Huawan Power

Technical Specification of Huawan

30/11kV Oil Immersed Power Transformers

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Contents

30/11kV Oil Immersed Power Transformers

1 Scope and service conditions

1.1 Scope

This specification covers the 30/11kV oil-immersed ground mounted three (3) phase power transformers for outdoor installation of the distribution network.

1.2 Service conditions

1.2.1 Normal service conditions

The transformers shall be installed at indoors or outdoors. The transformers shall be suitable for continuous operation at the below site conditions.

(a) Maximum altitude: 1,000m (ASL).

(b) Maximum ambient air temperature: +50°C

(c) Minimum ambient air temperature: -10°C

(d) Monthly average temperature of the hottest month: 40°C

(e) Yearly average temperature: 30°C

1.2.2 Unusual service conditions

Condition other than those listed in 1.2.1 for transformers are considered to be unusual. The manufacturer should discuss with Huawan for the unusual service conditions.

2 Normative references

The power transformers shall confirm to the latest edition of following international standards:

(a) IEC 60076: Power transformers

(b) IEC 60137: Insulated bushings for alternating voltages above 1 000 V

(c) IEC 60214: Tap-changers

(d) IEC 60296: Specification for unused mineral insulating oil for transformers and switchgear

(e) IEC 60354: Loading guide for oil-immersed power transformers

(f) IEC 60507: Artificial pollution tests on high-voltage insulators to be used on ac. systems

(g) BS 171: Power transformers

(h) BS 6436: Specification for ground mounted distribution transformers for cable box or

unit substation connection

(i) IEEE Std. C57.12.00: General requirements for liquid immersed distribution, power, and regulating transformers

(j) Huawan: Unused mineral insulating oil for transformers

3 Definitions

3.1 Oil-immersed type transformer

A transformer of which the magnetic circuit and windings are immersed in oil

3.2 Terminal

A conducting element intended for connecting a winding to external conductors

3.3 Winding

The assembly of turns forming an electrical circuit associated with one of the voltages assigned to the transformer

3.4 Tapped winding

A winding in which the effective number of turns can be changed insteps

3.5 High-voltage winding

The winding having the highest rated voltage

3.6 Low-voltage winding

The winding having the lowest rated voltage

3.7 Rating

Those numerical values assigned to the quantities which define the operation of the transformer in the conditions specified in this part of IEC 60076 and on which the manufacturer's guarantees and the tests are based

3.8 Rated voltage of a winding

The voltage assigned to be applied, or developed at no-load, between the terminals of an untapped winding, or of a tapped winding connected on the principal tapping. For a three-phase winding it is the voltage between line terminals.

3.9 Rated voltage ratio

The ratio of the rated voltage of a winding to the rated voltage of another winding associated with a lower or equal rated voltage.

3.10 Rated power

A conventional value of apparent power assigned to a winding which, together with the rated

voltage of the winding, determines its rated current

3.11 Rated current

The current flowing through a line terminal of a winding which is derived from rated power and rated voltage U_r for the winding

3.12 Tapping

In a transformer having a tapped winding, a specific connection of that winding, representing a definite effective number of turns in the tapped winding and, consequently, a definite turns ratio between this winding and any other winding with fixed number of turns

3.13 Principal tapping

The tapping to which the rated quantities are related

3.14 Tapping step

The difference between the tapping factors, expressed as a percentage, of two adjacent tappings

3.15 Tapping range

The variation range of the tapping factor, expressed as a percentage, compared with the value '100'

3.16 No-load tap-changer

A device for changing the tapping connections of a winding, suitable for operation while the transformer is de-energized, it means off circuit tap changer

3.17 On-load tap-changer

A device for changing the tapping connections of a winding, suitable for operation while the transformer is energized or on load

3.18 No-load loss

The active power absorbed when rated voltage (tapping voltage) at rated frequency is applied to the terminals of one of the windings, the other winding or windings being open-circuited

3.19 No-load current

The r.m.s. value of the current flowing through a line terminal of a winding when rated voltage (tapping voltage) is applied at rated frequency, the other winding or windings being open circuited

3.20 Load loss

The absorbed active power at rated frequency and reference temperature associated with a pair of windings when rated current (tapping current) is flowing through the line terminals of one of the windings, and the terminals of the other winding are short circuited.

3.21 Total losses

The sum of the no-load loss and the load loss

3.22 Short-circuit impedance of a pair of windings

The equivalent series impedance $Z = R + jX$, in ohms, at rated frequency and reference temperature, across the terminals of one winding of a pair, when the terminals of the other winding are short-

circuited and further windings, if existing, are open-circuited. For a three phase transformer the impedance is expressed as phase impedance (equivalent star connection).

In a transformer having a tapped winding, the short-circuit impedance is referred to a particular tapping. Unless otherwise specified the principal tapping applies.

3.23 Temperature rise

The difference between the temperature of the part under consideration and the temperature of the external cooling medium

3.24 Monthly average temperature

Half the sum of the average of the daily maxima and the average of the daily minima during a particular month - over many years

3.25 Yearly average temperature

One-twelfth of the sum ofthe monthly average temperatures

3.26 Sound pressure level

Ten times the logarithm to the base 10 of the ratio of the square of the sound pressure to the square of the reference sound pressure (p_0 = 20 ■ 10^{-6} Pa). It is measured in decibels.

4 Kinds and ratings

4.1 Kinds

Rated power of transformer shall be determined according to the Table 1 of this specification.

Table 1 - Kinds of transformers

Specification No.	Rated voltage ratio (kV)	Rated power (MVA)		Tap changing
		ONAN	ONAF	
2232101	30/11	5	-	NLTC
2232102		7.5	-	NLTC
2232103		10	-	OLTC
2232104		12.5	-	OLTC
2232107		20	-	OLTC
2232108		20	25	OLTC

4.2 Rating

4.2.1 Rated power

Normal rated power specified in Table 1 shall be the continuous rating under the worst temperature conditions encountered in Libya.

4.2.2 Highest voltage for equipment and rated frequency

Highest voltage for equipment shall comply with Table 2 of this specification. Rated frequency shall be 50Hz.

Table 2 - Highest voltage for equipment

Nominal voltage (kV)	30	11
Highest voltage for equipment (kV)	36	12

4.2.3 Vector group and winding connection

Vector group and winding connectionshall comply with Table 3 ofthis specification.

Table 3 - Vector group and winding connection

Rated voltage ratio (kV/kV)	30/11
Vector group (kV)	Dyn11
Connection of HV windings	o (3-phase 3-wire)
Connection ofLV windings	Y (3-phase 4-wire) (Neutral point shall be solidly earthed)

4.2.4 Parallel operation

Transformers supplied against each order shall be designed to operate in parallel satisfactory with the others when operating on the same rated power and tap position.

5 Requirements

5.1 Required structure

5.1.1 Type

The transformers shall be conservator type for outdoor installation. Transformers with rated power below than 10MVA shall be provided with no load tap changer. Rated power equal or above than 10MVA transformers shall be provided with on load tap changer.

Construction features shall permit local repairs to be easily carried out in the event of equipment failure.

5.1.2 Cooling

Cooling system of the transformers below than 25MVA shall be of natural circulation of oil and air (ONAN). And the transformers equal or above than 25MVA shall be of natural circulation of oil and forced air (ONAF) as specified in Table 1.

Electric fan(s) for ONAF cooling system shall circulate air and increase rated power not less than 25%. They shall be designed for low sound level, high efficiency and shall be covered by protection steel net. Structure of electric fan(s) shall be of easy maintenance, installation and shall not obstruct the operation of adjacent fan(s).

ONAF cooling system shall be provided with winding temperature relay, Auto-Manual switch and a control box to contain control devices.

5.1.3 Core

The core shall be of high grade cold rolled grain oriented steel sheets and securely clamped. The core shall be assembled in a manner which reduces vibration and minimize inherent noise. Both sides of individual stampings shall be coated with an insulating material which shall be

resistant against oil and temperature. The complete core shall be effectively earthed.

The maximum flux density in any part of the cores and yoke at normal voltage and frequency shall not be more than 1.65 Tesla.

The bidder shall provide saturation curve of the core material, proposed to be used. Laminations of different grade(s) and different thickness(s) are not allowed to be used in any manner or under any circumstances.

5.1.3.1. The thickness of lamination shall be 0.27 mm or less. Surface insulation of laminations shall be rust resistant and have high interred laminar resistance. Insulation shall withstand annealing temperature as high as 850^0C. Insulation shall be resistant to hot cooling medium. Laminations are not to be punched.

5.1.3.2. Bidder should have in house core cutting facility for proper monitoring & control on quality and also to avoid any possibility of mixing of prime material with defective/second grade material. This should be indicated invariably in the QAP. The Huawan engineers may witness the core-cutting process. In case the in-house core cutting facility is not available, then the same shall be carried out in the presence of the representative of Huawan.

5.1.3.3. Bidder will offer the core for stage inspection and get approval from Huawan during manufacturing stage. The bidder has to produce following documents at the time of stage inspection for confirmation of use of prime core materials.

a) Invoice of supplier

b) Mills approved test certificates.

c) Packing list

d) Bill of lading

e) Bill of entry certificate by custom.

5.1.3.4. As stated above in and in order to avoid any possibility of mixing of 'Prime material' with any other second grade/ defective material, the imported packed slit coils of cold rolled grain oriented materials shall be opened in the presence of the Huawan representative. Only after the inspection and approval from Huawan reprehensive, the core material will be cut in-house OR sent to external agency for cutting individual laminations. In case the core is sent to external agency for cutting, the Huawan representative will have full access to visit such agency for the inspection of the cutting of core.

5.1.3.5. After having sheared, the laminations shall be treated to remove all burrs and shall be re annealed in a non- oxidizing atmosphere to remove all residual stresses and restore the original magnetic properties of CRGO sheets. The insulation of the lamination shall be inert to the action of hot transformer oil. Paper and varnish insulation will not be accepted.

5.1.3.6. The core shall be rigidly clamped to ensure adequate mechanical strength and to prevent vibration during operation. The clamping structure shall be so constructed that eddy currents will be minimum.

5.1.3.7. The design of magnetic circuits shall be such as to avoid static discharges, development of short circuit paths within itself or to the earthed clamping structure and production of flux components at right angles to the plane of the laminations which may cause local heating.

5.1.3.8. Internal Earthing:

All metal parts of the transformer core assembly except individual core laminations, core bolts and side-clamping plates shall be maintained at earth potential. The magnetic circuit shall be earthed to the clamping structure through one removable core insulation test link only, placed in an accessible position beneath an inspection opening in the main tank cover. The connection to the link shall be on the same side of the core as the main clamping structure earth connection to the tank and taken from the extreme edge of the top yoke. Magnetic circuits having an insulated sectional construction shall be provided with a separate link for each individual section and the arrangement of the connections shall be subject to approval.

5.1.3.9. The core shall be provided with lugs suitable for lifting the complete core and coil assembly of the transformer.

5.1.4 Windings

The HV and LV windings shall be constructed from the best drawn copper coil with high conductivity. All turns of windings shall be adequately supported to prevent movement. The windings shall be designed to meet the three fundamental requirements: mechanical, thermal and electrical.

All windings shall be fully insulated according to IEC 60076 for standard insulation level and for a system highest voltage for transformer of 36kV and 12kV. And windings shall be wound with adequate bracing and securing tapes in order to achieve a strong, self supporting structure. Adequate cooling ducts shall be provided to ensure that temperature rise is within the permissible limits at normal operating conditions.

The windings shall be capable of sustaining short circuit forces on the transformer as required in clause 7.3 of this specification.

5.1.5 Tank

Tank shall be fabricated from excellent quality mild steel, suitably stiffened and oil tight welded. The thickness and bracing of the tankshall be such that the tank together with core and oil can be lifted and transported without deformation or loss of oil tightness. The base of the tank shall be so designed that it shall be possible to move the complete transformer unit in any direction without injury when using rollers, or skidded over plates or rails. The transformers tankshall be capable ofwithstanding full vacuum without deflection exceeding the values stated in Schedule of Tests.

Where the design of the tank is such that the bottom plates will be skid type bases, the plates shall have the following minimum Thickness:

Length of Transformer	Tank Minimum Thickness	
	Side Plates	Bottom Plates
Less than 2500mm	6mm	9mm
Greater than 2500mm	9mm	12mm

Where the design of the tank is such that the bottom plates will be in direct contact with the

surface ofthe foundations, the plates shall have the following minimum thickness:

Length of Transformer	Tank Minimum Thickness	
	Side Plates	Bottom Plates
Less than 2500mm	6mm	19mm
Greater than 2500mm	9mm	25mm

The tank shall be so designed that with the cores and windings in position there shall be no possibility of air or gas being trapped when filling the tank with oil. Likewise, water shall not be trapped on the exterior of the tank. The tank shall be fitted with pockets for a thermometer and the bulb of a winding temperature indicator and an oil temperature indicator. The thermometer pocket(s) shall befitted with captive screwed cap to prevent the ingress of dirt and water. The pocket(s) shall be located in the position ofmaximum oil temperature at rated power. It shall be possible to remove the instrument bulbs from the pockets.

The top cover of tank shall be designed in such a way that water does not accumulate. The transformer undercarriageshall be provided with bi-directional rollers to allow longitudinal and transverse movement on skid rail.

5.1.6 Radiator

The radiators shall be hot dip galvanized and painted. The design and manufacturing of the radiators shall be such as to assure vibration free operation and absence of any oil leakage, irrespective of wind velocity and atmospheric condition. The radiators shall be sturdy construction and shall be strongly fastened to the tank.

Radiators shall have enough capacity for heat radiation and mechanical strength. The design shall also avoid pockets in which water can collect. If detachable type radiators are provided, they shall be connected directly to the tank and shall be provided with flanged inlet and outlet branches. Radiator valves shall be provided on each radiator connection to the tank so that any radiator maybe removed for repairs without taking the transformer out of service. The radiator valves shall have the open and closed positions clearly marked. The radiators shall befitted with lifting lugs, suitable drain and vent plugs so that they can be completely drained and vented. Radiators shall be designed fully vacuum proof and pressure tested and shall be liquid tight.

5.1.7 Tank finish

Prior to the painting of the tank, cover and oil conservator shall be sand blasted or shot blasted. External surfaces shall be immediately after pretreatment with a two-pack epoxy primer coat. The finishing is carried out by a two-pack polyurethane paint. Total thickness shall be at least 180µm.

The inside of the transformer tank shall be painted with a two-pack epoxy primer to a minimum thickness of approximately 30µm. The external surfaces of the radiators shall be hot-dip galvanized and minimum thickness shall be 60µm.

Note: The manufacturer may propose his methodology for painting and seek Huawan approval if it is approved that it exceeds this specifications in quality and technology.

Huawan Power

5.1.8 Bushing

HV and LV bushings including neutral bushing shall be plug-in type which are connected with elbow connector or tee connector. They shall be mounted on the tank wall or on the top cover and sealed by cable boxes. The minimum phase to phase clearance and phase to earth clearance shall not be less than those stated in Table 5 of IEC 60076-3. HV bushings shall be connected with single core XLPE insulated 630mm^2 copper or aluminum cable and LV bushings shall be connected with single core XLPE insulated 400mm^2 copper or aluminum cable.

The plug-in type bushings shall be installed in a manner to prevent ingress of moisture and to facilitate easy connection with heat shrinkable or pre-molded elbow connectors.

Current rating, number and dimensions of bushings shall comply with Table 4 and Figure 1, 2, 3 of this specification.

Table 4 - Rating and number of bushings

Rated Power (MVA)	HV		LV	
	Current Rating (A)	Number of Bushings	Current Rating (A)	Number of Bushings
5	200	3 for Phase	630	3 for Phase / 1 for Neutral
7.5	200		630	
10	400		630	
12.5	400		630	6 for Phase / 1 for Neutral
20	630		630	
25	630		630	9 for Phase / 2 for Neutral

5.1.9 Cable boxes

The transformer shall have HV and LV cable boxes. The HV and LV cable boxes shall be mounted on opposite sides of the tank or on the top cover, and arranged for cables entering vertically from bottom side. All cable boxes shall be completely sealed and provided with sealing glands to suit cables and fitted with suitable means to clamp the non-armored cables.

HV cable box shall be suitable for terminating single core XLPE 630mm^2 copper or aluminum cable via 3 glands. LV cable box shall have following number of glands and shall be suitable for terminating following number of cables by rated power.

Table 5 - Number of glands and cables to be connected to LV bushings

Rated Power (MVA)	No. of Glands	No. of Cables by Phase	No. of Cables for Neutral	Cross Sectional Area of a Cable
5	4	1	1	Single Core XLPE 400mm^2
7.5				
10				
12.5	7	2	1	
20				
25	11	3	2	

All cable boxes shall withstand a continuous load of each rated power and 20% over load of transformer.

5.1.10 Glands

The glands shall be electrically separated from cable box, and the dielectric characteristics of the insulation between gland and cable box shall meet the requirements listed below.

(a) Power frequency withstand voltage: 2 kV at least

(b) Impulse withstand voltage: 6 kV at least

5.1.11 Conservator and breather

(a) The transformer shall be provided with overhead conservator tank, connected to the main tank as well as the tap changer tank at the highest point to prevent the trapping air or gas under the main tank cover.

(b) The capacity of the conservator tank shall be adequate for the expansion and contraction of oil in the whole system under specified operating conditions.

(c) Bolted end plate for internal cleaning, filling cap, drain valve with captive cap, and oil level indicator shall be provided with conservator. Valves shall be provided at the conservator to cutoff the oil supply to the transformer tank as well as tap changer tank.

(d) The conservator shall be provided with an oil seal type silica gel breather.

5.1.12 Silica gel

Silica gel breather shall contain much larger quantity of gel than normal to avoid the need for frequent replacement of the gel. The silica gel shall be free from toxic components.

5.1.13 Oil level indicator

Oil level indicator of shall be fitted to the conservator tank to show the oil level at all temperature with minimum, maximum markings and normal level marking at 30°C clearly visible from normal access level.

5.1.14 Earthing terminal

2 earthing terminals shall be provided near the bottom of tank at opposite side. The terminal shall be able to connect the earthing wire of which cross sectional area between 25mm^2 and 70mm^2.

5.1.15 Gaskets

The gasket shall be of NBR (Nitrile (Acrylonitrile) Butadiene Rubber) or better to maintain the sealing effectively through life span of transformer and shall prevent seeping of oil due to ageing and extreme operating temperature.

The gasket provided with the transformer shall be suitable for making oil tight joints, and there would be no deleterious effects on either gaskets or oil when the gaskets are continuously in contact with hot oil. Exterior gaskets shall be weatherproof and shall not be affected by strong sunlight.

Huawan Power

5.1.16 Fittings

The following fittings and accessories shall be provided but not limited.

(a) Conservator with filling holes and caps and a shut-offvalve between the conservator and the main tank

(b) Oil level gauges marked to indicate normal level at 30°C one or each side of the conservator

(c) Silica gel breather

(d) Pocket on tank cover for oil thermometer.

(e) Earthing terminals on diagonally opposite corners

(f) Weatherproofmetallic marshalling box to house all terminals, controls, etc.

(g) Bi-directional flangedrollers or skid base suitable for plinth mounting application

(h) Cable supports

(i) Ladder

(j) AVR mounted cabinet

(k) Air release device

(l) Jacking pads

(m) Lifting lugs for tank cover

(n) Lifting lugs for core and winding assembly

(o) Lifting lugs for whole tank

(p) Hauling lugs

(q) Rating and diagram plate

(r) Valve schedule plate

5.1.17 Valves

The transformer shall be fitted with following valves at the following locations for filling, draining, filtering, conservator isolation etc.

(a) Oil filtering valves located near to the bottom and the top ofthe main tank

(b) Drain and filling valve ofconservator tank

(c) Drain valve for main tank

(d) Drain valve for OLTC tank

(e) Valve between main tank and conservator tank on connecting pipe

(f) Valve between OLTC tank and conservator tank on connecting pipe

(g) Valve between main tank and each radiator

(h) Drain valve for each radiator

(i) Oil sampling cocks for main tank and OLTC tank

(j) Other necessary valves

All valves shall be made of gunmetal. They shall be of the sluice type having non-rising spindles and shall be closed by turning the hand wheel in a clock wise direction. Each valve shall be provided with an indicator to show clearly the position of the valve and also a name plate to indicate the purpose of the valve.

The valves shall have machined flanges and equipped with locking pins for locking in the closed / open position. Blank flange plates or captive screw caps shall be fitted to all valves. If possible, all valves shall be mounted such that an observer at ground level can operate them easily.

5.2 Protection devices

Following protection devices shall be provided as minimum.

(a) Buchholz relay with alarm and trip contacts

(b) Oil temperature indicator with alarm and trip contacts

(c) Winding temperature indicator with maximum pointer and alarm / trip contacts

(d) Pressure relief device with trip contact

(e) Buchholz relay for OLTC with trip contact

5.2.1 Buchholz relay with alarm and trip contacts

(a) Buchholz relayshall befitted to the oil feed pipes from the conservator tank to transformer tank as well as tap changer tank. The relays shall be mounted in such a way that all gas arising from the tanks shall freely pass into the Buchholz relay.

(b) The relays shall have alarm contacts to close on collection of gas and trip contacts to close following oil surge or low oil level conditions. The relayshall have provision for checking its operation and facility to collect gas sample at a safe and convenient level. Gas releasing valve shall be fitted with suitable operating position.

5.2.2 Oil temperature indicator with alarm and trip contacts

(a) Oil temperature indicator shall provide indication of the hottest oil temperature.

(b) The deviceshall be of dial type indicator, and, in addition,a pointer to register the highest temperature reached, which shall be re-settable.

5.2.3 Winding temperature indicator with alarm and trip contacts

(a) Winding temperature indicator shall provide indication of the maximum winding temperature.

(b) The device shall be of dial type indicator, and, in addition, a pointer to register the highest temperature reached, which shall be re-settable.

5.2.4 Pressure relief device with trip contact

(a) A pressure relief device of suitable size shall be mounted on the tank cover for the rapid release of any pressure that maybe generated in the tank.

(b) The device shall be capable of maintaining the oil tightness of the transformer under all conditions of normal service. It shall prevent the ingress of rain/moisture or oil flow

from the transformer after the operation of the device to relieve an internally generated pressure.

5.2.5 Contacts

All kinds of contacts for alarm, trip and signal shall be normally open type and shall not be earthed. Voltage rating shall be 110V DC.

6 Tap changer

6.1 No load tap changer (Off circuit tap changer)

The HV winding of the 5MVA and 7.5MVA transformers shall be provided with no load tap changer having minimum 9 tapping positions. They are principal tapping and ±2.5%×4 tapping positions. It shall be manually operated at outside of transformer and shall be operated by tap changing handle. Tap position indication shall be cleared marked.

Switching position of No.1 shall correspond to maximum plus tapping. The tap position of each phase shall be placed at same position with a single handle operation.

6.2 On load tap changer

The HV winding of transformers equal or above 10MVA shall be provided with **vacuum type** onload tap changer having minimum 17 tapping positions. They are principal tapping and ±1.25%×8 tapping positions operated by an on-circuit taping switch.

OLTC shall be suitable for the rated current and 20% overload current of each transformer. The tap position of each phase shall be placed at same position with a single operation.

6.2.1 Type

The vacuum OLTC shall consists of tap selector, tap changing vacuum switches, current limiting resistance or reactor, motor driven device, control devices and protection devices.

The tap-changing mechanism shall be motor-driven, quick-break type, and shall be completely oil-immersed. OnLoad Tap Changer (OLTC) shall be provided with the transformer and made by a reputational manufacturer (Manufacturer of the vacuum OLTC shall be approved by Huawan). The tap changer shall be designed for voltage control through local control panel and also remote control panel in a control room. OLTC shall comply with the requirements of IEC 60214.

6.2.2 Structure

Current making and breaking switches integral of OLTC shall be contained in a separate tank. Tank design shall make it impossible of the oil mixture with oil in the tap selector and main transformer.

The tap changer shall be easily accessible so that it could be inspected and removed without removal main tank cover.

6.2.3 Manual operation

Manual operation by means of a suitable operating handle shall be possible. Interlocks shall be provided to prevent simultaneous operation of manual and electric drive. The tap changing process once initiated shall be completed even in case of power failure to the driving

mechanism and shall not be left in an intermediate position. The manual operating handle shall be provided and housed in the control box.

6.2.4 Power supply

The OLTC motor shall operate on single phase 230V AC or three phase 230/400V AC and control circuit / instruments shall be designed for 110V DC supply.

6.2.5 Lifespan

The on load tap changer shall be electrically operated at least 300,000 times, and mechanically operated at least 500,000 times without maintenance.

6.2.6 Control box

The mechanism, fuses, relays and control equipment shall be housed in a suitable weather proof metallic control box (IP 55) mounted on wall of main tank.

The front panel assembly shall be constructed to provide direct control interchangeability without removal of the control enclosure. Visible means shall be provided to de-energize the control and short the current transformer prior to control testing or removal.

All leads in the control enclosureshall be color coded and labeled for easy identification. The terminal strips of the control back panel shall consist of clamp-style quick connectors for ease of access. All printed circuit boards shall be conformal coated for fungi and moisture protection.

There shall be a locking device at outside of the box. The doorshall be hinged type and there shall be a hole at the bottom side for entrance of control cables.

6.2.7 Control functions

The control shall have following devices and functions as minimum.

(a) Tap position indicator which tracks the movement of the tap changer motor

(b) A six-digit electronic operations counter, which counts every tap changes

(c) A AUTO / MANUAL switch, which allows automatic or manual operation of the OLTC. Motor control shall be permitted only when the switch is on the AUTO position.

(d) A RAISE / LOWER switch, which shall only be active when the control switch is in the MANUAL position

(e) Adjustable time delay

(f) Adjustable set voltage bandwidth

(g) Terminal block which have symbol marking to connect control cables with control circuits, current transformers and voltage transformers

(h) Automatic voltage regulator with resistance / reactance and voltage control devices

(i) Asingle phase 230V power outlet for lamp

(j) Heater to prevent condensation

(k) All necessary meters, relays, signal lamps and switches for automatic OLTC operation

(l) Accuracy of control devices shall be ±1.0%

7 Required characteristics

7.1 Short circuit impedance

The minimum short circuit impedance shall comply with Table 6 of this specification.

Table 6 - Minimum short circuit impedance (ONAN)

Rated Power (MVA)	Minimum short circuit impedance
5	7 %
7.5	8 %
10	8 %
12.5	8 %
20	**10** %

The guaranteed short circuit impedance shall be stated by the supplier. The toleranceshall be ±10.0% of the declared value at principal tapping and ±15.0% of the declared value at other tappings.

7.2 Temperature rise

The transformers shall be capable of carrying their full normal rated current continuously under the worst temperature conditions encountered in Libya. Temperature rise of top oil shall not exceed 50°C as measured by thermometer and temperature rise of windingshall not exceed 55°C as measured by resistance.

The transformers shall be continuously operated at 105% of secondary rated voltage and 80% of load factor without exceeding above temperature rise limit. And they shall be continuously operated also at 110% of secondary rated voltage at no load without exceeding above temperature rise limit.

7.3 Duty under faults

The transformers shall be capable of sustaining short circuit current without damage or distress at least 2 seconds.

7.4 Insulation

The insulation of the bushings, terminations and windings shall be suitable as to meet the requirements of the appropriate insulation class as specified in Table 7 and Table 8 of this specification.

Table 7 - Insulation level oftransformers

System highest voltage (kV)	Lightning impulse withstand voltage (kV peak)	Power frequency withstand voltage (kV rms)
12	75	28
36	170	70

Table 8 - Insulation level of bushings

System highest voltage (kV)	Lightning impulse withstand voltage (kV peak)	Power frequency withstand voltage (kV rms, wet and dry)
12	75	28
36	170	70

7.5 Load and no load losses

Load loss and no load loss shall be stated by the supplier. Tolerance shall not exceed +15% of no load loss, +15% of load loss and +10% of total loss. No-load loss and load loss limits shall be according to the following table:

Table 9 - No-load loss and load loss limit

Rated Power	No Load Loss (KW)	Load Loss (KW)
10 MVA	10	70
20 MVA	14	96

7.6 No-load current

No-load current shall be stated by the supplier. Tolerance shall not exceed +30% of the declared value.

7.7 Voltage drop

The maximum voltage drop shall be stated by the supplier. All values shall be measured at 1.0 power factor, 100% load and adjusted to 75°C.

7.8 Efficiency

The minimum efficiency shall be stated by the supplier. All values shall be measured at 1.0 power factor, 100% load and adjusted to 75°C.

7.9 Bushing

The electrical characteristics of bushings shall meet the requirements of IEC 60137 and IEC 60507.

7.10 Sound level

All transformers with their accessories shall be designed and manufactured to reduce noise and vibration to acceptable level. The average surface sound level of transformers shall not exceed the following values. The transformershall be subjected to sound level measurement as per IEC 60076-10.

Table 10 – Sound level limit

Rated Power	Maximum Sound Level	
	ONAN	ONAF
5 MVA	65 dB	-
7.5 MVA	67 dB	-
10 MVA	68 dB	-
12.5 MVA	69 dB	-
20 MVA	71 dB	-
25 MVA	71 dB	73 dB

7.11 Insulation oil

The transformer shall be supplied with being filled with mineral insulation oil. The characteristics of insulation oil shall meet the Table 2 of IEC 60296 and GES 6071101. The oil shall not be contaminated by Poly Chlorinated Biphenyls (PCB).

8 Tests

Routine tests shall be repeated in the presence of Huawan representatives on all the quantity offered for inspection. Huawan reserves the rights to ask for several kinds of type tests and/or special tests to confirm the quality ofthe transformers in the presence of Huawan representatives.

Huawan inspectorscantest distribution transformers by using their own testing instruments at manufacturer's premises. During the witnessing of testing of transformer at the supplier's works Torrent power will also connect Huawan's meters and supplier has to agree for the same.

Huawan may carry out routine tests in its laboratory on random basis on 20% of each batch delivered to Huawan stores. If one transformer fails, Huawan can decide to reject the batch, if pass Huawan can decide to test any number of transformers of the same batch and the supplier shall replace any failed transformer.

Huawan may, at its option, open a transformer supplied to the stores, in supplier presence at site or at departmental stores. If any of the technical particulars are seen to be at variance than the guaranteed technical particulars, the whole lot of transformer will be rejected and risk purchase resorted to.

In addition to the above, Huawan may pickup any transformer and decides to get it type tested from competent and authorized body at Huawan's cost. The supplier will be invited to witness packing of the transformer at Huawan's stores, and the type tests. If the transformer fails to meet the requirement at type tests, the quantity of the transformer ordered on them will be forthwith rejected.

8.1 Type tests

(a) Temperature-rise test (IEC 60076-2)

(b) Lightning impulse test (IEC 60076-3)

8.2 Routine tests

(a) Visual inspection

(b) Oil Leakage Tests:

All tanks and oil filled compartments shall be tested for oil tightness by being completely filled with air/oil of a viscosity not greater than that of insulating oil conforming to the latest edition of IS: 335 at an ambient temperature and subjected to a pressure equal to the normal pressure plus 0.35 Kg/cm2 measured at the base for a period not less than 12 hours for oil and I hour for air during which time no leakage shall occur.

(c) Measurement of winding resistance (IEC 60076-1, 10.2)

(d) Measurement of voltage ratio and check of phase displacement (IEC 60076-1, 10.3)

(e) Measurement of short-circuit impedance and load loss (IEC 60076-1, 10.4)

(f) Measurement of no-load loss and current (IEC 60076-1, 10.5)

(g) Separate source voltage withstand test (IEC 60076-3)

(h) Induced overvoltage withstand test (IEC 60076-3)

(i) Test on OnLoad Tap Changer, if applicable (IEC 60214)

8.3 Special tests

(a) Partial discharge test (IEC 60270 and Annex A of IEC 60076-3)

(b) Chopped wave test, if applicable (IEC 60076-3)

(c) Determination of capacitances windings-to-earth, and between windings

(d) Determination of transient voltage transfer characteristics

(e) Measurement of zero-sequence impedance(s) on three-phase transformers (IEC 60076-1, 10.7)

(f) Short-circuit withstand test (IEC 60076-5)

(g) Determination of sound levels (IEC 60076-10)

(h) Measurement of the harmonics of the no-load current (IEC 60076-1, 10.6)

(i) Measurement of the power taken by the fan and oil pump motors

9 Rating and diagram plates

The transformer shall be provided with a rating plate and tapping connection diagram and valve schedule diagram plates of weatherproof material, fitted in a visible position and clearly readable at safety distance when cables are connected, showing the appropriate items indicated below but not limited. The characters shall be English roman letters and Arabic numeral characters.

Symbols and text shall be indelibly molded, stamped or engraved in a plate material and they shall be at least 4.0mm high. If not contrasting in colour, they shall be grooved at least 0.5mm high.

9.1 Rating plate

The rating plateshall include following items;

(a) Kind oftransformer

(b) Applicable international standard

(c) Manufacturer's name

(d) Manufacturer's serial number

(e) Year ofmanufacture

(f) Number ofphases

(g) Rated power in MVA

(h) Rated frequency in Hz

(i) Rated voltages and tapping range ofHV(kV) and LV(V)

(j) Rated currents ofeach tapping ofHV and LV in A

(k) Drawing ofvector group

(l) Short-circuit impedance, measured value in percentage

(m) Type ofcooling

(n) Total mass

(o) Mass ofinsulating oil

(p) Insulation level ofHV and LV

(q) Temperature rises oftop oil and windings

(r) Insulating liquid

(s) Normal operation conditions: Highest ambient temperature and altitude

10 Marking

Terminal markings shall be easily visible when the transformer is in service and the entries shall be indelibly marked. The characters shall be English capital roman letters and Arabic numeral characters. HV terminal symbol shall be 1U, 1V and 1W. LV terminal symbol shall be 2U, 2V, 2W and 2N. Terminal symbols shall be indelibly marked in front ofterminal bushings and on cable box both.

11 Packing and Delivery

The suppliershall provide packing ofthe transformers as is required to prevent their damage or deterioration during transit to their final destination and long period ofstorage. The packing shall be sufficient to withstand, without limitation, rough handling during transit and exposure to extreme temperatures, salt and precipitation during transit and open storage.

(a) Core and windings shall be fully dried before shipping or assembling. Bushings, radiators and other fittings which are easily damaged during transportation shall be separated from main tank and packed with special packing materials. The parts which are sensitive to humidity shall be packed with dehumidifying agent.

(b) The tankshall be filled with Nitrogen Gas and pressure shall be checked frequently.

(c) Shock recorder shall be installed at the bottom of transformer during the transportation. The recorder shall be returned to supplier after transportation.

(d) All transformers and its components shall be shipped from the factory to the specified site.

(e) The parts of a transformer shall be packaged by one set even though the numbers of transformers to be supplied are plural.

(f) Each shipment shall include a detailed packing list identifying all items by part number, including hardware.

(g) All materialshall be carefully loaded for protection during shipment.

(h) Small parts and fasteners shall be carefully boxed, crated, bagged or otherwise containerized and protected for shipment.

(i) All materials shall be arranged to allow safe unloading at the site.

(j) There shall be handling instruction to minimize damage.

The outer packing must be clearly marked on at least four (4) sides as follows;

(a) Name ofthe procuring department

(b) Name ofthe supplier

(c) Contract description and number

(d) Final destination

(e) Gross weight

(f) Any special lifting instructions

(g) Any special handling instructions

(h) Any relevant pollution or environment classifications

12 Spare parts and special tools

12.1 Spare parts

A list and detailed prices of recommended spare parts including followings shall be furnished with the offer.

(a) 1 set ofall kinds ofgasket

(b) Buchholz relay

(c) Winding temperature indicator

(d) Oil temperature indicator

(e) Raise & lower relay for OLTC

(f) A complete set of current breaking contact of OLTC

(g) Moving cylinder of OLTC

(h) Recommended spare parts for good operation

12.2 Special tools

The supplier shall specify if any special tools are required for the maintenance of transformers. A schedule of prices and quantities of special tools shall be given with the offer.

13 Document and certificate

The transformers and all associated materials quoted by the supplier shall be approved by Huawan. The quantity of documents and certificates submitted shall be not less than three copies. The transformer shall conform to the latest edition of IEC including Clause 2 of this specification or any other equivalent international standards. The design and construction of transformer shall be subjected to the approval of Huawan.

13.1 Information to be provided with the BID

Technical descriptions, data sheets, catalogues and other information shall be submitted with the BID and those which are submitted shall be sufficient to enable Huawan to evaluate thoroughly the proposal as to its compliance with the requirements of this specification.

The minimum requirement is as follows:

(a) Detailed summary of difference with this specification

(b) Technical Data Sheet duly filled in and signed (Annex A)

(c) Material safety data certificates of all chemical materials used for manufacturing such as insulating fluid, painting, gasket and gas, etc.

(d) Detailed drawing of all components in A3 or A4 size

(e) Control circuit diagram including OLTC

(f) Characteristics curve and/or data of protection devices

(g) Detailed handling, installation and maintenance manual & schedule for good operation

(h) Brochures and catalogues containing outline dimensions, main electrical and mechanical data, etc.

(i) Applicable design specification and standards in English language

(j) Test certificates approved by international institute

(k) Quality control system and relevant certificate

13.2 Documents to be approved by Huawan

The supplier shall furnish all relevant technical information, drawings etc. to Huawan for approval prior to the start of manufacture. Offers without Technical Data Sheet completely filled in will be rejected.

(a) Vendor(s) details/ Reference list

(b) Technical Data Sheet

(c) Tests schedule and procedures

(d) Transportation schedule and storage conditions

(e) Drawings of materials (All drawings shall be in A3 or A4 size with title block approved by Huawan)

13.3 Documentation

All documents supplied under this specification shall be documented to the extent that the end user can easily understand its theory of operation, performance, installation and maintenance for the product. All documents shall be submitted being filed in order to approve of Huawan and reorder later.

Language in all documents and drawings shall be written in English and dimensions shall be used in metric SI-units.

14 Warranty

The supplier shall provide a full FIVE (5) years limited warranty on all equipment supplied. The warranty shall cover all parts and all costs, which are directly attributable to the supplier. Warranty coverage shall begin on the date that the equipment is received.

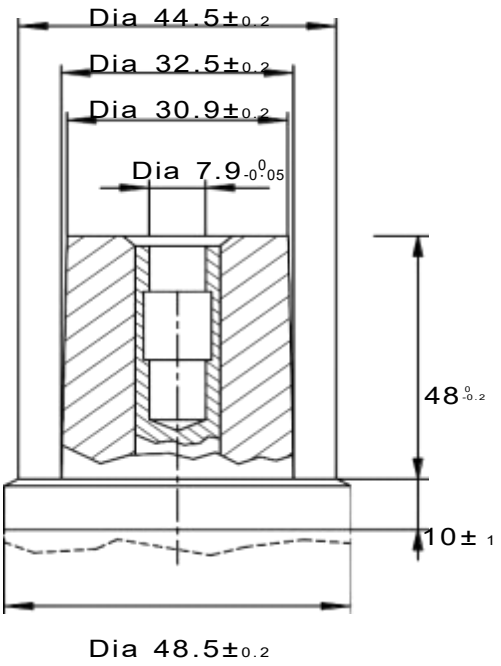

Figure 1 - 200A plug-in type bushing

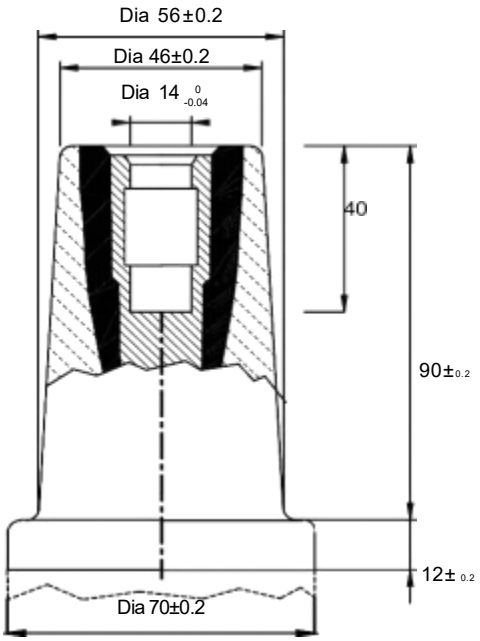

Figure 2 - 400A plug-in type bushing

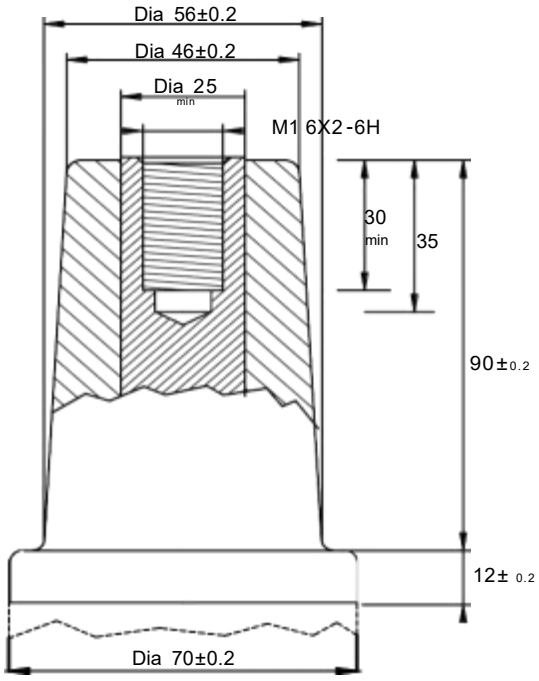

Figure 3 - 630A plug-in type bushing

Technical Data Sheet

No.	Description	Particulars
1	Manufacturer's name & Country oforigin	
2	Applicable international standards	
3	Conservator or sealed type	
4	Rated power (ONAN/ONAF, MVA)	
5	Rated voltage ratio at principal tapping (kV/V)	
6	Rated frequency (Hz)	
7	System highest voltage (kV) a) HV b) LV	
8	Cooling type	
9	Vector Group	
10	Tap changer (NLTC or OLTC)	
11	Tapping range (for NLTC)	
12	Core a) Maximum flux density at nominal voltage and frequency (Tesla) b) Thickness of lamination (mm) c) Iron loss per kg. weight of core (W)	
13	Winding a) Material of HV winding b) Material of LV winding	
14	Resistance ofwindings per phase at 75°C a) HV winding (Ω) b) LV winding (Ω)	
15	Cross sectional area of winding a) HV winding (mm^2) b) LV winding (mm^2)	
16	Cable box a) Number of gland(s) and adaptable cable size at HV terminal b) Number of gland(s) and adaptable cable size at LV terminal	

Signature : _____

Technical Data Sheet

No.	Description	Particulars
17	Short circuit impedance (ONAN)	
	a) At principal tapping & rated frequency (%)	
	b) At highest tapping & rated frequency (%)	
	c) At lowest tapping & rated frequency (%)	
18	Short circuit impedance (ONAF)	
	a) At principal tapping & rated frequency (%)	
	b) At highest tapping & rated frequency (%)	
	c) At lowest tapping & rated frequency (%)	
19	Short circuit duration (Sec.)	
20	Maximum temp. rise at rated full loading:	
	a) Oil (°C)	
	b) Winding (°C)	
21	Losses	
	a) Load loss at rated voltage and tapping, on full load at 75°C (kW)	
	b) No load loss at rated voltage & frequency (kW)	
	c) Total loss (kW)	
22	No load current (%)	
23	Voltage regulation	
	a) At 1.0 P.F (%)	
	b) At 0.8 P.F. lagging (%)	
24	Efficiency	
	a) 100% load at 1.0 P.F. (%)	
	b) 100% load at 0.8 P.F. (%)	
25	Sound level (ONAN/ONAF, dB)	
26	Insulation level	
	a) HV	
	i) Power frequency withstand voltage (KV rms)	
	ii) Lightning impulse withstand voltage (kV peak)	
	b) LV	
	i) Power frequency withstand voltage (KV rms)	
	ii) Lightning impulse withstand voltage (kV peak)	

Signature : _____

Technical Data Sheet

No.	Description	Particulars
27	Tank	
	a) Material of tank	
	b) Thickness of tank	
	i) Body (mm)	
	ii) Bottom (mm)	
	iii) Cover (mm)	
	iv) Radiator (mm)	
	c) Max. pressure tank can sustain (kg/cm^2)	
28	Tank finish	
	a) Type of paint applied internally	
	b) Type of paint applied externally	
	c) Color of tank	
	d) Thickness of coating (inside / outside, µm)	
	e) Thickness of hot dip galvanization of radiator (µm).	
29	Gasket	
	a) Material	
	b) Thickness (mm)	
30	Insulation oil	
	a) Total oil required (Liters)	
	b) Mass of oil (kg)	
	c) Breakdown voltage at 2.5mm distance (kV)	
31	c) Oil grade and standard specification adopted OLTC (if applicable)	
	a) Name of manufacturer	
	b) Rated Voltage (kV)	
	c) Rated Current (A)	
	d) BIL (kV)	
	f) Range of voltage regulation (%)	
	e) Number of steps	
	i) Number of steps for boost	
	ii) Number of steps for buck	
	iii) Step numbers	

Signature : _____

Technical Data Sheet

No.	Description	Particulars
	f) Power supply for OLTC motor	
	i) Power supply method	
	ii) Voltage (VAC)	
	iii) Auxiliary power supply (V DC)	
32	g) IP of control box Bushing	
	a) Clearance between bushings	
	i) HV bushings	
	ii) LV bushings	
	b) Insulation level of HV bushings	
	i) Power frequency withstand voltage (kV rms, dry/wet))	
	ii) Lightning impulse withstand voltage (kV peak)	
	c) Insulation level of LV bushings	
	i) Power frequency withstand voltage (kV rms, dry/wet))	
	ii) Lightning impulse withstand voltage (kV peak)	
	d) Current rating and number of bushings	
	i) HV (A, Nos.)	
	ii) LV (A, Nos.)	
33	Valves	
	a) Material	
	b) Type	
	c) Size	
	d) Locations	
34	Cooling fan	
	a) Number of fans	
	b) Power of fans (kW, VAC)	
35	Mass	
	a) Core and winding (kg)	
	b) Complete transformer excluding oil (kg)	
	c) Transformer arranged for shipment (kg)	

Signature : _____

Technical Data Sheet

No.	Description	Particulars
36	Overall dimensions (Height (mm) × Length (mm) × Width (mm))	
37	Protection devices and initial settings	
38	List of fittings	
39	List and number of valves	
40	List of recommended spare parts	

Signature :_____

Designation :_____

Name of Tenderer :_____

_____

Date :_____