

Indoor type Rectifier transformer unit with core/shell type construction is required. The Rectifier transformer shall be designed/ sized as per IEEE std. C57.18.10 and C57.110.

I. Scope of Supply

1. Rectifier transformer with cooling system & protection CTs
2. Spares
3. Transportation to end user works
4. Supervision of erection
5. Commissioning of the equipment

II. Application

The Rectifier transformer steps down the voltage and is used in conjunction with rectifier units for conversion of AC power in to DC. This shall feed the large DC current requirement in the process industries for electrolytic process.

III. Service conditions

Ambient temperature	50°C
Humidity	100% tropical at 40°C
Elevation	<1000m above mean sea level
Seismic Zone	III as per IS 1893

IV. Constructional features & Auxiliaries

1. Core

- i. Transformer with core type construction of CRGO steel.
- ii. The core assembly shall be tank mounted
- iii. Core assembly shall be rigidly clamped to ensure adequate mechanical strength and to prevent vibration during transportation and operation under abnormal service conditions
- iv. Provision is to be provided for inspecting individual core and coil unit from the top after removal of transformer tank cover or manhole covers.
- v. Lifting provision is to be provided for the core coil assembly.
- vi. The frame, clamps and core-bolts shall be electrically insulated from the core. Provision for checking the insulation level of these items individually shall be provided.
- vii. Magnetic circuit core bolt withstand voltage for one minute shall be at least 2KV

2. Windings

- i. The winding material shall be copper.
- ii. Conductor area for HV wdg: 308.8 sqmm
- iii. Conductor area for LV wdg (star) : 476.3 sqmm
- iv. Conductor area for LV wdg (delta) : 274.9 sqmm
- v. Maximum allowed current density is 3A/sqmm
- vi. Electrostatic shield shall be provided between the HV & LV winding

3. Insulation

- i. Turn insulation for HV & LV : Nomex paper
- ii. Core to LV insulation : pressboard /Oil
- iii. HV to LV insulation : pressboard /Oil

4. Tap changer : OCTC shall be provided on HV side of the transformer to suit various operating points of the rectifier, with following features

- i. OCTC with 5 steps. Tapping range shall be from 285 to 368.4V
- ii. Operating handle of the OCTC shall be easily accessible by a person standing on the ground or platform provided by the manufacturer.
- iii. Two Tier/ Double Decker Tap Changer switch operated through a common spindle shall be provided for Transformer having 2 Nos. primary windings/ axially split construction/ primary windings.
- iv. Padlocking arrangement shall be provided for each tap position with indicator.
- v. Potential free contacts to indicate the tap position and confirmation of the Tap operation shall also be provided
- vi. Visual tap position indicator is required both at local & remote location.
- vii. All taps shall be rated for **maximum continuous CURRNT rating** of the transformer and shall be suitable for operation at sustained voltage corresponding to the highest voltage that would be impressed by the supply system.
- viii. Current rating of OCTC shall be min.**1.5 times** the transformer rated current.

5. *Terminal arrangement*

- i. HV winding leads have to be brought out in cable boxes on the shorter side of the transformer.
- ii. Oil insulated disconnecting chambers shall be provided, segregated from the main tank and with oil filling plug, drain plug, oil level indication and hand holes with proper rubber gasketing. Disconnecting chambers shall house the CT's for easy access without draining oil of main tank or opening the cover of main tank.
- iii. Care should be taken to arrest any leakage from the bushings of the HT terminals.
- iv. The LV winding leads of the transformer shall be brought out through suitable insulating bushings for connection to rectifier through copper busbar from the top cover

6. *Current Transformer* : CT's for metering and protection to be provided inside the transformer HV terminal box with following specifications

- i. Quantity: 1 no. per phase per primary (3no.s)
- ii. Ring core type CT's are to be provided inside the transformer HV terminal box
- iii. No. of cores: 2 (one for metering and other for protection)
- iv. CT ratio for metering: 1800/1A ,Accuracy class : 1.0
- v. CT ratio for metering: 1800/1A, Accuracy class : 5 P 15
- vi. VA burden: 15VA
- vii. Termination: Terminals to be brought out on side of the transformer tank

7. *Tank*

- i. Tank shall be of all welded construction and fabricated from low carbon steel material/ SS-316 as elaborated below. The tank shall have sufficient strength to withstand mechanical shocks during transportation and oil filling under vacuum without any deformation; tank wall shall be reinforced by stiffeners of structural steel for rigidity. The tank material shall be non-magnetic type (SS-316) where secondary and IPT terminals are brought out to minimize the heating due to induced stray current. The stiffeners used in the secondary side bushing shall also be of non-magnetic material.
- ii. Thickness
 - a) Sides: 8 mm
 - b) Cover 12 mm.
 - c) Bottom 10 mm

- iii. Adequate clearance shall be provided between the windings/ winding leads and tank wall to minimize stray current circulation and heating of Tank wall stiffener/ Tank top cover holding bolts due to induction current. Tank Top holding cover bolts shall be Stainless Steel SS-316.
 - iv. The tank cover shall be provided with opening of adequate size having gasketed cover, for inspection of terminals and internals of the tank. Weatherproof, hot oil resistant, neoprene rubber gasket shall be provided for complete oil tightness. If gasket is compressible, metallic stops shall be provided to prevent over compression.
 - v. Transformer tank shall be provided with one set of bi-directional rollers or flanged wheels for rolling the transformer to the foundation.
 - vi. All heavy removable parts shall be provided with eyebolts for ease of handling.
 - vii. Thermometer pocket for noting top oil temperature (for customer use) shall be provided on tank cover with cap.
 - viii. 4 Nos. jacking pads and hauling lugs shall be provided to facilitate jacking of the transformer. Location of jacking pad shall be such that they are outside the extreme edge of wheels/ rollers to ensure clear space for placing the jack.
 - ix. Tank surface temperature shall not exceed 70 deg. C when the transformer is subjected to full load with actual load connected at site.
8. *Cooling System* : The transformer cooling system shall be OFWF to the following specifications
- i. Connection diagram as per ANNEXURE-B
 - ii. The OFWF type of cooling system shall have provision of **100% standby for oil circulation pumps, heat exchanger and associated piping arrangement**. The interconnection shall be such that any of the coolers can be used with either of the pumps by regulating the interconnected valves. Isolating valves shall be provided on both sides of the Pumps and Coolers (for water as well as oil) to facilitate removal of the same for maintenance when the transformer is in service. **Pumps shall be provided with non-return valve to allow auto starting from remote**. End user will provide cooling water connection at one point on the cooling unit. Further connections, piping including the inlet valve, pressure reducer, etc. shall be in transformer supplier's scope.
 - iii. Heat exchangers shall be of double wall design of shell & tube construction. with provision of water leakage detector. Heat exchanger shall be rated for min 150% of total transformer losses including harmonic losses. **Acceptable makes for heat exchanger are Boldrochi/ TADA/ GEA.**
 - iv. The heat exchangers will be mounted horizontally on the shorter side of the transformer opposite the cable box.
 - v. The transformer oil circulation pump shall be radial flow in-line type, with an integral motor. Pump impeller shall be screwed and locked on the driving motor shaft. The motor unit shall be located inside the pump casing completely immersed in transformer oil and shall be cooled by surrounding oil. Complete pump assembly shall be leak proof, glandless close-coupled unit suitable for outdoor installation. The casing of the pump shall be of cast iron with suction and delivery flange suitable for bolting to the transformer pipeline. The pump impeller shall be made of bronze. The pump characteristic curve shall be flat, not drooping. **Acceptable make is Flowell.**
 - vi. The cooling water is to be maintained at a flow of 34.5 cu.m/hr, with inlet pressure of 3 Kg/sq.cm g and outlet pressure of 2 Kg/ sq.cm g. The Inlet temperature shall be at 33°C and out temperature shall not be more than 40°C
 - vii. All gauges, meters and instruments shall have isolation valve with pressure release feature for easy maintenance. Oil flow indicator shall have isolation valve and bypass line with a valve for on- line changing facility without affecting the system
 - viii. Accessories: A list of accessories for cooling system is as below. However the final list will be based on drawings & documents approved for manufacturing clearance.
 - d) Water flow indicator 1 no.

e) Oil flow indicator	1 no.
f) Expansion joints	2 no.
g) Pressure gauge with valve in oil inlet & outlet	2 no.
h) Pressure gauge with valve in water inlet & outlet	2 no.
i) Shut off valves-oil pump suction & discharge	2 no. each
j) Shutoff valves-HE inlets & outlets	2 no. each
k) Drain valve	1 no.
l) Oil inlet temperature indicator	1 no.
m) Oil outlet temperature indicator	1 no.
n) Water inlet temperature indicator	1 no.
o) Water outlet temperature indicator	1 no.
p) Water & oil leakage detector	2 no.
q) Provision and valve required for nitrogen injection system installation shall be provided in transformer	

9. *Oil Preservation System :*

The Transformer oil preservation system shall be a constant oil seal system with conservator tank. Conservator shall be diaphragm type preventing the oil from coming in contact with external atmosphere. The conservator tank shall be equipped with a drain valve and breather system. The silica gel breather assembly shall be approachable from ground. Care should be taken to arrest any oil leakage from the conservator tank.

10. *Grounding :* Grounding pads with bolt, nut and washers shall be provided as follows:

- i. On tank surface suitable for connecting ground conductor – 2 no.
- ii. Inside and outside of primary and secondary terminal boxes – 2 no. each
- iii. On marshalling box, cooling system panel, etc.- 2 no. each
- iv. Core grounding – 1 no.
- v. Ground jumpers shall be provided between the main tank and detachable parts such as terminal boxes.

11. *Marshalling Box :*

- i. A weatherproof marshalling box with IP55 enclosure protection suitable for outdoor service shall contain all auxiliary devices except those which must be mounted in the field.
- ii. The Box shall be made of CRCA material of minimum 2.5 Sqmm thick, neoprene rubber shall be used for gasketing.
- iii. All terminal blocks for external cable connection shall be located in this box.
- iv. The control terminals shall be suitable for termination of 1.5 sq. mm (except for RTD wiring) stranded copper conductor and mounted on channel at least 200 mm above gland plate. A removable bottom cable gland plate shall be provided for cable entry. Minimum size of power terminal block shall be 4 sq. mm. 20% spare terminals shall be provided. Signals from the devices shall be wired individually to the terminal block for Purchaser's use; looping of common terminal is not permitted. The terminal block for RTDs shall be suitable for 1.0 sq. mm.
- v. Tinned copper PVC insulated crimping type lugs are to be used.
- vi. The marshalling box shall have hinged front door and handle with padlocking arrangement. Door shall be fitted with glass to enable viewing the OTI/ WTI reading without opening the door.

- vii. Thermostat controlled space heater and cubicle illumination lamp, 1 ph. 16 A socket outlet and plug top with MCB or fuse shall be provided in the marshalling box.
- viii. Seven channel RTD scanner to be provided for winding & oil temperature measurement.

12. Control Wiring :

- i. Wiring from all transformer mounted auxiliary devices to marshalling box/ local control cabinet shall be carried out by the manufacturer with 1100-volt grade, stranded copper, PVC insulated armoured cables and all these inter-connecting cables shall be supplied along with cable glands and lugs.
- ii. Minimum size of control wire/ cable conductor shall be 1.5 sq. mm for control and 2.5 sq. mm for Current Transformer/ Power wiring. RTDs shall be wired with 0.75 sq.mm twisted pair individual shielded signal cable.
- iii. Not more than two wires shall be connected to one end of terminal of the terminal block in the marshalling box.
- iv. 20% spare terminals shall be provided for Purchaser's future use in each terminal block.
- v. Terminals for CTs shall be disconnecting and shorting type.
- vi. Cables shall be routed on transformer body through GI cable trays.

13. Fittings and Accessories : The following accessories are required

- i. Duplex type RTDs two in each phase shall be installed for monitoring the winding temperature of the rectifier transformer in addition to WTI. RTDs shall be connected to temperature scanner mounted in Marshalling Box.
- ii. Conservator with filter cap, drain plug & oil level gauge
- iii. Silica gel breather with connecting pipe and oil seal
- iv. Shut-off valve between conservator & tank (conservator side)
- v. Air release plugs
- vi. Oil filtration valve with threaded adapters
- vii. Drain valve with threaded adapters
- viii. Oil sampling valve top /middle /bottom
- ix. Anti-earthquake clamps
- x. Man hole for access to interior tank
- xi. Cover lifting eye bolts
- xii. Jacking pads, hauling and lifting lugs
- xiii. Bidirectional flat rollers or flanged wheels
- xiv. Spool piece between conservator and buchholz relay
- xv. Weatherproof marshaling box for control equipment etc
- xvi. Rating plate, name plate and terminal marking plate
- xvii. Cooling unit
- xviii. HV, LV terminal bushings
- xix. Interconnecting XLPE insulated copper unarmoured control cables
- xx. Buchholz relay with 1NC contact for alarm+1 NO contact for trip
- xxi. Buchholz relay isolation valve on tank side & conservator side.
- xxii. Accessible, gas sampling pipe for Buchholz relay
- xxiii. Magnetic oil level gauge with 1NC contact for alarm

- xxiv. Winding temperature indicator with 1NC contact for alarm + 1NO contact for trip along with 2no. RTD per phase. 4-20mA output shall be provided for indication at RCP.
- xxv. Oil temperature indicator with 1NC contact for alarm + 1NO contact for trip along with 1no. RTD for top oil complete with scanner. 4-20mA output shall be provided for indication at RCP.
- xxvi. Pressure relief valve with 1NC contact for alarm + 2NO contact for trip
- xxvii. Double compression cable glands for interconnecting cables
- xxviii. Ladder to approach tank top
- xxix. Valves for nitrogen injection and oil draining for fire-fighting system

14. Surge Arrester :

The transformer shall be fitted with a surge arrester, to suppress any surge appearing on the incoming cable due to switching of upstream breaker or lightning if the cable is exposed. Surge arrester shall be located in primary cable chamber.

15. RLC Based Surge Suppressor :

The transformer shall be fitted with a RLC surge suppressor. Selection basis and calculation details shall be submitted during detail engineering.

16. Paint :

- i. Final paint shade: Light grey to shade 631 as per IS-5
- ii. Primer: 2 coats of epoxy primer
- iii. Final paint: 2 coats of epoxy paint
- iv. Minimum paint thickness: 100 microns

17. Shipping

- i. The rectifier transformer is to be directly shipped to site, details provided in the enquiry.
- ii. The transformer to be shipped oil filled with 10% oil supplied separately as spare.

V. Rating & other specs

Item-1

Quantity	1 nos.
Rated KVA (primary)	18.28 MVA
Rated KVA (secondary)	2 * 9.14 MVA
Primary line voltage	6.6KV
Secondary no-load voltage	368.4 V (Voltage difference Y & should be limited with-in 1% only)
Primary rated current	1605A
Secondary rated current	14323A
No. of Phases	HV : 3 phase; LV : 6phase
Vector Group	Dd0Y11
Frequency	50 ± 5Hz
Maximum noise level	75dB at 1m
Reactance at rated current & frequency	7.96%
Highest system voltage for HV winding design	7.2KV
Inrush current & duration during switching on	5-6 times of FLC
System Grounding	HV side: Non effectively grounded LV side: Floating
Duty factor	Continuous (100%)

VI. Performance specification

- One minute power frequency withstand voltage in KV (rms)
 - a. HV: 20 KV
 - b. LV : 3 KV
 - c. HV/LV to neutral: 20 KV
- Impulse withstand voltage in KV (peak)
 - a. HV: 60 KV
 - b. LV : NA
- Fault withstand time without injury:
 - a. 3 phase short ckt of sec terminal: 2sec
 - b. 1 phase short ckt of sec terminal: 2sec
- Regulation at full load (75°C)
 - a. 1.27% (at unity power factor)
 - b. 6.17% (at 0.8PF lag)
- Efficiency
 - a. > 99% (at 100% load)
- Impedance at rated current & frequency
 - a. Principal tap: 8%
- Temperature rise above cooling water temperature
 - a. In oil by thermometer : 50°C
 - b. In winding by resistance method : 55°C
 - c. Hottest spot shall be limited to : 90°C
- Over load capacity of the transformer: As per IS 6600
- Transformer on rated load without oil pumps: 10 minutes

VII. Trip & alarm signals

S. No.	Device	Non-trip alarm	Alarm & Trip	Monitoring
1	OTI	Yes	Yes	
2	WTI	Yes	Yes	
3	Buchholz relay	Yes	Yes	
4	MOG (Oil level low)	Yes		
5	PRV (oil pressure high)		Yes	
6	Cooling water flow failure		Yes	
7	Oil flow failure		Yes	
8	Cooler/ heat exchanger oil/ water leak detector	Yes	Yes	
9	Oil pump failure		Yes	
10	Transformer Tap switch position			Yes
11	OTI			Yes, 4-20mA
12	WTI			Yes, 4-20mA
13	Emergency trip actuated	Yes	Yes	

* for all trip contacts wired from Rectifier marshaling box, hand rest type high speed tripping relays shall be provided

VIII. Spare list

S. No	Device	Unit	Qty
1	WTI	No	1
2	OTI	No	1

3	Buchholz Relay	No	1
4	HVBushing	No	1
5	Silica gel breather	No	1
6	OIL Level Gauge Alarm and Trip contact	No	1
7	Oil Flow Indicator with Contact	No	1
8	Water Flow Indicator with Contact	No	1
9	Pressure Relief Valve	No	1
10	Set of Gasket Set	Set	one of each type & rating
11	Valves	Set	one of each type & rating
12	Pressure Gauges Set one of each type & rating	Set	one of each type & rating
13	Temperature Indicators Set	Set	one of each type & rating

- a. one of each type & rating *Heat run test*
- b. *Impulse withstand test (with full wave & chopped wave on all three phases)*

IX. Type Tests as per IEC to be carried out

- c. *Heat run test*
- d. *Impulse withstand test (with full wave & chopped wave on all three phases)*

X. Additional Tests to be carried out

- a. *Measurement of acoustic noise level*
- b. *Measurement of power consumption by cooling system*
- c. *Leakage test on tank with normal head of oil+ 0.352 kg/sqcm for 12 hrs for oil & 1 hr. for air*
- d. *Magnetic balance test*
- e. *Off Circuit Tap Changer test & operation check*
- f. *BDV test on insulating oil*
- g. *Hot spot temp checks on Tank wall & Top*
- h. *Measurement of individual secondary currents during short Circuit Test.*
- i. *Tan-delta Test of Oil*
- j. *DGA of Oil before and after heat run test.*
- k. *SFRA (test to be repeated at site)*
- l. *PI value test: HV/Ground; LV1/Ground; LV2/Ground; LV1/LV2; HV/LV1 ; HV/LV2: Yes (PI Value shall be min 2.5)*
- m. *The pre-commissioning test report shall be in the format given as annexure A*

XI. Guaranteed Values

S. No	Performance parameter (Transformer system losses)	Guaranteed Values	Penalty Details	Rejection in case non-performance is more than guaranteed values
1	Iron loss (fixed loss)	16.5 KW	Rs 4,53,000 per KW for every KW greater than the guarantee value	Greater than 10% of guaranteed value (including tolerance)*
2	Copper loss	120 KW	Rs 4,13,000 per KW for every KW greater than the guarantee value	Greater than 10% of guaranteed value (including tolerance)*

3	Auxiliary loss	3.2 KW	Rs 1,81,000 per KW for every KW greater than the guarantee value	Greater than 10% of guaranteed value*
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**Note: in case equipment is rejected due to performance deficiency supplier shall be given a chance to rectify the equipment at their own cost and risk without effecting project schedule*

XII. Guarantee Figures for Efficiency

Vendor to provide efficiency & losses at various operating points

S. No	Losses in KW	Operating taps				
		1	2	3	4	5
1	Iron loss (fixed loss)	14	14	14	14	16.5
2	Main winding Copper losses	90	108	120	120	120
3	Stray losses					

XIII. Figures for AC current harmonics

Vendor to provide details of harmonics as detailed below

1.	<u>Current Harmonics generated / Circulated at rated load of 35 kA, 400 V (without filter bank connected) :</u>		
	i. On 6.6 KV line side	5 th - *	23 th - *
		7 th - *	25 th - *
		11 th - *	29 th - *
		13 th - *	31 st - *
		17 th - *	35 th - *
		19 th - *	37 th - *
	ii. In Primary winding	5 th - *	23 th - *
		7 th - *	25 th - *
		11 th - *	29 th - *
		13 th - *	31 st - *
		17 th - *	35 th - *
		19 th - *	37 th - *
	iii. In Secondary windings.	5 th - *	23 th - *
		7 th - *	25 th - *
		11 th - *	29 th - *
		13 th - *	31 st - *
		17 th - *	35 th - *
		19 th - *	37 th - *

XIV. Applicable standards

- IEC 76 : power transformer

2. IEEE std C57.18.10 : IEEE standard practices & requirements for semiconductor power rectifier transformers
3. Indian Electricity Act & Indian Electricity Rules & CEA
4. IEC 185 : Current transformer
5. IEC 529 : Degree of protection provided by enclosures
6. IEC 289 : Reactors
7. IEC 61508 : Functional safety of Electrical/ Electronics/ programmable electronic safety related system
8. IS 2026: specification for power transformer
9. IEEE std. C57.110 : IEEE recommended practice for establishing transformer capability when supplying Non sinusoidal load currents
10. IS 2099, 9431, 3347 (specification for transformer bushings)
11. Fire Insurance Authority Regulations
12. CBIP manual for power transformer
13. IEC 34 : rotating electrical machines

XV. Drawings & documentation (stage wise)

Drawings and documents to be provided as per listed in ANNEXURE-C

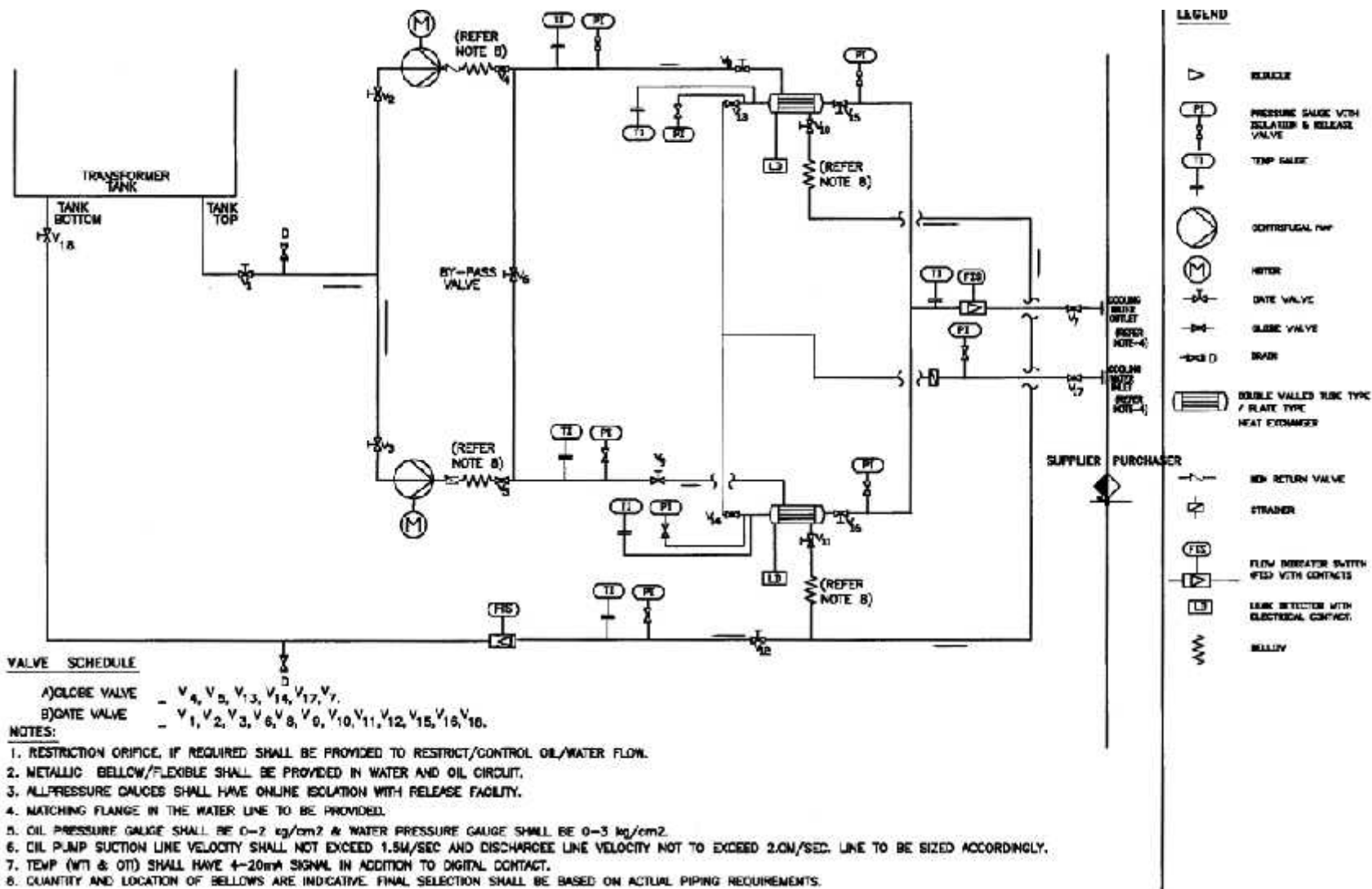
XVI. Special Notes

1. Auxiliary Supply voltage available are
 - a. *415V +/-3%, 50Hz, 3 phase for three phase motors*
 - b. *230V +/-3%, 50Hz, 1 phase for control & monitoring*
 - c. *110V DC for control & monitoring*
 - d. *110V AC from UPS for control & monitoring*
2. Delivery is required 6 months from drawing approvals.
3. Prices shall be FOR Nirma Caustic expansion project, Kalatalav, Bhavnagar Gujrat and shall be inclusive of packing forwarding & transportation charges.
4. Prices shall be inclusive of supervision during installation/ erection, testing and commissioning at site.
5. Acceptance of all the clauses of our specification. Deviation if any should be clearly spelt out.
6. Data sheet as provided in ANNEXURE-D to be filled & submitted by the vendor at the time of approval.
7. BHEL representative will witness the routine and type tests on the transformer, inspection call to be given at least 10 days prior.
8. Performances guarantee to be reckoned after 18 months of successful commissioning & acceptance of equipment or 24 months after completion of supply whichever is earlier.
9. Liquidated damages (LD) will be charged @ 0.5% of total order value per each completed week of delay and part thereof subject to a maximum of 5% of the total order value

ANNEXURE - A

PRE-COMMISSIONING REPORT

ANNEXURE-B COOLING SYSTEM



ANNEXURE-C DRAWINGS & DOCUMENTATION

S.No.	Description	Prints with offer	Prints for approval	Prints with final documents
1	Dimensional dwg. showing GA, foundation plan etc	Soft copy	1+Soft copy	
2	Rating plate drawing	Soft copy	1+Soft copy	4+2 CD
3	GA of marshalling box	Soft copy	1+Soft copy	4+2 CD
4	Power & control schematic of marshalling box		1+Soft copy	4+2 CD
5	Dwg. of major components as bushings, auxiliary devices etc		1+Soft copy	4+2 CD
6	Terminal arrangement drawing	Soft copy	1+Soft copy	4+2 CD
7	Complete B.O.M. indicating make, type, quantity etc		1+Soft copy	4+2 CD
8	O&M manuals for transformers and all auxiliary equipment			4+2 CD
9	Manufacturing schedule	Soft copy	1+Soft copy	
10	Quality Assurance and Inspection Test Plan	Soft copy	1+Soft copy	4+2 CD
11	Computation of Harmonic loss factors & losses for loading during heat run	Soft copy	1+Soft copy	4+2 CD
12	RLC Surge suppressor calculation		1+Soft copy	4+2 CD
13	Type test certificates	Soft copy	1+Soft copy	4+2 CD
14	S.C. test reports of identical transformer	Soft copy		4+2 CD
15	Heat exchanger data sheets	Soft copy	1+Soft copy	4+2 CD
16	Pump data sheets	Soft copy	1+Soft copy	4+2 CD
17	P & I diagram of cooling system for OFWF	Soft copy	1+Soft copy	4+2 CD
18	Catalogues for individual accessories with technical details		1+Soft copy	4+2 CD

ANNEXURE-D DATA SHEET

1		Efficiency (at 75 °C) in %	
	a)	100% Load :	
	b)	75% Load :	
	c)	50% Load :	
2		No -Load current at 50Hz in A	
	a)	At 90% rated voltage :	
	b)	At 100% rated voltage :	
	c)	At 110% rated voltage :	
3		Impedance at rated current and frequency, at 75 °C in %	
	a)	Principal tap :	
	b)	Lowest Tap :	
	c)	Highest tap :	
4		Tap changer (Off Circuit Tap Changer)	
	i)	Make :	
	ii)	No Load voltage at tap position in V	
	a)	Tap No. 1 :	
	b)	Tap No. 2 :	
	c)	Tap No. 3 :	
	d)	Tap No. 4 :	
	e)	Tap No. 5 : (Nominal)	
5		Harmonics in %	
		AC Current harmonic :	
		DC Voltage harmonic :	
		Winding eddy current harmonic loss Factor (FHL-WE) :	
		Other Stray loss harmonic loss factor (FHL-OSL)	
6		Bushings & terminal arrangement	
	i)	Primary Bushing (palm type) (no.):	
	a)	Make :	
	b)	Voltage class (kV):	
	c)	Current rating (A):	
	d)	Space required at top/ side for removal (mm):	
	ii)	Clearance in air, H.V. side (mm)	
	a)	between phases (minimum) :	
	b)	between phase and ground (minimum):	
	iii)	Secondary Bushing : ____Nos.	
	a)	Make :	
	b)	Rating :	
	c)	Creepage distance (minimum)(mm):	
	d)	Space required at top/ side for removal (mm):	

**ANNEXURE-D
DATA SHEET**

	iv)	Clearance in air & L.V. side (mm)	
	a)	between phases :	
	b)	between phase and ground :	
	c)	between phase and neutral :	
	d)	between phase and earth :	
7		Tank	
	a)	Positive pressure(kg/sqm):	
8		Oil	
	a)	Volume of oil in main tank(Kilo ltrs):	
	b)	Make of oil	
	c)	Volume of oil in conservator (ltrs)	
9		Temp. rise above cooling water temperature in (degree Celsius)	
	a)	In oil by thermometer :	
	b)	In winding by resistance method :	
	c)	Oil temperature high, alarm :	
	d)	Oil temperature high, trip :	
	e)	winding temperature high alarm :	
	f)	winding temperature high, trip :	
10		Instrumentation	Make
	a)	Buchholz relay	
	b)	Magnetic oil Level gauge	
	c)	Wdg. Temp. Indicator	
	d)	Oil temp. indicator	
	e)	Pressure relief valve	
	f)	Control/Selector switch	
	g)	Push buttons	
	h)	Wiring/Cables	
	i)	Termination lugs (Crimping type)	
	j)	Terminal blocks (Clip-on type)	
	k)	Indicating lamps	
	l)	CT's	
11		Accessories for cooling system:	Make
	a)	Water flow indicator	
	b)	Oil flow indicator	
	c)	Expansion joints	
	d)	Pressure gauge with valve in oil inlet and outlet	
	e)	Pressure gauge with valve in water inlet & outlet	
	f)	Shutoff valves-oil pump suction & discharge	

**ANNEXURE-D
DATA SHEET**

	g)	Shutoff valves-HE inlets & outlets	
	h)	Drain valve	
	i)	Oil inlet temperature indicator	
	j)	Oil outlet temperature indicator	
	k)	Water inlet temperature indicator	
	l)	Water outlet temperature indicator	
	m)	Water & oil leakage detector	