	1 set each
(d) Diaphragm for diaphragm valve	5 pieces each size
(e) Diaphragm valve	1 set each size
(f) Gauge glass of chemical tank and inspection hole of tower	1 set each
(g) Gland packing, gasket, etc. for valve	1 set each size
(h) Solenoid valve	5 pieces
(i) Relay	1 set

	Number of spare
(j) Lamp for operation and annunciator	50%
(k) Recording charts, pens, ink, etc.	for one year
(l) Pressure switches, flow switches and level switches	1 set each
(m) Standard spare parts for transmitter and controller	1 set
(n) Control switch	1 set
(o) Rascing ring	50%
(p) Standard spare parts for silica meter	2 sets
(q) Mini-pump for silica meter	5 complete sets
(8) Demineralized water tank	
(a) Packing for manhole	100%
(b) Diaphragm for level control valve	1 set
(c) Gland packing, gasket, etc. for valve	1 set each size
(d) Standard spare parts for level transmitter	1 set
(e) Demineralized water transfer pump and motor	
(i) Bearing for pump	1 set
(ii) Gland packing for pump	1 set
(iii) Shaft sleeve for pump	1 set
(9) Fire protection system	
(A) Diesel and Motor driven emergency fresh water fire pump	
(a) Piston ring for engine	1 complete set
(b) O ring for engine	1 complete set
(c) Fuel injection valve	2 pieces
(d) Inlet valve assembly	2 complete sets

- | | Number of spare |
|---|-----------------|
| (e) Exhaust valve assembly | 2 complete sets |
| (f) Bearing for pump | 1 complete set |
| (g) Gland packing for pump | 1 set |
| (h) Shaft sleeve for pump | 1 set |
| (i) Gauge glass for fuel oil tank | 1 set |
| (B) Air foam concentrate injection equipment | |
| (a) Pressure proportioner | 1 complete set |
| (b) Pressure switch | 1 set |
| (c) Transmitter | 1 set |
| (d) Strainer | 1 complete set |
| (e) Valve | 1 set each size |
| (f) Packing for manhole | 1 set each size |
| (C) Piping and valve | |
| (a) Gland packing, gasket, etc.
for valve | 1 set each size |
| (b) Solenoid valve | 1 complete set |
| (D) Control panel, fire protection panel, gas alarm panel and instrumentation | |
| (a) Lamp for operation and annunciator | 50% |
| (b) Pressure switch | 1 set |
| (c) Relay | 1 set each |
| (d) Transmitter | 1 set each |
| (e) Control switch and push button | 1 set each |
| (10) Intake screen | |
| (a) Shear pin for traveling screen | 16 pieces |
| (b) Conduction chain | 2 sets |
| (c) Roller chain for traveling screen | 2 sets |

	Number of spare
(d) Bearing and seal for wash pump	1 set
(e) Gland packing, gasket, etc. for valve	each size 1 set
(f) Lamp for operation and annunciator	50%
(g) Relay	1 set
(h) Control switch	1 set
(11) Heavy oil suction heater	
(a) Tube of heavy fuel oil suction heater	5%
(b) Gasket	100%
(12) Heavy oil transfer pump	
(a) Bearing for pump	1 complete set
(b) Gland packing for pump	1 complete set
(c) Percolate element of strainer	1 set
(d) Diaphragm for pressure control valve	1 set
(e) Gland packing, gasket, etc. for valve	1 set
(f) Lamp for operation and annunciator	50%
(g) Pressure switch	1 set
(h) Control switch	1 set
(13) Fuel oil and natural gas piping	
(a) Gland packing for valve	1 set each size
(b) Valve	1 set each size

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	Number of spare
(14) Drainage and waste water treatment system	
(a) Bearing for all pumps and blowers	1 set each size
(b) Gland packing for all pumps	1 set each size
(c) Diaphragm for control valve	1 set each size
(d) Diaphragm for chemical feed pumps	1 set each size
(e) Gland packing, gasket, "O" ring, etc. for valve	1 set each size
(f) Gauge glass for chemical tank	1 set each size
(g) Lamp for operation and annunciator	50%
(h) Relays	1 set each
(i) Control switch	1 set
(j) Solenoid valve	1 set
(k) Recording chart, pens, ink, etc.	1 year
(l) KCl for pH meter	1 kg
(m) Standard spare parts for analyzer	1 set
(n) pH electrode	5 pieces each electrode
(o) Fuse	200%
(15) Chlorination system	
(a) Bearing, gland packing for all pumps and shaft sleeve	1 set each
(b) Gland packing, gasket, etc. for valve	1 set each size

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	Number of spare
(c) Inner parts for strainer	1 set
(d) Fuse	100%
(e) Lamp for operation and annunicator	100%
(f) Gauge glass for injection flow meter	2 sets
(g) Pressure switches, flow switches and level switches	1 set
(h) Relays	1 set each
(i) Electrode	2 sets
(j) Rectifier element	1 set
(k) Solenoid valve	5 pieces each size
(16) Yard instrument air system	
(a) Wrist pin bushing	1 set
(b) Pair of crane pin bearing shells	1 set
(c) Pair of connecting rod bolts and nuts	1 set
(d) Complete valve assembly for cylinder	1 set
(e) Piston ring	1 set
(f) Packing ring	1 set
(g) Gasket and O ring	1 set
(h) V belt	1 set
(i) Filter cartridge	50%
(j) Gland packing gasket for valve	50%
(17) Laboratory	
(A) Spectrophotometer	
(a) W lamp	5 pieces
(b) D ₂ lamp	5 pieces

	Number of spare
(c) Filters	2 pieces each
(d) Tungsten lamp	5 pieces
(e) Standard spare parts	1 set
(B) pH meter	
(a) pH electrodes	2 sets
(b) Standard spare parts	1 set
(C) Conductivity water	
(a) Standard cell (K=1.0)	2 sets
(K=0.1)	2 sets
(K=10)	2 sets
(b) Standard spare parts	1 set
(D) Drying oven	
(a) Heating element	1 set
(E) Muffle furnace	
(a) Heating element	1 set
(b) Standard spare parts	1 set
(c) Thermocouple	2 sets
(F) Magnetic stirrer	
(a) Standard spare parts	1 set
(G) Water bath	
(a) Standard spare parts	1 set
(H) Shaker	
(a) Bottle holder	2 sets
(b) Standard spare parts	1 set
(I) Demineralizer	
(a) Cation and anion resin	100%
(b) Standard spare parts	1 set

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	Number of spare
(J) Jar test apparatus	
(a) Glass parts	1 set
(b) Lamp	5 pieces
(K) Indigo carmine apparatus	
(a) Glass parts	1 set
(b) Standard spare parts	1 set
(L) Calorimeter	
(a) Combustion capsules	10 pieces
(b) Fuse wire	4 cards
(c) Sealing rings	200%
(d) Drive belts	200%
(e) Valve seats	2 sets
(M) Pour points bath	
(a) Standard test jar	6 pieces
(b) Cock ring gaskets for test jar	6 Pkts
(c) Cock discs for test bath pockets	6 Pkts
(N) Flashpoint testers	
(a) Thermometer	2 sets
(b) Probe plug and socket	1 set
(c) Flexible drive	1 set
(d) Gas tube	10 m
(O) Hot plates	
(a) Heating element	1 set each
(b) Standard spare parts	1 set

	Number of spare
(P) Centrifuge	
(a) Centrifuge tubes	10 pieces
(b) Standard spare parts	1 set
(Q) ORSAT Apparatus	
(a) Glass parts (Complete set)	2 sets
(b) Pipettes	2 sets
(c) Rubber expansion bag	2 sets
(d) Burettes	2 sets
(R) Sulfur content apparatus	
(a) Heating element	4 sets
(b) Quartz tube	2 sets
(S) Atomic absorption flame spectro photometer	
(a) Hollow cathodic lamp	1 set each
(b) Filter	1 set
(c) Recorder chart	1 year
(T) NOx, SOx, O ₂ analyzer	
(a) Gas sampler	1 complete set
(b) Scrubber	2 sets
(c) Converter	2 sets
(d) Standard gas	1 set each
(18) Fork lift	
(a) Bearing	1 set
(b) Oil seal	1 set
(c) Hose	1 set
(d) O ring	1 set
(e) Packing	1 set

	Number of spare
(f) Tires	100%
(19) Truck crane	
(a) Bearing	1 set
(b) Oil seal	1 set
(c) Hose	1 set
(d) O ring	1 set
(e) Packing	1 set
(f) Tires	100%

16.2 SPARE PARTS FOR UNIT 2

	Number of spare
(1) Drainage and waste water treatment system	
(a) Bearing for all pumps and blowers	1 set each size
(b) Gland packing for all pumps	1 set each size
(c) Diaphragm for control valve	1 set each size
(d) Gland packing, gasket, "O" ring, etc. for valve	1 set each size
(e) Lamp for operation and annunciator	50%
(f) Relays	1 set each
(g) Control switch	1 set
(h) Solenoid valve	1 set
(i) Recording chart, pens, ink, etc.	1 year
(j) KCl for pH meter	1 kg
(k) Standard spare parts for analyzer	1 set
(l) pH electrode	5 pieces each electrode
(m) Fuse	200%
(2) Fuel oil and natural gas piping	
(a) Gland packing for valve	1 set each size
(b) Valve	1 set each size
(3) Fire protection system	
(A) Piping and valve	
(a) Gland packing, gasket, etc. for valve	1 set each size
(b) Solenoid valve	1 complete set

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Number of spare

(B) Control panel, fire protection panel, gas alarm panel and instrumentation

- (a) Lamp for operation and annunciator 50%
- (b) Pressure switch 1 set
- (c) Relay 1 set each
- (d) Transmitter 1 set each
- (e) Control switch and push button 1 set each

(4) Intake screen

- (a) Shear pin for traveling screen 16 pieces
- (b) Conduction chain 2 sets
- (c) Roller chain for traveling screen 2 sets
- (d) Bearing and seal for wash pump 1 set
- (e) Gland packing, gasket, etc. each size 1 set
for valve
- (f) Lamp for operation and annunciator 50%
- (g) Relay 1 set
- (h) Control switch 1 set

(5) Chlorination system

- (a) Bearing, gland packing for 1 set each
all pumps and shaft sleeve
- (b) Gland packing, gasket, etc. for 1 set each size
valve
- (c) Inner parts for strainer 1 set
- (d) Fuse 100%
- (e) Lamp for operation and annunciator 100%
- (f) Gauge glass for injection flow meter 2 sets
- (g) Pressure switches, flow switches 1 set

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Number of spare

and level switches

- (h) Relays 1 set each
- (i) Electrode 2 sets
- (j) Rectifier element 1 set
- (k) Solenoid valve 5 pieces each size

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PART II

SECTION V

GENERATOR AND ELECTRICAL EQUIPMENT

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Description:

Items marked * indicate a value recommended by the Tenderer.

1. GENERATOR EQUIPMENT

1.1 GENERATOR, EXCITATION EQUIPMENT AND ACCESSORIES

1.1.1 APPLICABLE STANDARDS AND CODES

The following standards and codes of latest edition shall be applied.

International Electrotechnical Commission (IEC)

34: Rotating electrical machines.

34-1(1983)Part 1: Rating and performance.

34-2(1972)Part2: Methods for determining losses and efficiency of rotating electrical machinery from tests (excluding machines for traction vehicles).

34-2A(1974) First supplement: Measurement of losses by the calorimetric method.

34-3(1968)* Part 3: Ratings and characteristics of three-phase, 50 Hz turbine-type machines.

34-4(1985) Part 4: Methods for determining synchronous machine quantities from test.

34-5(1981) Part 5: Classification of degrees of protection provided by enclosures for rotating machines.

34-6(1969) Part 6: Methods of cooling rotating machinery.

34-7(1972) Part 7: Symbols for types of construction and mounting arrangements of rotating electrical machinery.

34-8(1972) Part 8: Terminal markings and direction of rotation of rotating machines.

34-9(1972) Part 9: Noise limits.
16 pp. Fr.s. 22.- (First edition)

34-10(1975) Part 10: Conventions for description of synchronous machines.

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Other pertinent International Electrotechnical Commission (IEC) standard, or equivalent shall be applied for electrical machineries and apparatuses.

1.1.2 SCOPE OF SUPPLY

The generating unit and auxiliary equipment shall include, but not be limited to the following equipment with complete accessories.

For Unit No.1

- One (1) set - Generator with Accessories
- One (1) set - Exciter with Accessories
- One (1) set - Hydrogen Gas Supplying Unit
- One (1) set - Hydrogen Gas Generator and Storage Tank with Accessories
- One (1) set - Carbon Dioxide Supply Equipment
- One (1) set - Seal Oil unit

For Unit No.2

- One (1) set - Generator with Accessories
- One (1) set - Exciter with Accessories
- One (1) set - Hydrogen Gas Supplying Unit
- One (1) set - Carbon Dioxide Supply Equipment
- One (1) set - Seal Oil unit

1.1.3 TECHNICAL INFORMATION FOR GENERATOR

1.1.3.1 GENERAL

The generator should be directly coupled with the steam turbine.

Generator set will operate at continuous rated out put of 200 MW. Generator shall be capable of parallel operation with the system and other unit.

1.1.3.2 TYPE

Three-phase alternating synchronous generator, turbine direct connected, horizontal, cylindrical, rotating field type.

Indoor use, totally enclosed, pressure-proof, explosion proof.

1.1.3.3 COOLING SYSTEM

Stator Winding H₂ gas cooled

Rotor Winding H₂ gas cooled

1.1.3.4 RATING

Class of Rating Continuous

Capacity 250,000 kVA

Hydrogen Gas Pressure * kg/cm²g

Power Factor 0.8 (lagging)

Voltage 15.0 - 21 kV

Current * kA

Frequency 50 Hz

Phase 3

Pole 2

Connection Wye (neutral point shall be connected to neutral grounded transformer)

Speed 3,000 RPM

Field Voltage * V

Field Current * A

Insulation Class F (Temp. B rize) or B
(Stator and Rotor)

Short Circuit Ratio Not less than 0.5 at rated condition

Variation of Frequency (speed)	±5% or less
Variation of Voltage	±5% or less
Simultaneous change of voltage and Frequency of generator	The sum of the absolute value of the percentage of both changes shall be within 5%.
Overspeed Strength	115% of rated speed for two (2) minutes (120% transient)
Generator Voltage Wave Shape	10% or less
Generator Rotation	Direct coupled with turbine
Unbalanced Current	Indirect cooled rotor 10
	Direct cooled rotor 8
Temperature Rise	
Hydrogen Gas Pressure	*kg/cm ² g
Standard Coolant Temperature	* °C
Stator Coil (by embedded thermometer method)	According to IEC-34-1
Rotor Coil (by resistance method)	Ditto
Collector Ring (by thermometer method)	Ditto

1.1.3.5 GENERATOR CAPABILITY

The withstand capacity against short time overcurrent shall be in accordance with IEC-34-1.

When a negative phase sequence current occurs, the generator shall be able to withstand without damage in accordance with IEC-34-1.

The generator shall be capable of operating at rated active load over the power factor range 0.8 lagging to 0.95 leading without loss of stability and control under all operational conditions defined in this specification.

1.1.3.6 CHARACTERISTIC CURVE

The following characteristic curves shall be provided.

Short Circuit Characteristic Curve

No Load Curve

Capability Curve

V Curve

1.1.3.7 SHOP TEST

The shop tests shall be, but not limited to, the following, and the tests shall be conducted in the presence of the Owner and the Engineer.

Construction test

Temperature test

Measurement of winding resistance

Measurement of each reactance

Measurement of each time constant

Measurement of no load saturation curve

Measurement of short circuit curve

Overspeed test

Withstand voltage test

Measurement of wave shape

Meggering

Voltage regulation test

Checking of phase sequence at the terminal

Measurement of GD^2

Measurement of \tan

Measurement of vibration

Measurement of losses

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Calculation of generator constant
Calculation of efficiency
Balancing test
Measurement of H₂ gas leakage
Measurement of bearing insulation resistance
Measurement of shaft current

1.1.4 GENERATOR EQUIPMENT

1.1.4.1 STATOR FRAME CONSTRUCTION

The stator frame shall be constructed of welded rolled steel in accordance with ASTM A 285 Grade C, or equivalent.

The stator frame shall be of welded connection, and shall be able to maintain sufficient H₂ gas tightness and sufficient strength in case of emergency explosion.

The joints between bearing brackets, terminal housing, hydrogen gas coolers and stator frame, etc., shall be assembled so as to keep sufficient H₂ gas tightness by means of seal compound and adequate gaskets.

The above parts shall be convenient for maintenance, assembling and overhauling.

Rocked plates to be fixed to the steel core inside the stator frame and gas ducts shall be constructed of rolled steel in accordance with ASTM A 283 Grade B, or equivalent.

The piping to supply hydrogen gas shall be installed at the top of the stator, and the piping to supply carbonic dioxide gas shall be installed at the bottom of the stator.

Adequate manholes shall be installed at the bearing bracket (end plate) and stator frame.

1.1.4.2 BEARING BRACKET

The bearing brackets shall be constructed of welded rolled steel and bolted to the stator frame.

The bearing brackets on both sides of the turbine and collector ring shall be split into top and bottom halves and shall be of sufficient mechanical strength.

The inner end shield plates shall be split into top and bottom halves and bolted to the spring bars.

1.1.4.3 STATOR CORE

The stator cores shall be constructed of cold rolled directional silicon steel plate, and shall have little iron loss after each insulation treatment.

The stator core shall be supported by a sufficient number of spring bars and attached to the stator frame, and shall be constructed so as not to deliver magnetic noise or vibration outside the frame.

1.1.4.4 STATOR COIL

The stator coils shall be of one turn coil and installed in the slot of stator core.

The component wire shall be of insulated electric copper.

All component wires shall be transposed to minimize eddycurrent loss, circulating current, etc.

Mica or epoxy resin having a similar thermal expansion coefficient as the stator coil shall be used for grounding insulation to prevent damage by corona effect or insulation breakage of coil due to thermal effect.

The coil ends shall be tightened to the end core supporter

through bind cushions by glassfiber strings to resist heavy load due to short circuit.

The coil ends shall be insulation coated to prevent corona effect.

1.1.4.5 ROTOR SHAFT

The rotor shaft shall be of forged alloy steel equivalent to ASTM 469-65 "Vacuum Treated Steel Forgings for Generator Rotor".

As high mechanical strength is required for the rotor shaft, precise inspection such as mechanical property inspection, magnetic characteristic inspection and supersonic inspection, shall be carried out.

As a countermeasure against occurrence of vibration and eccentricity of generator rotor due to combined difference of coil slots and pole axis, cross slots shall be installed on the pole axis at appropriate intervals.

The balancing weight groove shall be provided on the side of the turbine end coupling.

1.1.4.6 FIELD WINDING

The field winding shall be silver-copper having superior creep characteristics.

The laminator of glassbase resin shall be used for insulation between each turn coil and slot.

The rotor shall have a sufficient number of wind passages, and shall be designed to maintain good cooling effect and prevent reverse current.

The wedges shall be designed to resist large centrifugal forces

under all service conditions.

1.1.4.7 RETAINING RING

The retaining rings shall be of non-magnetic material. The ring shall be able to protect rotor coil ends from large centrifugal forces and prevent leakage flux and stray load loss.

1.1.4.8 FAN BLADE

Axial fan blades shall be installed on both ends of the rotor to cool the stator coil and rotor coil.

The fan blades shall be of high strength aluminum alloy or alloy steel to resist centrifugal force.

1.1.4.9 COLLECTOR RING

The insulated collector rings of alloy steel shall be fitted to the rotor shaft, and spiral grooves shall be machined on the surface of the collector ring to improve the cooling effect and brush contact.

1.1.4.10 BEARING

The bearing shall be of the self alignment type to retain good support of shaft journals, and shall be installed with adequate oil passages.

Oil deflectors shall be installed to prevent oil leakage.

The bearings shall be of a construction which permits overhaul under the fill of hydrogen gas in the stator.

Care shall be taken to prevent oil flushing of the bearing.

Measure shall be taken to prevent shaft current of the bearing, seal oil housing and oil deflector.

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1.1.4.11 SEAL OIL HOUSING

The generator rotor shaft shall be sealed at the bearing bracket to maintain gas tightness and to prevent hydrogen gas leakage.

The seal oil mechanism shall be constructed so as to seal the oil between rotor shaft and sealing ring of the housing.

The seal oil ring shall be supported so as to be free from shaft movement, maintain a steady oil film and prevent hydrogen gas leakage.

1.1.4.12 OIL DEFLECTOR

The oil deflector shall be installed to prevent lubricating oil leakage from generator bearings and seal oil housings.

1.1.4.13 HYDROGEN GAS COOLER

The hydrogen gas cooler shall be designed so as to keep the gas temperature within the specified value under the maximum continuous output.

The cooling water of hydrogen gas cooler shall be taken from the cooling water line.

The hydrogen gas cooler shall be constructed so as to allow inspection and cleaning of the cooler without the exhausting of hydrogen gas.

1.1.4.14 GENERATOR TERMINAL

All six (6) terminals shall be made removable from the machine and shall be available for external connections.

The generator terminal housing shall be installed at the bottom of generator stator. The terminal housing shall be of non-magnetic material to prevent overheating due to eddy

current.

Three (3) generator bushings shall be installed on both the line side and the neutral side. The bushings shall be able to withstand voltage rising of sound phases after one phase grounding under a salt contamination condition of 0.03 mg/cm^2 when the humidity of the air around bushings is 100 %.

The rating of generator bushing shall be as follows.

Type	Dry
Impulse withstand voltage	150 kV (full wave)
Withstand voltage	50 kV
Current	* A
Rated voltage	23 kV

1.1.5 GENERATOR ACCESSORIES

1.1.5.1 TRANION

The tranions shall be installed on the generator stator to enable lifting of the stator by lifting device at the time of initial installation.

The tranions shall be bolted to the generator stator so as to be convenient for assembling and removal of the stator.

1.1.5.2 SOLE PLATE

The sole plates of mild steel shall be placed on the concrete foundation to support the generator.

1.1.5.3 RESISTANCE TYPE TEMPERATURE DETECTOR (RTD)

The RTD shall be of the fiberglass strip type and installed at the places of stator coil slot where the highest temperature is expected.

The quantities of RTD shall be not less than twenty (20).

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The specifications of RTD shall be 100 ohm at 0°C.

The necessary number of RTD shall be installed at the inlet and outlet of hydrogen gas coolers and inside of generator to detect the gas temperature.

The leads of RTD to be led out from inside the stator frame and connected to the terminal box shall be sufficiently sealed to prevent hydrogen gas leakage.

The RTD shall be connected to the recorder and computer.

1.1.5.4 RTD TERMINAL BOX

The RTD terminal box shall be installed at the side of generator stator.

The RTD terminal box shall have sufficient space.

The specified holes for steel conduits which shall be decided at the design stage by manufacturer.

1.1.5.5 VIBRATION AND TEMPERATURE DETECTOR

The vibration and temperature detectors shall be installed at both generator bearings.

1.1.5.6 COLLECTOR RING HOUSING

The collector ring hood shall be constructed of mild steel to cover the collector ring and brush rigging, and shall be made lighted for convenience of maintenance.

Inspection and maintenance doors shall be installed on the collector ring hood, and inspection windows of acrylic resin shall be installed on the doors.

1.1.5.7 BRUSH RIGGING

The brush rigging shall comprise brush holder, brush rigging

barrier, field cable terminals, inspection lamp, etc., and shall be installed in the collector ring hood.

The brush holder shall be of the cartridge type with a position mark to indicate wear of collector ring brushes.

1.1.5.8 BRUSH

The brush shall be of high speed use and medium hard, low electric resistance carbon.

The brush shall be installed in the brush holder, and shall contact the collector ring under the intended pressure.

The required number of carbon brushes shall be supplied so as to meet the rated field current.

1.1.5.9 BUSHING TYPE CURRENT TRANSFORMER

Bushing type current transformers shall be used for generator instruments, relays and excitation system.

The standard ratings, ratios and number of cores of different current transformers shall be as shown in table given below.

The contractor shall however, make detailed calculations to determine the ratios and burden ratings most suitable for protection and metering.

	<u>For excitation system</u>	<u>For instruments</u>	<u>For relaying</u>
CT Ratio	* /5A	* /5A	* /5A
Quantity	3	3	9
Burden	40 VA	40 VA	40 VA
Accuracy Class	5P20	0.2	5P20

Note: The CT ratio shall be a minimum 11,000/5A.

1.1.5.10 GROUNDING LUG

Two (2) bronze grounding terminals of compression type each 250 mm², shall be installed at the diagonal corners of the generator stator.

As the grounding terminals and the stator frame are of different material, sufficient welding shall be carried out, and the grounding terminals shall not be painted.

1.1.5.11 NAME PLATE

The name plate shall be of stainless steel of SUS 304, and shall be attached at a convenient location from the floor.

The following items shall be indicated on the name plate.

Name

Type

Phase

Rated output

Rated power factor

Class of rating

Frequency

Pole

Speed

Armature rated voltage

Armature rated current

Field rated voltage

Field rated current

Degree of protection

Cooling method

Hydrogen gas pressure

Coolant temperature

Armature winding temperature

Insulation class

Manufacturing number

Date of manufacture

Name of manufacturer

Code number

1.1.5.12 ACCESSORY

The flange joints shall be installed at the bottom of generator stator to connect the piping of hydrogen gas, carbon dioxide gas, seal oil, bearing oil and cooling water.

The air vent piping shall be installed at the bottom of the hydrogen coolers.

The sight flow indicators, thermometers, thermocouples, seal oil pressure gauges, oil filters and other necessary pertinents shall be installed at proper places on both sides of the generator.

The generator skirt shall be installed around the generator stator.

1.1.5.13 SPECIAL TOOL

One (1) set of special tools for (standard) erection, maintenance and overhauling shall be provided.

1.1.6 TECHNICAL INFORMATION FOR EXCITATION EQUIPMENT

1.1.6.1 GENERAL

Excitation equipment used to supply field current to generator field coil and an automatic voltage regulator of superior voltage response shall be supplied.

The automatic voltage regulator shall be equipped with under excitation limiter, over excitation limiter, line voltage drop compensator, automatic follow up device, power system stabilizer and automatic reactive power regulator.

The excitation equipment shall be of the static excitation.

1.1.6.2 TYPE

Type	Static excitation system
Quantity	One (1) set/unit
Installation of Excitation Transformer	Indoor

1.1.6.3 RATING

Class of Rating	Continuous
Output	* kW
Voltage	* V
Current	* A

1.1.6.4 CHARACTERISTICS

The following characteristics curves and diagrams shall be provided.

- Scope of voltage adjustment
- Scope of voltage setting
- Excitation system voltage response time
- Excitation system nominal ceiling voltage
- Excitation system ceiling voltage
- Block diagram of excitation system

The excitation ceiling voltage shall be 2 times the rated voltage or higher.

1.1.7 EXCITATION EQUIPMENT

1.1.7.1 EXCITATION TRANSFORMER (ETR)

The ETR shall be connected to the Isolated Phase Bus (IPB) of the generator line terminal side to serve as the power source for generator field circuits.

The ETR shall be designed to take into account wave form frequency and pulsing of current and voltage due to rectifier operation.

Type	Indoor used, dry tyupe self air cooling
Rating	
Capacity	* kVA
Class of rating	Continuous
High tension voltage	* kV
Low tension voltage	* V
Frequency	50 Hz
High tension connection	*
Low tension connection	*
Angular displacement	*
Insulation class	H
Bushing type	Dry

(1) Construction of steel core material

For the steel core material, cold rolled directional silicone steel plate excellent in magnetic property shall be provided. The exciting current loss shall be reduced, and measures required to reduce eddy current loss and stray load loss of the winding shall be provided.

The magnetic and mechanical connections shall be carried out in full, and attention shall be paid to reduce no load current and noise.

(2) Construction of winding material

For the component wire, high purity electric copper shall be applied and sufficient heat treatment shall be carried out.

Sufficient insulation shall be applied between the component wires. The wires shall be transposed, and sufficient consideration shall be given to insulation between layers and layers, between the ground and winding. In regard to countermeasures against surge voltage and dynamic over voltage, internal potential distribution of the winding shall be kept at a uniform value and care shall be taken to prevent internal potential vibration.

(3) Insulating material

The transformer is of large capacity dry type. Therefore, the insulating material shall be excellent in dielectric strength, corona-proof property, heat-proof property, moisture-proof property and dust-proof property. Material having large heat conductivity and large mechanical strength shall be applied, and sufficient attention shall be paid to this at the time of manufacture.

(4) Cooling system

(5) Bushing

The high tension side bushing shall be connected to the isolated phase bus duct, and shall be in accordance with item specification.

The flanges to connect the isolated phase bus duct shall be provided.

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The bushings shall be able to withstand the voltage rising of sound phases after one phase grounding with condition of salt contamination of 0.03 mg/cm^2 when the humidity of the air around bushings is 100%.

The low tension side of the power transformer shall have a construction which facilitated easy connection of outside cables.

(6) Accessory

The following accessories shall be provided.

(1) Temperature indicator

The temperature indication of the dial type shall be provided to measure the temperature in the upper part of the .

A bar thermometer shall be attached to enable easy supervision from the floor.

A temperature alarm device with variable adjuster and a maximum temperature indicator shall be provided for the indicator.

An alcohol thermometer shall be provided for the bar thermometer, which shall be of a construction not easily damaged by outside shocks.

The measuring sensor of the dial type temperature indicator shall be of double construction with enables easy exchange of the measuring sensor, and car shall be taken to prevent insulation oil leakage.

(2) Winding temperature indicator

This device shall be used to equivalently indicate the winding temperature by means of a temperature

compensator, and shall have a construction enabling easy supervision from the floor.

The measuring sensor shall be of double construction which enables easy exchange of the measuring sensor, and care shall be taken to prevent insulating oil leakage.

(3) Terminal cabinet

The terminal cabinet shall serve as an accessory electrical device of the transformer, and shall be used for connection of outside cable, which shall be attached to the transformer body.

(4) Grounding lug

Two (2) grounding lugs shall be mounted along the diagonal line of the The brass clamp having four (4) fixing bolts shall be provided.

As the grounding terminal and the . . . are connected by different kinds of metals, sufficient welding shall be provided. The grounding terminal shall not be painted.

(5) Anchor bolts and nuts, foundation base

The anchor bolts and nuts, and foundation base shall not be damaged when the conditions described in Clause 6 "Design Conditions" in Part I overlap.

(6) Lifting lug, jack bos, pulling hole, etc.

Careful attention shall be paid to the fixing positions of the lifting lugs, jack bosses, pulling holes, etc., so that transportation and installation can be easily provided.

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(7) Piping and wiring

Wiring between the accessory electrical devices of transformer and the terminal cabinet shall be provided, and shall have thick steel conduit tubes.

(8) Name plate

The name plate shall be fixed at a position easy to see from the floor.

The materials corresponding to SUS shall be applied.

The name plate shall have the following items

recorded on them and these items shall not be erased under any atmospheric condition.

Name

Code No.

Name of manufacturer

Manufacture No.

Date of manufacture

Rated capacity

Frequency

Phase

Rated voltage

Tap voltage (including tap indication)

Rated current

Vector

Connecting diagram

Impedance voltage

Type of cooling

Insulation class

Insulation level

Total weight

Quantity of oil

Indoor or outdoor type

Temperature rise

Noise

(7) Noise level

The noise level of the power potential transformer shall be measured, and shall be in accordance with "Measurement of Transformer and Reactor Sound Level" (IEC-551).

1.1.7.2 EXCITATION CUBICLE

The excitation cubicle shall be an indoor, self standing enclosed type with single door and equipped with ventilating louvers.

The following components shall be installed in the excitation cubicle.

(1) Comparison and trigger circuit

The above circuit shall detect the generator voltage from PT of AVR, and shall transfer to the operational amplifier the differential voltage between generator voltage and setting voltage by means of the voltage comparison circuit.

The above circuit shall also transfer to the operational amplifier the differential signal between active power and reactive power by means of the active and reactive power compensating circuits with secondary circuit from PT and CT.

(2) Under excitation limiting device (UEL)

The under excitation limiting device shall be provided to prevent operation of the excess leading area of generator. The limiting device shall be adjustable.

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(3) Over excitation limiting device (OEL)

The over excitation limiting device shall be provided to prevent of the excess temperature due to over current.

The setting range shall be adjustable.

(4) Automatic follow up device (AFU)

The automatic follow up device shall be provided to enable suitable operation of the generator.

(5) Power system stabilizer (PSS)

The power system stabilizer shall be provided to improve the dynamic stability at the parallel operation of the generator with system.

The setting range shall be adjustable.

(6) Automatic reactive power regulator (AQR)

An automatic reactive power regulator shall be provided to enable regulation of the active power and reactive power of the generator.

(7) Manual regulator

The manual regulator shall be provided for manual regulation of the generator terminal voltage, and shall consist of motor driven field rheostat, switches, position indicator or gate phase control, pulse amplifier and all necessary pertinents.

(8) Rectifier

The rectifiers shall be provided to transfer the rectified output of ETR to generator field winding, and shall consist of the silicon element rectifier. A sufficient number of silicon elements shall be provided for replacement during operation.

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The thyristor firing control circuit shall be capable of normal function during system faults.

The fuses shall be installed at the power input and output side.

The rectifier shall be protected with fuses.

(9) Excitation starting equipment

The excitation starting equipment shall be used for initial excitation of generator, and its power source shall be supplied from the DC 220V No.1 or No.2 distribution panel.

(10) Field discharge resistor

The field discharge resistor shall be used as discharge resistance of generator field winding, and shall be connected to generator field winding in parallel and to "b" contact of field circuit breaker in series.

(11) Main excitation field circuit breaker

The main excitation field circuit breaker shall comprise the following.

Two pole with field discharge contact

Draw out type

Mechanical trip free operating mechanism trip button

Operating target

Interlocks

Auxiliary switches

Primary and secondary disconnecting devices

Operating mechanism DC 220V solenoid or motor

operated type

(12) Arrester

The arresters shall be connected to the rectifier in

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parallel, and shall be used to absorb the abnormal peak voltage at the time of transient.

(13) Shunt

Shunts shall be provided for generator field ammeter and generator field temperature indicators.

(14) Relay

The generator field ground detector relay, ETR differential relays, ETR over current relays and auxiliary relays shall be provided.

(15) Field temperature indicators

The field temperature transmitter with indicator and sensors shall be provided to indicate the generator field temperature by detecting field voltage and current. The annunciator contact shall be provided to warn of high temperature of field winding.

(16) Annunciator

The annunciator shall be provided to warn of any trouble in the excitation equipment. The annunciator shall be capable of operating under the following conditions.

Rectifier over current

AVR pulse failure

Rectifier fuses blown

AFU manual operation

AFU long pulse

AFU fuse blown

Rectifier temperature high

Generator field grounding

Under excitation limit operated

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ETR temperature high

Initial excitation failure

The annunciator shall be provided at the front side of panel for convenience of observation, and shall have lamp or target indication.

The annunciator shall consist of indicator, alarm horn, test button, reset button, acknowledge button and all necessary pertinents.

The control voltage of the annunciator shall be DC 220V.

(17) Meters

The proper number of meters necessary for operating, maintenance and adjustment of AVR excitation system shall be provided.

(18) DC and AC control source

The control source of the excitation equipment shall be as follows.

DC source	220 V
AC source	220 V

(19) Equipment to be installed on boiler-turbine-generator board

The following equipment, but not limited to the items below, shall be installed on the boiler-turbine-generator board for operation and supervision of the excitation equipment.

However, the following shall be excluded from this section of the specification, Refer to "BTG Board" in Clause 4.1.

Automatic voltage regulator transfer switch

Manual-Test-Auto

Automatic reactive power selector switch

No use-Use

Automatic reactive power rheostat

Field circuit breaker control switch

Open-Close

Main excitation manual voltage adjuster control switch

Lower-Raise

Main excitation automatic voltage control switch

Lower-Raise

Generator field voltmeter

Generator field ammeter

AVR balance meter

Indication lamp of generator field circuit breaker

Automatic reactive power selector switch

Main excitation automatic voltage control switch

Main excitation manual voltage adjuster control switch

1.1.8 HYDROGEN GAS SUPPLYING UNIT

The hydrogen gas supplying unit shall be used to supply hydrogen gas to the generator from the hydrogen gas cylinder via manifold. The hydrogen gas supplying unit shall enable the following functions.

Replacement CO₂

Automatic pressure control of H₂ gas in generator

Supervision of pressure and purity of H₂ gas alarming

The equipment shall be installed in a control cubicle, and shall include H₂ gas automatic pressure control valve, hand valves, meters and all necessary pertinents.

The valve station shall be installed at the bottom of the generator.

The above equipment shall be constructed so as to enable convenient operation and maintenance.

1.1.8.1 H₂ GAS MANIFOLD AND VALVE

The H₂ gas manifold shall consist of cocks to be connected to H₂ gas cylinders, pressure gauges, valves and safety valve. And appropriate number of cocks for H₂ gas cylinders shall be provided.

The valves shall be used to control the pressure and flow of H₂ gas, and to supply H₂ gas to generator through H₂ gas control cubicle.

The valves shall be of durable and long-lasting construction. The safety valves shall be used to protect the H₂ gas manifold from over pressure.

1.1.8.2 H₂ GAS CONTROL CUBICLE

The H₂-gas control cubicle shall be installed on the first floor, and shall be connected to the piping from H₂ gas cylinder and CO₂ gas cylinder.

These gases shall be supplied to the generator through control valves in the cubicle.

(1) Type

Indoor self standing, metal clad

(2) Construction

The H₂ gas control cubicle shall comprise gas and electrical compartments to prevent gas explosion or fire hazard.

The electrical wirings between the gas and electrical compartments shall be protected by explosion proof fitting of steel conduit.

The H₂ gas control cubicle shall be constructed so as to be ventilated by convection air, and shall have sufficient louvers installed to prevent excess density of gas due to leakage.

The H₂ gas compartment shall be equipped with gas inner and outer piping, automatic pressure control valve, hand valves, gas pressure meters, differential fan pressure gauge, flow meters, gas purifier and all necessary pertinents.

The electrical compartment shall be equipped with purity indicator, annunciator, computer input, plugs and terminal boards.

(3) Automatic pressure control valve

The automatic pressure control valve shall be used to control the hydrogen gas pressure in the generator stator at the specified value.

(4) Hand valve

The hand valves shall be used for the replacement operation of H₂ and CO₂ gases, and shall be installed at the front side of panel to enable convenience of operation and maintenance.

Mimic lines, colored to show correct operation, shall be provided.

(5) Meter

(a) Purity meter

The purity meter with remote indicator shall be provided to indicate the percentage of hydrogen in the air inside the generator stator during operation. The purity meter for CO₂ or H₂ gas shall be able to indicate the value of air in CO₂ (0 to 100%) and hydrogen in CO₂ (0 to 100%), respectively.

(b) Gas temperature meter

The gas temperature meter shall be provided for connection to RTD in the generator, and shall be used to indicate the gas temperature in the generator.

(c) Flow meter

The flow meter shall be provided to indicate the flow of hydrogen gas to the gas analyzer cell block of hydrogen purity meter.

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(6) Machine gas pressure gauge

The machine gas pressure gauge shall be provided to indicate the pressure in the generator.

(7) Differential fan pressure gauge

The differential fan pressure gauge shall be provided to detect the axial fan performance by measuring the differential pressure at the inlet and outlet of fan blades.

These differential pressure gauges shall be used for detecting hydrogen purity in the generator.

(8) Annunciator

The annunciator shall be provided with reannunciation system to warn of any trouble in the hydrogen gas supplying unit and seal oil unit.

The following items shall be provided.

Low hydrogen gas purity

High or low hydrogen gas pressure

High liquid detector level

Low seal oil differential pressure

Low seal oil discharge pressure

High seal oil drain level

Vacuum pump trip

Main H₂ seal oil pump trip

Emergency H₂ seal oil pump running

Emergency H₂ seal oil pump trouble

Low vacuum tank for seal oil

Low vacuum tank level for seal oil

Low H₂ supply pressure

AC control power failure

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DC control power failure

The annunciator shall be provided at the front side of panel for convenience of observation, and shall have lamp or target indication.

The annunciator shall consist of indicator, alarm horn, test button, reset button, acknowledge button and all necessary pertinents.

The control voltage of the annunciator shall be DC 220V.

1.1.8.3 H₂ GAS DRYER

The H₂ gas dryer shall be provided to dry H₂ gas in the generator, and shall consist of fan with rotor or generator rotor fans, heater, silica gel or activated alumina, valves, etc., and the heater shall regenerate the silica gel or activated alumina.

The silica gel or activated alumina in the dryer shall be made convenient for renewal of silica gel or activated alumina.

1.1.8.4 LIQUID DETECTOR

The liquid detector shall be provided to detect the drain at the bottom of generator stator casing, and shall be connected to the H₂ control cubicle for alarm.

Drainage of generator stator casing shall be made possible through the drain valve at the bottom of generator stator.

1.1.8.5 PIPING

Carbon steel or copper pipings shall be installed, and the number of flange fittings shall be kept to a minimum to prevent gas leakage.

Adequate piping slope shall be applied to prevent drain

trouble.

The pipings shall be provided for the replacement operation of air - CO₂ - H₂ gases and emergency exhausting. Color bands shall be attached to each pipeline for easy distinction of the kinds of pipings.

1.1.8.6 H₂ GAS CYLINDER

The total number of fifteen (15) H₂ gas cylinder per unit shall be provided.

1.1.9 HYDROGEN GAS GENERATING SYSTEM

1.1.9.1 GENERAL

The hydrogen gas generating system shall be provided to generate hydrogen gas to cool the generator.

The hydrogen gas shall be generated by electrolyzing of water, and shall be stored with gas cylinders.

The hydrogen gas generating system shall be operated manually and automatically.

The feed water shall be supplied from the make up water line which shall be connected to discharge piping of make up water transfer pump.

The hydrogen gas generating system shall be operated for continuous operation of maximum load.

1.1.9.2 SCOPE OF SUPPLY

One (1) set hydrogen gas generating plant.

The hydrogen gas generating plant shall include but not be limited to the hydrogen gas generator, feed water tank with level control valve, hydrogen gas holder, hydrogen gas compressor, hydrogen gas dryer, gas analyzer control panel, piping, valves, etc.

1.1.9.3 HYDROGEN GAS GENERATING EQUIPMENT

The hydrogen gas generating equipment shall be provided in accordance with the following requirements.

- Two (2) sets H₂ gas generator Indoor, package electrolytic type
- One (1) set H₂ gas holder Outdoor, 25 Nm³,
- Two (2) sets H₂ gas compressor Indoor,

1.1.10 CARBON DIOXIDE SUPPLY EQUIPMENT

The carbon dioxide supply equipment shall be provided to replace generator hydrogen gas by carbon dioxide gas, and shall consist of CO₂ gas manifold, control valves, pressure gauges and all necessary pertinents.

The control valves for gas replacement shall be provided in H₂ gas control cubicle for convenience of supervision and operation.

1.1.10.1 CO₂ GAS MANIFOLD AND VALVE

The CO₂ gas manifold shall consist of cocks to be connected to CO₂ gas cylinders, pressure gauges, valves and safety valve.

An appropriate number of cocks for CO₂ gas cylinders shall be provided.

The valves shall be used to control the pressure and flow of CO₂ gas, and to supply CO₂ gas to generator through H₂ gas control cubicle.

The valves shall be of durable and long-lasting construction.

The safety valves shall be used to protect the CO₂ gas manifold from over pressure.

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1.1.10.2 PIPING AND VALVE

Necessary pipings and valves shall be provided so as to ensure safe connection of the generator hydrogen gas unit and carbon dioxide gas equipment.

The piping and valve arrangement shall be installed so as to facilitate convenience of operation, supervision and inspection.

1.1.10.3 CO₂ GAS CYLINDER

The total number of ten (10) CO₂ gas cylinder per unit shall be provided.

1.1.11 SEAL OIL UNIT

The seal oil unit shall be provided to seal the hydrogen gas in the generator by the sealing oil.

The vacuum system of sealing unit shall be provided to maintain stable hydrogen gas pressure in the generator and to minimize H₂ gas consumption.

1.1.11.1 BEARING DRAIN ENLARGEMENT EQUIPMENT

The bearing drain enlargement equipment shall be provided to recover seal oil which has leaked to the air side of generator sealed bearing, and shall be installed under the generator.

The air in the bearing drain enlargement oil tank shall be removed by vent pipe and shall be discharged into the atmosphere. The seal oil from bearing drain enlargement equipment shall be returned to the oil reservoir.

1.1.11.2 SEAL DRAIN ENLARGEMNET EQUIPMENT

The seal drain enlargement equipment shall be provided under the generator to recover the seal oil which has leaked to hydrogen gas side.

The mixed hydrogen gas shall be removed by the seal drain enlargement equipment, and shall be exhausted to the atmosphere.

The seal oil from seal drain enlargement equipment shall be returned to the oil reservoir.

1.1.11.3 SEAL OIL CONTROL UNIT

The seal oil control unit shall consist of differential pressure regulator, oil filter, instrumentation and all necessary pertinents, and shall automatically control the generator shaft seal oil.

The seal oil control unit shall be provided on the first floor, and shall facilitate easy operation and maintenance.

(1) Differential pressure regulator

The differential pressure regulator of diaphragm type shall be provided to control seal oil pressure automatically, to maintain the constant differential pressure of hydrogen gas and seal oil, and to minimize the leakage of hydrogen gas in the generator.

(2) Instrumentation

The differential pressure gauge, vacuum gauge, seal oil supply pressure gauge, annunciator, interlock switch and other necessary pertinents shall be provided for the convenience of operation and supervision of seal oil unit. All alarms and annunciators shall be attached on the H₂ gas control cubicle.

(3) Oil filter

The oil filter shall be provided to remove dirt and clean the seal oil.

The oil filter shall be constructed so as to enable filter cleaning by a handle operation.

This oil filter shall be provided near the generator shaft seal equipment or seal oil unit equipment.

(4) Valve and piping

All necessary valves and pipings shall be provided on the seal oil control unit to enable proper operation, supervision and maintenance.

The name plates shall be attached to the valves for the convenience of operation, and color marks shall be painted on the pipings for purposes of service operation.

(5) Vacuum tank

The vacuum tank shall be provided to remove the air and hydrogen gas from seal oil, and to return the seal oil from the seal drain enlargement equipment and the bearing drain enlargement equipment.

The float trap, float switch, oil spray, oil level gauge, sight hole and all necessary pertinents shall be provided on the vacuum tank.

(6) Seal oil pump

The seal oil pump of Motor AC 380 V 3 ϕ 50 Hz shall be provided.

The emergency seal oil pump of Motor DC 220 V shall be provided.

The main oil pump to seal the generator shaft and the recirculation pump to recirculate the seal oil in the vacuum tank shall be provided.

The emergency seal oil pump shall be provided to back up the main seal oil pump, and shall be started automatically by signal of seal oil pressure.

Untreated seal oil by vacuum system shall be supplied to the generator shaft during emergency use of emergency seal oil pump.

The bearing oil supply equipment shall be provided to supply seal oil from bearing oil system directly, in case of emergency.

(7) Vacuum pump

The vacuum pump shall be provided to keep the vacuum in the vacuum tank and to improve hydrogen gas purity.

Vacuum pump of motor AC 380 V 3 ϕ 50 Hz shall be provided.

The oil tank, oil level gauge, solenoid valve, cooling water unit and all necessary pertinents shall be provided for vacuum pump system.

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(8) Oil cooler

The oil cooler shall be provided to cool return oil from the main seal oil pump and emergency seal oil pump.

The cooling water of the cooler shall be supplied from cooling water line.

Location of the oil cooler may be either of the two (2) cases.

Case 1: The oil cooler shall be located on the seal oil unit.

Case 2: The oil cooler shall be located inside the turbine lubrication oil tank which is mainly used for turbine generator lubrication oil system.

1.2 ISOLATED PHASE BUS DUCT

1.2.1 APPLICABLE STANDARDS AND CODES

The following standards and codes of latest edition shall be applied.

International Electrotechnical Commission (IEC)

IEC-137 "Bushings for alternating voltage above 1000 V"

Other pertinent International Electrotechnical Commission (IEC) standards, or equivalent shall be applied generally for electrical apparatuses.

1.2.2 SCOPE OF SUPPLY

The isolated phase bus ducts shall be provided for generating power from generator to main and auxiliary transformers, and shall comprise, but not be limited to, the following components.

One (1) set Isolated phase bus duct with accessories for Unit No. 1

One (1) set Isolated phase bus duct with accessories for Unit No. 2

Main circuit	Generator to main transformer
Sub circuit	Main circuit to auxiliary transformer
Branch circuit	Main circuit to PT cubicle, SA cubicle and ETR cubicle
Neutral point circuit	Generator neutral to three phase joint to neutral ground cubicle
Structures	For above equipment

1.2.3 TECHNICAL INFORMATION

1.2.3.1 TYPE

The bus duct shall be of the self cooled, heavy duty, metal clad, isolated phase bus type designed for indoor and outdoor

service.

1.2.3.2 RATING

The rated current, and mechanical and thermal stresses resulting from momentary short circuit current of each circuit shall be as follows.

	Main bus circuit	Sub bus circuit	Branch bus circuit
Rated voltage (kV)	*	*	*
Rated current (A)	*	*	*
Momentary symmetrical current (kA)	*	*	*

Note: The rated current of the main bus shall be a minimum 11,000 A.

The temperature rise shall be as follows.

Enclosure	40°C or less
Conductor	65°C or less

1.2.3.3 MATERIAL

Conductors	High purity aluminum and heat treated aluminum alloy
Enclosures	High purity aluminum
Structures	Hot dipped galvanized steel

1.2.4 CONSTRUCTION

1.2.4.1 BUS DUCT

The bus ducts shall consist of unit ducts and their joints.

Each unit duct shall be of welded construction and have sufficient insulation distance from the conductor, and minimum induction heating to outside.

Each unit duct shall be connected by the insulator, and the

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cover shall be supported by the structure.

The bus duct shall have cushions for thermal expansion and generator vibration, and shall be able to withstand the magnetic force due to three phase short circuit.

The inspection holes shall be provided on the duct for the convenience of inspection and maintenance.

1.2.4.2 CONDUCTOR

Bare aluminum bar of superior conductivity shall be used for conductors, and shall be able to withstand dynamic and thermal stress forces due to three-phase short circuit.

The duration of three-phase short circuit to be considered for thermal stressed shall not be less than 2 seconds.

The dimension and type of conductor shall be recommended by the Contractor.

The flexible conductors shall be installed at the connecting joints between conductors and apparatus and conductors themselves to absorb thermal expansion and vibration.

In principle, the connecting joints between conductors shall be welded and have sufficient contact area.

1.2.4.3 INSULATOR

The insulators shall be able to withstand the conductor temperature, dynamic force of three-phase short circuit and voltage rising of other sound phases after single phase grounding under a salt contamination condition of 0.03 mg/cm^2 when the humidity of the air around the insulators is 100%.

Impulse withstand voltage 150 kV (full wave)

Withstand voltage 50 kV

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1.2.4.4 SUPPORTING FRAME AT PASSING HOLE AT WALL OF TURBINE ROOM

The non magnetic supporting frame to support bus ducts shall be provided at the passing hole of wall of turbine room to maintain adequate sealing.

The frame shall be constructed to have sufficient strength, and shall facilitate convenience of installation.

1.2.4.5 DRAINAGE EQUIPMENT

The necessary drain valves shall be provided at indoor and outdoor bus ducts.

The drain pipings shall be flanged at the isolated phase bus ducts and extended to the floor.

1.2.4.6 FLANGE

The flange joints shall be provided at each end of bus ducts of generator, main transformer, auxiliary transformer, PT cubicle and ETR cubicle.

Technical coordination shall be carried out for flange design of each equipment.

The necessary bolts, nuts, washers, gaskets, etc., for flange joints shall be provided.

1.2.4.7 TERMINAL

The flexible terminals fittings and their bolts and nuts to connect the conductors to equipment shall be provided.

1.2.4.8 SUPPORTING STRUCTURE

The structures to support the bus ducts shall be constructed by hot dipped galvanized steel.

The necessary bolts, nuts, washers, embedded materials for

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indoor, foundation bolts for outdoor, etc., shall be provided.

Each structure shall be provided with grounding terminals and connected grounded buses.

1.2.4.9 REMOVABLE LINK

Removable links shall be provided for the auxiliary transformer sub bus circuit and shall facilitate convenience of maintenance.

1.2.4.10 SUNSHADE

The sunshade shall be provided on the bus ducts to protect the bus ducts from sunshine.

The sunshade material shall be of aluminum alloy.

1.2.4.11 GROUNDING LUG

The grounding lugs shall be provided. For detailed specifications, refer to Clause 10 "Erection" in Section V of Part II.

1.3 POTENTIAL TRANSFORMER CUBICLE

1.3.1 APPLICABLE STANDARDS AND CODES

The following standards and codes of latest edition shall be applied.

International Electrotechnical Commission (IEC)

IEC-186 "Voltage transformer"

Other pertinent International Electrotechnical commission (IEC) standard, and/or equivalent shall be applied generally for electrical apparatuses.

1.3.2 SCOPE OF SUPPLY

The potential transformer (PT) cubicle shall be provided for measurement and protection of generator and AVR, and shall consist of, but not be limited to the followings.

For Unit No.1

One (1) set Potential transformer for instruments relays
Single phase x 3

One (1) set Potential transformer for AVR
Single phase x 3

For Unit No.2

One (1) set Potential transformer for instruments relays
Single phase x 3

One (1) set Potential transformer for AVR
Single phase x 3

1.3.3 TECHNICAL INFORMATION

1.3.3.1 TYPE

Indoor, self cooled, self standing metal clad, draw out.

1.3.3.2 RATING

Type	Molded type single pole
Rated voltage	Generator voltage/ 3 : 110 V/ 3
Frequency	50 Hz
Accuracy class	0.3
Burden Connection	* VA/Phase Wye

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1.3.4 CONSTRUCTION

1.3.4.1 CUBICLE

The potential transformer cubicle shall consist of potential transformer, power fuse, bushing with current limiting resistor, enclosed fuse and all necessary pertinents. Each phase shall be installed on the separated upper and lower double rack.

The front door shall be interlocked to the potential transformer draw out device, and the PT circuit shall be grounded automatically when the front door is in the open position.

The necessary flanges and bushings to connect the isolated phase bus ducts shall be provided.

The outgoing cables shall be placed at the same corner.

1.4 SURGE ABSORBER CUBICLE

1.4.1 APPLICABLE STANDARDS AND CODES

The following applicable standards and codes of latest edition shall be applied.

International Electrotechnical Commission (IEC)

IEC-99 "Lightning Arresters"

Other pertinent International Electrotechnical Commission (IEC) standards, and/or equivalent shall be applied generally for electrical apparatuses.

1.4.2 SCOPE OF SUPPLY

The surge absorber cubicle shall be provided, but not be limited to the followings to absorb outside surge voltage and to protect the generator.

One (1) set Lightning arresters and capacitors for Unit No.1

One (1) set Lightning arresters and capacitors for Unit No.2

1.4.3 TECHNICAL INFORMATION

1.4.3.1 TYPE

Indoor, self standing, metal clad, draw out.

1.4.3.2 RATING

The lightning arrester shall be of superior and stable performance to absorb surge voltage from the transformer so as not to cause short circuit of generator.

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1.4.4 CONSTRUCTION

1.4.4.1 CUBICLE

The surge absorber cubicle shall consist of lightning arresters, capacitors, bushings and all necessary pertinents.

The front door shall be interlocked to the draw out device, and the surge absorber circuit shall be grounded automatically when the front door is in the open position.

The primary circuit of surge absorbers shall be branched from the potential transformers.

Each surge absorber shall be fitted with surge counter.

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1.5 NEUTRAL GROUNDING RESISTOR CUBICLE

1.5.1 APPLICABLE STANDARDS AND CODES

The following standards and codes of latest edition shall be applied.

International Electrotechnical Commission (IEC)

IEC-76 "Power Transformers"

Other pertinent JIS, JEC and/or International Electrotechnical Commission (IEC) standards, or equivalent shall be applied generally for electrical apparatuses.

1.5.2 SCOPE OF SUPPLY

The neutral grounding transformer with resistor shall be connected to the neutral point of the generator for protection against surge voltage and to limit the grounding current.

The neutral grounding resistor shall comprise, but not be limited to the followings.

- One (1) set Neutral grounding cubicle for Unit No.1
- One (1) set Neutral grounding cubicle for Unit No.2

1.5.3 TECHNICAL INFORMATION

1.5.3.1 TYPE

Indoor self cooled, self standing, metal clad

1.5.3.2 RATING

(1) Grounding transformer

Type	Dry
Rated capacity	* kVA
Rated voltage	Generator voltage : 190V
Class of rating	5 minutes

(2) Grounding resistor

Type	Grid
Resistance	* ohm
Current	* A
Class of rating	5 minutes

(3) Disconnecting switch

Type	Manual operated, single pole single throw
Rated voltage	24 kV
Rated current	20 A

1.5.4 CONSTRUCTION

1.5.4.1 CUBICLE

The neutral grounding resistor cubicle shall consist of grounding transformer, grounding resistor, disconnecting switch and all necessary pertinents.

The grounding transformer shall be provided with draw out guides.

The heat radiation shall be considered for the grounding transformer and grounding resistor.

The disconnecting switch shall be installed at the upper part of cubicle, and shall be operated by the disconnecting hook rod from the floor.

The front door shall be provided.

The flanges and bushings to connect the generator neutral bus shall be provided.

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2. POWER TRANSFORMER

2.1 MAIN TRANSFORMER

2.1.1 APPLICABLE STANDARDS AND CODES

The following codes of latest edition shall be applied.

International Electrotechnical Commission (IEC)

- IEC - 76 "Power Transformers"
- IEC - 137 "Bushings for alternating voltage above 1,000 V"
- IEC - 296 "Electrical Insulating Oil"

Other pertinent International Electrotechnical Commission (IEC) standard, and/or other equivalent international standards shall be applied generally for electrical machineries and apparatuses.

2.1.2 SCOPE OF SUPPLY

The transformer shall be connected to the 250 MVA generator generator and used as the voltage stepup transformer.

One (1) set Main transformer with complete accessories for
Unit No.1

One (1) set Main transformer with complete accessories for
Unit No.2

2.1.3 TECHNICAL INFORMATION

2.1.3.1 TYPE

Outdoor, oil immersed, forced-oil, forced-air-cooled (OFAF),
three-phase, two (2) windings

2.1.3.2 RATING

Capacity	250,000 kVA
Class of rating	Continuous
Voltage	
Low tension side	Generator voltage
High tension side	220 kV
On load, voltage tap changer	+ 7.5% (6 steps) - 20% (16 steps)
Frequency	50 Hz
Connection (Vector group)	Ynd1
Low tension side	Delta
High tension side	Wye
High tension neutral	Direct grounding
Impedance voltage	14.0% (at rated MVA base)
Insulation class	A
Insulation	
Low tension side	Full insulation
High tension side	Grade insulation
Insulation level	
Low tension side winding	BIL 150 kV (Full wave)
High tension side winding	BIL 950 kV (Full wave)

2.1.3.3 SHOP TEST

The shop tests shall be as follows, but not limited to the items below. The tests shall be carried out in the presence of the Owner and the Engineer.

Construction test

Withstand voltage test

Induced voltage test

Applied voltage test

Impulse voltage test (with oscillograph)

Measurement of winding resistance

Measurement of transformer ratio

Polarity test

Angular displacement test

Impedance test

Temperature test

No load test

Measurement of $\tan \delta$

Operation test to show the correct function of all devices

Meggering

Noise measurement

Efficiency test

Auxiliary machine power consumption test

2.1.4 CONSTRUCTION

The transformer and all component parts shall be capable of withstanding mechanical and thermal stresses caused by short circuits, and shall be in accordance with IEC 76.

2.1.4.1 STEEL CORE MATERIAL AND CONSTRUCTION

The cold rolled directional silicon steel plates excellent in magnetic characteristics shall be applied. Measures rerquired to reduce not only exciting current loss but also winding eddy current loss and stray load loss shall be taken.

Complete magnetic and mechanical connections shall be provided, and the no load current and noise shall be reduced.

The transformer core ground connection shall be provided to prevent damage to core winding due to core faults.

2.1.4.2 WINDING MATERIAL AND CONSTRUCTION

For the component wire of the winding, sufficiently head-treated, high purity, electrolytic copper shall be applied.

The winding shall sufficiently be insulated at the portion between the component wires and shall be transposed.

Consideration shall be given to insulation between layers and ground.

As a countermeasure against surge voltage, the internal potential distribution of the winding shall be made uniform, and care shall be taken to prevent internal potential vibration.

2.1.4.3 INSULATING MATERIAL AND CONSTRUCTION

For the insulator, the materials which are excellent in dielectric strength, oil-proof and corona-proof properties, and have large heat conductivity, mechanical strength and impulse ratio shall be applied.

Sufficient consideration shall be given to prevent entrance of dust and moisture during the manufacture.

2.1.4.4 TANK

The tank shall be of a steel plate welded construction having appropriate reinforcement materials. It shall withstand external shocks, internal vacuum and internal pressure rise produced during normal operation. The pipings shall be jointed by flanges using appropriate packings, and shall be of a construction that will prevent loosening due to vibration, temperature change and other undesirable effects.

Tank base shall be of the shoe type.

2.1.4.5 ON LOAD TAPCHANGER

(1) General

The on load tapchanger shall be of the Jansen type design having an oil immersed tap selector, an arcing or transfer switch with current limiting resistors contained in a separated pressure tight oil filled vessel inside the transformer tank, motor operated mechanism and controls, and shall be in accordance with IEC Publication 214 (1976).

The on load tapchanger shall have current rating (*) as specified and be suitable to withstand mechanical and

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thermal stresses. At all taps of the on load tapchanger, the transformer winding shall be capable of withstanding the impulse test voltage and the power frequency test voltage specified.

(2) Construction

(a) The on load tapchanger shall permit high speed change over with long life-span, high switching and short-circuit performance and shall be mechanically robust.

The spring operated energy stored diverter switch shall transfer with rapid action the power circuit from one tap to the next, while two adjacent taps are bridged, without the possibility either for a portion of the transformer winding to be short circuited, except through the current limiting resistors, or open circuited. The main contacts shall be faced with suitable alloy for extending their working life.

Diverter switch shall be designed to permit easy removal and installation in the tank.

Suitable guides shall be provided for correct alignment of diverter switch and its contacts.

(b) Diverter components shall be easily renewable and enclosed in a separate oil-filled vessel fitted with drain valve, oil level indicator, relief vent and a gas alarm relay of suitable type and design with two contacts. The connection of this separate oil-filled vessel to the conservator shall be via an easily replacable filter and such that fouled oil can be

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tapped off while the transformer is in service and is automatically replaced with fresh oil from the conservator or alternatively the conservator may be divided into two compartments separated by a filter, for connection to the main tank and the tapchanger compartment.

(c) An operation counter shall be provided to register the accumulated number of tapchanges performed.

(3) Control

(a) The tapchanger shall be remote controlled manually from the BTG board in the central control room.

It shall also be possible to operate the tapchanger locally. A local/remote switch shall be provided in the tapchanger control cabinet to select the point of operation. A crank for hand operation of the drive mechanism shall be provide. It shall be electrically interlocked to prevent operation of the motor while the hand crank is engaged.

(b) The motor drive control shall follow the step by step principle i.e. after energization, the switching operation is automatically and irrevocably accomplished.

If after a voltage drop out during the running time of the motor drive the voltage is present again, the motor drive automatically shall restart in the direction in which it had previously started. A safety connection shall be provided to interrupt the supply voltage in case of false phase sequence.

(c) The tapchanger shall be equipped with an emergency stop switch. Mechanically operated electric limit switches and mechanical stops shall be provided in the driving mechanism to prevent over-travel beyond the maximum raise and lower position.

(4) Position indicator

Two position indicators shall be provided, one shall be installed on the BTG board with central control room and the other on the transformer. The remote indicator shall be fitted with adjustable maximum and minimum indicating stops. The local indicator shall be so located that it can be read while operating the tapchanger. The remote indicator shall be of the servo type. The position indicators shall be marked as follows.

The principal tap shall be marked on the dial center line, and shall be indicated by the letter N. The range for raising the voltage of the LV winding with respect to the HV winding shall be on the right hand side of the dial, and this range shall be marked with an arrow and the letter R. The lower range shall correspondingly be on the left side and marked with the letter L. The tap position numbers shall also be marked on the dial in smaller figures. The markings shall correspond to the tap numbers given on the rating plate.

(5) Housing

The control equipment and the drive mechanism shall be housed in a sheet steel or cast aluminum vermin proof, well ventilated weather and corrosion proof cabinet. The

doors shall have lift-off type hinges and be fastened by integral handles with provision for locking.

Identification labels on the outside of the doors shall be provided.

2.1.4.6 OIL CONSERVATOR

The oil conservator shall be of an atmo-seal system and shall be led to the atmosphere through a breather. The breather shall consist of a moisture absorbing chamber and an oil filter chamber, and shall be easy to handle. Exchange of moisture absorbing materials from aboveground and supervision of moisture absorbing condition shall be made easy. In addition, the insulation oil level shall be made easy to supervise from aboveground and shall have alarm contact.

2.1.4.7 COOLING SYSTEM

The cooling system shall consist of a removable radiator which is composed of a unit radiator, a header, a oil pump and a fan. The removable radiator shall have welded flanges attached on the main tank through packings, and a spare removable radiator shall be mounted on the transformer as a standby unit. An indicating type shut off valve shall be mounted on the tank side to enable removal of each radiator.

An oil pump, an oil indicator shall be fixed to the oil pump, and the pump shall be of a construction enabling supervision of normal oil flow direction.

A totally enclosed motor shall be used for the cooling fan. The fan shall be excellent in cooling performance and cause as little noise as possible.

The rating of the above oil pump and fan motors shall be AC 380V, 3 ϕ . For details, refer to "Standard of Electric Motor" in Clause 9.7 in Section I.

2.1.4.8 BUSHING

(1) High tension side bushing

The high tension side bushing shall be of an elephant type with porcelain, and connected to 220 kV, CV cable.

The bushing in the oil and the one in the air cable head, and each terminal at elephant parts shall not be included in the scope of estimate, but the leads between the bushing in the oil cable head and the transformer side bushing in the oil shall be included in the scope of estimate.

The elephant shall be provided for each phase independently, and the bushing oil shall be charged separately.

The bushings shall be able to withstand the voltage rising of sound phases after one phase grounding with condition of salt contamination of 0.03 mg/cm² when the humidity of the air around bushings is 100%.

The following accessories shall be attached on the elephant parts.

Oil conservator

Pressure relief device

Valves

N₂ pressure meter

(2) Low tension side bushing

The low tension side bushing shall be connected to the isolated phase bus duct, and shall be in accordance with item specification.

The flanges to connect the isolated phase bus duct shall be provided.

The bushings shall be able to withstand the voltage rising of sound phases after one phase grounding with condition of salt contamination of 0.03 mg/cm^2 when the humidity of the air around bushings is 100%.

(3) Neutral side bushing

The neutral lead side bushing shall be drawn out together with each phase, and shall be connected together with three-phases at the bushing terminal by means of copper band. The neutral lead shall be supported by an insulator pulled down up to the lower part of the transformer.

The neutral CT shall be attached on each phase and wired up to the terminal cabinet.

The rating of neutral shall be as follows.

CT ratio /5A

Burden 40 VA

Accuracy class 1.0

Over current strength 40

Over current constant >20

2.1.4.9 ACCESSORY

The following accessories shall be provided.

(1) Oil level gauge

The oil level gauge shall be of the dial type enabling ample supervision from the floor, and shall have an alarm contact.

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(2) Oil temperature indicator

The oil temperature indication of the dial type shall be provided to measure the temperature in the upper part of the tank.

A bar thermometer shall be attached to enable easy supervision from the floor.

A temperature alarm device with variable adjuster and a maximum temperature indicator shall be provided for the indicator.

An alcohol thermometer shall be provided for the bar thermometer, which shall be of a construction not easily damaged by outside shocks.

The measuring sensor of the dial type oil temperature indicator shall be of double construction which enables easy exchange of the measuring sensor, and care shall be taken to prevent insulating oil leakage.

(3) Winding temperature indicator

This device shall be used to equivalently indicate the winding temperature by means of a temperature compensator, and shall have a construction enabling easy supervision from the floor.

The measuring sensor shall be of double construction which enables easy exchange of the measuring sensor, and care shall be taken to prevent insulating oil leakage.

(4) Sudden pressure relay

The sudden pressure relay shall be designed to function in accordance with sudden internal pressure rise due to arcs in oil produced at the time of trouble inside the transformer. The sudden pressure relay shall have an alarm contact shaft but shall not be function in case of slight change during normal operation. The relay shall be of a construction to enable easy testing of its operating condition from outside.

(5) Gas detecting device

The gas detection device shall serve as a relay, and shall have an alarm contact which will function by catching the buoyancy of gas and the oil flow.

The gas detection shall have a construction which enables easy detection of the gas collecting condition and sampling.

(6) Pressure relief device

The pressure relief device shall be used for relieving abnormal high pressure inside the tank into the atmosphere at the time of trouble of the transformer.

The pressure relief device shall be drawn out from the upper part of the tank to the lower part, and shall consist of a bursting plate with alarm contact with operates at the designated pressure at the time of abnormal condition.

The bursting plate shall not function at the time of oil face change during normal operation.

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(7) Miscellaneous valve

The sampling valve, oil filter valve and drain valve shall be of flange with gasket construction to enable easy attachment to outside piping. Blind covers shall be provided for each valve.

(8) Terminal cabinet

The terminal cabinet shall serve as an accessory electrical device of the transformer, and shall be used for connection of outside cable, which shall be attached to the transformer body. The terminal cabinet shall be of the outdoor waterproof steel plate type with a door at its front. All cables shall be drawn out from the lower part and the inside shall be of construction which enables the power circuit and control circuit to be separated.

(9) Ladder

A ladder for inspection shall be mounted at the side of the transformer body, and a handrail shall be set up on the top. The ladder shall be locked with steel plates and a "Do Not Enter" sign shall be attached to prevent use by unauthorized personnel.

(10) Steel plate platform with handrail

The steel plate platform with handrail shall be provided around the tap changer for safety of maintenance and operation.

(11) Grounding lug

Two (2) grounding lugs shall be mounted along the diagonal line of the tank. The brass clamp having four (4) fixing bolts shall be provided.

As the grounding terminal and the tank are connected by different kinds of metals, sufficient welding shall be provided. The grounding terminal shall not be painted.

(12) Anchor bolts and nuts, foundation base

The anchor bolts and nuts, and foundation base shall not be damaged when the conditions described in Clause 6 "Design Conditions" in Part I overlap.

(13) Lifting lug, jack bos, pulling hole, etc.

Careful attention shall be paid to the fixing positions of the lifting lugs, jack bosses, pulling holes, etc., so that transportation and installation can be easily provided.

(14) Piping and wiring

Wiring between the accessory electrical devices of transformer and the terminal cabinet shall be provided, and shall have thick steel conduit tubes.

(15) Name plate

The name plate shall be fixed at a position easy to see from the floor.

The materials corresponding to SUS shall be applied.

The name plate shall have the following items recorded on them and these items shall not be erased under any atmospheric condition.

Name
Code No.
Name of manufacturer
Manufacture No.
Date of manufacture
Rated capacity
Frequency
Phase
Rated voltage
Tap voltage (including tap indication)
Rated current
Vector
Connecting diagram
Impedance voltage
Type of cooling
Insulation class
Insulation level
Total weight
Quantity of oil
Indoor or outdoor type
Temperature rise
Noise