

**UNITED ARAB EMIRATES**

**FEDERAL ELECTRICITY AND WATER AUTHORITY**

**DETAILED TECHNICAL SPECIFICATION FOR  
33/11KV 20/28MVA POWER TRANSFORMER,  
NER & RTCC PANELS**

## **SPECIFICATION NO. Tx- 1.03**

(Revised in March 2010)

### **SPECIFICATION FOR 20/28 MVA (ONAN/ONAF), 33/11KV POWER TRANSFORMER**

#### **TRANSFORMERS**

##### 1. **STANDARD SPECIFICATIONS:**

The transformers shall conform to the latest edition of IEC 60076 or any other equivalent international standard. The design and construction of the transformers shall be subject to the approval of the Federal Electricity & Water Authority (FEWA).

##### 2. **GENERAL**

The transformers shall be suitable for continuous operation on a three-phase 50 Hz high voltage transmission system as specified in the Schedule of Requirements.

The transformers shall be of the three phase oil immersed type and designed with particular attention to the suppression of harmonic especially the third and fifth harmonics and to minimize the detrimental effects resulting there from. All transformers shall be suitable for outdoor installation on concrete bases and shall be designed to operate satisfactorily in parallel with each other.

The cooling for the transformers shall be ONAN/ONAF as specified.

##### 3. **CLIMATE AND SITE CONDITIONS**

The climate is generally hot and humid desert climate. The contractor shall fully acquaint himself with the detailed climatological particulars which are summarized as follows :

Maximum ambient temperature	50 deg. C
Minimum ambient temperature	1 deg. C
Maximum surface temperature	85 deg. C
Maximum relative humidity	100 %
Silicate altitude	Below 1000 M
Isokeraunic level	less than 30 days P.A.

Rainfall is very erratic and the amount of precipitation under normal circumstances is of no significance but attention should be paid to the fact that during winter period sudden heavy rainfalls can occur for short periods and this causes run off from the steep mountains.

Strong winds are very common reaching velocities well over 100 Km/h. Sand storms and dust storms are very frequent.

Particular attention shall be paid to the prevailing severely corrosive conditions. A considerable amount of salt is contained in the atmosphere, thus producing severe corrosion attack, which is exacerbated by the high ambient humidity.

In the design of all plant and equipment for incorporation in the works it is to be recognized that the site is within an area of minimal seismic activity.

#### 4 EQUIPMENT MANUFACTURERS

##### Power Transformers and Associated Equipments

The power transformers, OLTC, RTCC etc. must be manufactured by quality manufacturer in Europe, North America or Japan only.

#### 5 RATED QUANTITIES

##### 5.1 Rated Power, Temperature Rise and Overload Capability

The transformer shall be capable of operating at the rated power specified in the schedule on a continuous basis and with the cooling classification given. Air temperature for the basis of design shall be not less than the maximum stated in the schedules to allow for high atmospheric temperatures, the allowable temperature rises shall be reduced in accordance with IEC 60076-2.

The continuous maximum rating specified in the schedules are under UAE site conditions and the Tenderer shall indicate in the Schedule of Technical Particulars the design rating based on IEC standard and the derating factor applied to arrive at the site rating specified.

The temperature rises specified in the schedule shall not be exceeded when the transformer is operated continuously at the stated power and cooling classification.

The transformer and associated equipment such as bushings, terminations, tap changers and integral instrument transformers shall be capable of overloading in accordance with IEC 354.

##### 5.2 Rated Voltage and Tappings

The principle tapping rated voltages shall be as specified in the schedules.

When tappings are specified these shall provide a variation in transformation ratio without producing phase displacement. Tapping step and tapping range shall be as specified in the schedules.

All tappings shall be full power tappings. Power flow shall be taken as bi-directional unless identified to the contrary in the Schedules.

##### 5.3 Operation at Higher than Rated Voltage

The transformer shall comply with IEC 76-1 in respect of operation at a voltage higher than rated voltage, including operation at up to 100% rated voltage.

##### 5.4 Impedance Voltage and Short Circuit Impedance

The impedance voltage at principal tapping shall be as specified in the schedule.

##### 5.5 Ability to withstand Short Circuit

The transformer shall be designed and constructed to withstand, without damage, the thermal and dynamic effects of external short circuits.

It is to be assumed that the amount of generating plant simultaneously connected is such that normal voltage will be maintained on one side of any transformer when there is a short circuit between phases or to earth on the other side.

All transformers shall be capable of withstanding, on any tapping, for TWO SECONDS without damage an external short circuit between phases.

Evidence shall be submitted with the tender as to the extent to which the manufacturer has proved or is able to prove either by calculation or test the ability of the specified transformer to withstand on any tapping, without damage under service conditions, the mechanical stresses arising under short circuit. In accordance with IEC 76 the electro-magnetic forces under short circuit shall be as determined from the asymmetrical peak value of the current in the windings, which shall be taken as not greater than 2.55 times the over current r.m.s. value derived from the appropriate conditions specified in the schedules.

The Tenderer shall state in the Schedule of Particulars a brief description of those transformers or parts thereof, which have been subjected to short circuit tests for which short circuit calculations are available. It is preferred that this information relates to designs comparable with the transformer tendered but in the event that this is not so the Authority reserves the right to seek calculations to prove that the design of the transformers tendered will satisfactorily comply with this clause.

#### 5.6 Insulation Levels

The rated impulse withstand voltages and rated short duration power frequency withstand voltages shall be as specified in the schedule.

#### 5.7 Type Tests

Certified copies of the type and special test certificates, not older than seven years from accredited laboratory, shall be supplied along with the offer. If approved type and special test certificates pertaining to similar transformers are not enclosed with the offer or the ones submitted are not acceptable to FEWA, the Authority reserve their right to ask for short circuit withstand test, impulse withstand test and temperature rise test to be carried out in the presence of Authority's representatives without any extra cost to the Authority.

Also the additional time required for carrying out such type tests shall not relieve the contractor of his obligations to complete the works within the contract completion time. In addition, the contractor shall bear all costs in connection with the witnessing of such tests by the Authority and such costs are deemed to be included in the contract price. However, the cost towards travel, accommodation etc. of Authority's representative shall not be included in the quoted price.

#### 5.8 Routine Tests

All transformers shall be subjected to routine tests including oil leakage tests, according to the relevant approved specifications in presence of FEWA representatives at manufacturers works. The transformers shall be subjected to pressure equal to the normal pressure plus 35 KN/m<sup>2</sup>. This pressure shall be maintained for a period of not less than 48 hours during which no leakage shall occur. It should be possible for FEWA representatives to check the pressure of any individual transformer at any time. Manufacturer shall give details of the procedure for this test in his offer.

The supplier shall make provision in his offer to bear all costs that are incurred in carrying out these tests to the satisfaction of FEWA. However, the costs towards travel, accommodation etc. of FEWA representatives shall not be included in the quoted price.

## 6 CORE

### 6.1 Material

All transformer cores shall be fabricated from cold-rolled grain oriented silicon or other approved steel having low-loss characteristics.

### 6.2 Construction

The magnetic circuit shall be of core type construction designed to avoid static discharges and the development of short circuit paths within itself or to the earthed clamping structure. Metered joints between cores and yokes shall be employed on all sizes of transformer in which this technique is practicable.

All parts of the core shall be robust design capable of with- standing mechanical shocks, and bracing of the core and winding assembly must be adequate to prevent any movement relative to the tank during lifting, transportation and handling of the transformer.

All structural members of the assembled cores shall be of steel except where conventional core-bolt clamping is replaced by an approved taping or banded clamping technique.

Adequate fitments shall be provided for lifting the completed core and windings, and suitable accommodation, attached to each transformer, shall be provided for the storage of any removable parts of the lifting facility.

All casings shall be fettled, and structural steel shall be adequately painted before being built into the structure. Any non-magnetic or high-resistance alloy included in the design shall be subject to approval.

The supporting framework of the core shall be designed to avoid the presence of pockets which would prevent complete emptying of the tank through the drain valve, cause the trapping of air during filling, or cause the trapping of gases which evolve during in-service faults.

### 6.3 Oil Ducts

Oil ducts shall be provided where necessary to ensure adequate cooling. The winding structure and main insulation shall not obstruct the free flow of oil through such ducts. Where the magnetic circuit is divided into packets separated by more than 2.5 mm by cooling ducts parallel to the plane of the laminations or by insulating material, tinned copper strip bridging pieces shall be inserted to maintain electrical continuity between the packets.

### 6.4 Insulation

Individual laminations shall be insulated with material, which will not deteriorate due to the action of pressure and hot oil.

The magnetic circuit shall be earthed, in accordance with Clause 6.5. With the earthing removed, the magnetic circuit shall be insulated from the clamping and supporting structure and all structural parts, and shall withstand a test voltage of 2000 volts (r.m.s.) for one minute.

The class and type of insulation used on the core bolts and under nuts and side plates shall be stated in the Schedules.

## 6.5 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.

Where oil ducts or insulating barriers parallel to the plane of the laminations divide the magnetic circuit into two or more electrically divided parts, the ducts or barriers shall be bridged in accordance with Clause 6.3 and the magnetic circuit shall not be regarded as being of sectional construction.

## 6.6 Flux Density

The maximum flux density in any part of the core and yokes at principal tapping ratio and rated voltage, and at nominal frequency shall not exceed 1.6 Tesla.

Provided the Contractor can provide adequate evidence that there will be no adverse effects due to core or stray flux heating with the quality of steel employed, designs may be offered such that when operating under the most onerous conditions, flux density in any part of the magnetic circuit does not exceed 1.9 Tesla.

Typical loss curve characteristics for the core material being used shall be submitted with the offer.

The Contractor shall state the maximum flux densities attained under the simultaneously applied operating stated in the Schedule of Particulars and Guarantees.

## 7 WINDINGS

### 7.1 Conductor Material

The windings shall be of high-conductivity electrolytic copper and transposed winding conductors shall be employed where appropriate.

### 7.2 Clamping and Bracing

The windings shall be designed to reduce to a minimum the out of balance electro magnetic forces in the transformer at all voltage ratios.

The windings and connections shall be adequately braced to withstand mechanical shocks and electro magnetic impulsive forces, which may occur during handling, transportation and in service.

The stacks of windings shall receive adequate shrinkage treatment before final assembly.

Coil clamping rings shall be of approved material. Axially laminated material other than bakelised paper shall not be used. Where such bakelised paper rings are used it will only be approved, as major insulation between the windings and earth if the creepage voltage stress obtained by dividing the line voltage by the creepage distance to earth does not exceed 200 kV/m. If metal clamping rings are used they shall be made of steel. They shall be earthed by connecting to core clamping structure on the same side of the transformer as the main connection and designed so that maximum operating temperature shall not exceed the average temperature of the windings.

Any metal pieces in contact with non metallic clamping rings shall be so designed and secured that they do not weaken the electrical or the mechanical properties of the rings.

If the winding is built up of sections or disc coils, separated by spacers, the clamping arrangements shall ensure that equal pressures are applied to all columns of spacers.

All such spacers shall be of approved material and shall receive adequate shrinkage treatment before assembly.

### 7.3 Insulation

The insulation of windings and connections shall not be liable to soften, ooze out, shrink or collapse during service.

For oil immersed transformers the winding insulation material shall be to Class A as defined in IEC 85.

All windings shall be fully insulated as defined in IEC 76-3 and shall have uniform insulation for 33kV and below.

### 7.4 Connections

The transformer windings shall be connected in accordance with the group of symbols in IEC 76-1 and as specified in the schedules.

The star point of star and interconnected star windings shall be brought to an external terminal.

### 7.5 Terminal and Tapping Marking

Terminal and tapping marking shall be in accordance with IEC 616.

## 8 TANK

### 8.1 Construction

The transformer shall be enclosed in a suitably stiffened welded steel oil tight tank. The thickness and bracing of the tank shall be such that the tank together with core and oil can be lifted and transported without damage 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 tank shall be capable of withstanding 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 in direct contact with the surface of the foundations, the plates shall have the following minimum thickness.

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

Where skid type bases are provided, the plates shall have the following minimum thickness.

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

Unless otherwise specified in the Schedule of Requirement transformers may have either flat or skid bases. Unless specifically approved by the Authority, detachable under bases must not be used.

The base of each track shall be so designed that it is possible to move the complete transformer unit in any direction without injury when using rollers, plates or rails. A design, which required that slide rails be placed in a particular position, is not to be used.

20/28 MVA and lower rate transformers shall be provided with base plates having bi-directional wheels for placing on rails.

All joints other than those, which may have to be broken, shall be welded. Caulking of defective welded joints will not be permitted but such defective joints may be re-welded subject to the written approval of the Authority.

Where called for in the Schedule of Requirements, accommodation shall be provided for bushing current transformers and also for outdoor weatherproof neutral current transformers as required.

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 be fitted with captive screwed cap to prevent the ingress of dirt and water. The pocket(s) shall be located in the position of maximum oil temperature at rated power. It shall be possible to remove the instrument bulbs from the pockets.

## 8.2 Pressure Relief Device

The transformer shall be fitted with a pressure relief device designed to protect the tank from damage and to control the expulsion of oil during an internal fault.

The pressure relief device shall be of the spring-loaded diaphragm type capable of opening fully within two milliseconds of detecting an excess pressure, and shall fully reseal after release of the exceeded pressure.

Corrosion resistant materials shall be used and a visual indication of operation shall be provided. Two pairs of normally open contacts and a suitable terminal box shall be provided for remote electrical indication and tripping.

## 8.3 Lifting and Haulage

The tank shall be provided with the following handling facilities, the first three of which must be capable of lifting and/or moving the transformer complete and filled with oil:-

- (a) Lifting lugs of ample dimensions designed so that standard lifting shackles can be readily attached without removing any tank attachments.
- (b) A minimum of four jacking pads suitably located in accessible positions shall be provided to enable the transformer to be raised or lowered using hydraulic or screw jacks. The pads shall be adequately braced and project a sufficient distance from the transformer side to enable a standard jack to be properly located. The minimum height of the jacking pads above the base shall be 450 mm.
- (c) Four anchor points shall be fitted to each transformer tank at not more than 750 mm from the base to enable the transformer, complete and filled with oil, to be slewed or hauled in any direction.
- (d) Lifting handles shall be provided on the tank lid and hand hole covers (where the size and weight of such covers would make handling difficult) to the approval of the Authority.

## 8.4 Covers

The tanks cover shall be so constructed that it can be removed and replaced without sustaining damage. Each tank shall be fitted with inspection covers not exceeding 25 kg in weight where these are necessary to allow access to the internal connections of bushings, current transformer(s), winding connections and earth link for testing.

## 8.5 Earthing Terminals

Substantial earthing terminals capable of carrying the maximum system earth fault current shall be provided close to the base of the tank structure. The terminals shall be designed to carry this current without damage, for duration at least equal to the short circuit period for which the main windings are designed. Two such terminals shall be provided on transformers rated 20 /28 MVA.

## 8.6 Joints and Gaskets

All joints faces shall be arranged to prevent the ingress of water or leakage of oil with a minimum of gasket surface exposed to the action of oil or air.

Oil resisting synthetic rubber gaskets are not permissible except where the synthetic rubber is used as a bonding medium for cork or similar material or where metal inserts are provided to limit compression.

Gaskets shall be as thin as possible, consistent with the provision of a good seal and full details of all gasket sealing arrangements shall be shown on the transformer drawings.

## 9 CONSERVATOR VESSELS

A conservator tank shall be mounted above the highest point of the oil circulating system of the equipment. Tanks shall be formed of substantial steel plate. Connections between the main tank and the conservator shall be such that air or gas is not entrapped and the Buchholz relays can be correctly installed.

The oil pipe from the base of the conservator tank shall project into the conservator for a distance of not less than 50 mm so as to form a water trap.

One end of the conservator shall be fixed by bolts so that it can be removed to enable the tank to be cleaned.

The capacity of each conservator tank shall be adequate to accommodate the expansion and contraction of oil in the whole system, over the extreme range possible in operation, i.e. equipment unenergised in an ambient temperature of 5 deg. C to the condition corresponding to maximum oil temperature rise. Each conservator shall be fitted with:-

- (a) A hydro compensator for separating oil and air. A dehydrating breather shall be used for the air intake of the hydro compensator. Alarm for leak of the hydro compensator shall also be provided.
- (b) At least one magnetic oil level indicator type visible from ground level and indicating the oil levels over the range specified above. The oil level indicator shall be marked to indicate the correct oil level with the oil at a temperature of 5 deg. C, 30 Deg. C and 90 deg. C. The temperature markings shall preferably be integral with the level indicating device but subject to the approval of the Authority.
- (c) Filling orifice and drain valve with an airtight captive screwed cap, cleaning door complete with lifting lugs.
- (d) Low oil alarm initiating device.

## 10 COOLING PLANT

### 10.1 General

Air-cooled transformers rated upto 2.5 MVA may have radiators welded to the tank. Larger air cooled transformers shall have radiators which are detachable from the tank or grouped into a separate cooler bank detachable from headers supported from the tank.

Cooling tubes and radiators shall be designed so that all painted surfaces can be thoroughly cleaned by hand and subsequently painted in situ by suitable brushes and sprays.

Cooling tubes and radiators shall be so designed as to avoid pockets in which moisture, dust or sand may collect. They shall withstand the pressure tests appropriate to the main tank.

## 10.2 Detachable Radiators

Where radiators are designed to be detachable from the main tank or headers, they shall be provided with machined or ground inlet and outlet branches.

Plugs shall be provided at the top and bottom of each radiator and header for draining, filling and deaeration. Valves shall be provided at each point of connection to the tank or headers to facilitate radiator removal without having to drain down the tank.

Blanking plates shall be provided where the valves are not drip tight.

## 10.3 Oil Pipes and Flanges

All oil piping necessary for the connecting of each transformer to its conservator, cooler banks and oil pumps, etc. shall be supplied.

The oil piping shall be of approved material with machined flanged joints.

Copper pipework is to comply with BS 61.

Dimensions of steel pipes shall be in accordance with BS 3600:1973 and the drilling of all pipe flanges shall comply with BS 4504:1969.

An approved expansion piece shall be provided in each oil pipe connection between the transformer and each oil cooler bank.

All necessary pipe supports, foundation bolts and all other attachments are to be provided.

It shall be possible to drain any section of pipework independently of the rest and drain valves or plugs shall be provided as necessary to meet this requirement.

## 11 TAP CHANGERS

### 11.1 Tap Position Numbering

All tap position indicators shall be marked with a number for each tap position, beginning at number 1. Adjacent taps shall be numbered consecutively in a manner, such that when moving a tap to a new tapping position which has a higher number, the no-load output voltage of the untapped windings increases, assuming constant voltage applied to the tapped winding. However, the Authority reserves the right to alter the above numbering system at the time of drawing approval stage.

### 11.2 General

Transformers shall be provided with voltage control equipment of the tap changing type for varying the effective transformation ratio. Control schemes shall utilize 110V a.c. centre tap earthed voltage derived from the 415V, 3 phase, 4 wire system.

Phase failure relays and under voltage relays shall be provided to ensure a secure supply.

### 11.3 On-load Tap Changers

- a) General On-load tap changers (OLTC) shall comply with IEC 214 and shall be suitable for power flow in both directions. Only designs, which have been type, tested in accordance with these standards will be accepted.

The OLTC shall be based on Dr. Jansen principle, comprising a selector switch with changeover switch and a diverter switch of high speed transition type. Transition current resistors of graphite element at all tapplings and fully rated.

The OLTC shall be capable of successful tap changes for the maximum current to which the transformer can be loaded (180% of the rated current).

The OLTC shall withstand all kinds of faults without damage.

The tap changing switches and mechanisms shall be mounted in separate tanks or compartments in accessible positions in or on the transformer tank.

Current making and breaking switches shall be contained in a tank designed in a manner to make it impossible for the oil therein to mix with oil in the tap selector and main transformer. The head of oil in this tank may be maintained by a separate compartment of the main conservator or by a separately mounted tank. An oil surge detector relay and an oil level indicator and a pressure relief device shall be provided. Exceptions to above requirements may be considered, however subject to approval of Authority, in respect of designs in which tap selection and current making and breaking are accomplished by the same contacts within a tank separate from the transformer.

Diverter switch compartments shall be equipped with internal suction pipe to be connected to an external drain and sampling valve mounted at a convenient floor height.

- b) Mechanisms - The tap change mechanism shall be designed such that when a tap change has been initiated, it will be completed independently of the operation of the control relays and switches. If a failure of the auxiliary supply during tap change or any other contingency would result in that movement not being completed, approved means shall be provided to safeguard the transformer and its auxiliary equipment.

Limit switches shall be provided to prevent over-running of the tap changing mechanism. These shall be directly connected in the operating motor circuit. In addition, mechanical stops shall be fitted to prevent over-running of the mechanism under any conditions. For on-load tap change equipment these stops shall withstand the full torque of the driving mechanism without damage to the tap change equipment.

Thermal devices or other approved means shall be provided to protect the motor and control circuit.

A permanently legible lubrication chart shall be provided and fitted inside the tap change mechanism chamber.

- c) Local and Remote Control - Equipment for local manual and electrical operation shall be provided in an outdoor cubicle. Electrical remote control panel to permit operation from the control room and remote LDC shall also be supplied with manual - auto control facilities of the OLTC.

The following operation conditions are to apply to the on-load tap selector controls :-

- i) It must not be possible to operate the electric drive when the manual operating gear is in use.
  - ii) It must not be possible for two electric control points to be in operation at the same time.
  - iii) Operation from the local or remote control switch shall cause on tap movement only unless the control switch is returned to the off position between successive operations.
  - iv) All electrical control switches and local manual operating gear shall be clearly labeled in an approved manner to indicate the direction of tap changing, i.e. raise and lower tap number.
  - v) It must not be possible for any transformer operating in parallel with one or more transformers in a group to be out of step with the other transformers in the group. A device shall be provided with each transformer to prevent further tap changing after a definite time delay interval if a transformer operating on parallel control with one or more identical design transformers is one or more taps out of step.
  - vi) It must not be possible to close bus section if transformers (with identical design parameters) on both sides of bus section are operating on unequal taps when using a master follower scheme.
- d) Indications - Apparatus of an approved type shall be provided on each transformer :-
- i) To give indications mechanically at the transformer and electrically at the remote control point of the number of the tapping in use.
  - ii) To give electrical indication, separate from that specified above, of tap position at the LDC, Necessary transducers shall be provided in the LDC interface marshalling cubicle.
  - iii) To give indication at the remote control point that a tap change is in progress, this indication to continue until the tap change is completed.
  - iv) To indicate the tap change mechanism the number of operations completed by the equipment.
  - v) To give alarm at the remote control point when identical design transformers operating in parallel are operating out of step.

#### 11.4 Automatic Voltage Control

Automatic Control shall be suitable for control of transformers operating in independent/parallel.

In addition to the methods of control covered by the Clause 11.3 specifying on load tap changers the following methods shall also be provided.

The voltage regulation scheme being provided shall meet the following general requirements :-

- to provide automatic and manual control of the transformer on-load tap changer (OLTC).
- to maintain transformer secondary voltage within preset limits.
- to provide line drop voltage compensation due to load current.
- to provide safe parallel operation of transformers.
- to monitor and alarm abnormal voltages and other operating conditions at the remote control panel and also to the remote LDC.

It must not be possible to operate any tap changer by remote or local electrical hand control while the equipment is switched for automatic operation. It shall be possible to select automatic or manual operation from the LDC.

The status of Auto-Manual-LDC position for OLTC control shall be wired to the LDC Interface-Marshalling Cabinet. Suitable control points for LDC shall also be provided to raise and lower the tap positions directly from LDC.

Alternative voltage control schemes employing circulating current principles with modern and proven voltage control/parallel operation schemes will also be considered acceptable provided the contractor demonstrates to the satisfaction of the Engineer that the offered scheme is equal to or superior to the standard master follower-independent scheme and incorporate all the operational requirements of the master-follower-independent scheme specified. It shall be noted further by the tenderers that the Engineer reserve the right to select any scheme based on the said merits and operational flexibility/simplicity of the scheme at the time of approvals and the contractor shall provide the approved scheme as per the requirement of the FEWA.

#### 11.5 Voltage Regulating Relays

Automatic voltage control shall be initiated by a voltage regulating relay of an approved solid state type. The type of relay used shall be the latest in design and fully suitable for the type of voltage control scheme selected with all facilities (like plain voltage control, line drop compensation, circulating current load shedding etc) and shall be subject to approval of the Engineer. The relay shall operate from the nominal reference voltage derived from a circuit mounted  $11\text{kV}/\sqrt{3}/110\text{V}/\sqrt{3}$  voltage transformers (located within the 11kV switchgear or bushing mounted) having minimum Class 1.0 accuracy to IEC 186.

The supply voltage shall be adjustable over a range of the transformer tap step percentage, the nominal setting being twice the transformer tap step percentage.

The relay shall be insensitive to frequency variation between the limits of 47 Hz and 51 Hz. The relay shall be complete with adjustable time delay elements for initial time delay and intertap time delay. The adjustable setting range of the time delays shall be to meet the requirement and subject to approval. The relay shall also incorporate an under voltage and over voltage blocking facility which renders the

control inoperative in the event of abnormal voltage levels. The voltage range shall be adjustable/selected to cover the expected normal voltage deviations and shall be to the approval of the Engineer.

On each transformer the voltage transformer supply to the voltage regulating relay shall be monitored for partial or complete failure. The specified indicating lamp and alarm will be inoperative when the circuit breaker controlling the lower voltage side of the transformer is open and also that it is disconnected when the tap changer is on control other than automatic control.

The voltage regulating relays shall have line drop compensation, over current inhibit/automatic minimization of circulating currents as appropriate and circulating current control facility as well.

## 11.6 **Remote On Load Tap Changer Control Panels**

The remote control panels specified shall be floor mounted sheet steel cubicles of approved type, layout and colour, and shall be provided for each transformer. The design and construction of which shall be in accordance to the approval of Authority. Each shall form a complete enclosure with lockable rear doors and shall be fitted with interior lamp, door switch, heaters, cable gland plates for bottom entry of cables and all other equipment to provide the features specified, the standard requirements (which may be varied to suit manufacturer's design) being as follows:

Instruments :

- Voltmeter (voltage at the low voltage terminals of the transformer) with expanded scale in the working range and a voltmeter selector switch)
- Tap position indicator with integral or separator scale to indicate the no load 11kV voltage in kV appropriate to each winding tap
- A winding temperature indicator
- Transducers for remote LDC indication of tap position, oil and winding temperatures.

Relays :

- Automatic voltage control with test facility.

Controls :

- Manual/auto/LDC selector switch (lockable)
- Pistol grip selector switch with neutral position for raise/lower.
- Emergency stop button for instant cutoff for power supply to OLTC motor

Indications and Alarms :

- Tap change in progress - white lamp
- Tap change out of step - amber lamp
- Tap change incomplete - amber lamp
- OLTC fault - amber lamp
- Tap change control on manual/auto/LDC - amber lamp
- VT fail alarm – amber

- Supply voltage to OLTC failure - amber
- Supply voltage to OLTC auto changeover - amber
- Control supply DC fail - amber
- Over voltage / under voltage alarms after a set time delay (adjustable)
- Lamps test – white lamp

All the above alarms and position of Manual/Auto/LDC switch shall also be wired to LDC Interface Marshalling Cubicle.

Logic circuits :

Logic to inhibit the possibility for any transformer to be in out of step when operating in parallel with one or more transformers as required in clause 11.3 (c) (v).

Logic to inhibit the parallel operation of more than two transformers together and also to prevent closing of a bus-section if transformers are operating on unequal steps, as required in clause 11.3 (c) (vi) and (vii).

Logic to automatically assign one transformer as master and the second as follower when the two operate in parallel. Under such conditions, the AVR or manual raise/lower commands (as determined by the selection of the auto/ manual/LDC switch) of the master transformer only shall operate the OLTC of the follower transformer.

#### Transformer Tap Position Indication for SCADA Interface

The position indication for SCADA shall include both the Analog signal (4-20mA) corresponding to the tap positions as well as a separate set of dry contact inputs with respect to a common point for each Tap Position. This shall be provided in the RTCC panel and not in the Transformer marshalling panel.

Tenderer shall also ensure that all signals related to Transformer device trip and alarms are provided for SCADA.

## 12 TERMINAL BUSHINGS

Bushings shall comply with IEC 137 except where amended by this specification.

Where current transformers are specified or proposed to be included in bushing turrets, it shall be possible to remove the complete bushing assembly without disturbing the current transformers, secondary terminal and connections, or pipework.

Bushing insulators shall be mounted on the tanks so that external connections to them will have not less than specified clearances. All internal connections to the bushing insulators shall be flexible.

Clamps and fittings made of steel or malleable iron shall be galvanized, and all bolt threads shall be greased before erection.

The bushings flanges shall not be re-entrant shape, which may trap air.

The creepage distance shall not be less than 50mm/kV for outdoor bushings.

Any stress shield shall be considered an integral part of the bushing assembly.

On all condenser bushings a tapping shall be brought out to a separate terminal for testing purposes on site.

## Porcelain

All porcelain shall be sound, free from defects, and thoroughly vitrified. The glaze must not be depended upon for insulation. The glaze shall be smooth and hard and shall cover completely all exposed parts of the insulator.

The porcelain must not engage directly with hard metal and, where necessary, gaskets shall be interposed between the porcelain and the fittings. All porcelain clamping surfaces in contact with gaskets shall be accurately ground and free from glaze.

All fixing material used shall be of suitable quality and properly applied and must not enter into chemical action with the metal parts or cause fracture by expansion in service. Cement thicknesses are to be as small and even as possible and proper care is to be taken to centre and locate the individual parts correctly during cementing.

Each porcelain bushing or insulator shall have marked upon it the manufacturers identification mark and such other mark as may be required to assist in the representative selection of batches for the purposes of the sample tests stated in the Schedule of Tests. Each porcelain part shall, in addition, be marked to indicate the date of firing. These marks shall be clearly legible and visible after assembly of fittings and shall be imprinted and not impressed. For porcelain parts the marks shall be imprinted before firing.

When a batch of insulators bearing a certain identification mark has been rejected, no further insulators bearing this mark shall be submitted and the Contractor shall satisfy the Authority that adequate steps will be taken to mark or segregate the insulators constituting the rejected batch in such a way that there can be no possibility of the insulators being re-submitted for the test or supplied for the use of the Owner.

## Mounting of Bushings

Bushing insulators shall be mounted on the tank in a manner such that electrical clearances are maintained between live points and earth. Neutral bushings shall be mounted in a position from which a connection can be taken to a neutral current transformer mounted on a bracket secured to the transformer tank.

## 13 ACCESSORIES

### 13.1 Winding Temperature Indicators

The transformer shall be provided with a winding temperature indicator and combined alarm and trip relays of approved design. The alarm and trip settings shall be adjustable. The winding Temperature Indicator shall also be provided with additional contacts for automatic 'start/stop' of cooling plant. It shall be fitted with dial indicator calibrated in degrees Celsius and fitted with a hand reset pointer the highest temperature attained.

The winding temperature indicator shall be so mounted in the transformer marshalling kiosk so that the dial is not more than 1500 mm from ground level. The cover shall be equipped with a viewing aperture of adequate size, fitted with clear, reinforced glass. Mechanical protection shall be provided for the capillary tube or sensor lead and sharp bends avoided e.g. at points where the capillary tube enters the marshalling kiosk.

The winding temperature indicator shall be activated by a current transformer connected to a heater coil, which heats the oil in which the bulb or sensor of the indicator is immersed or by other approved means.

An ammeter, special terminals and links shall be provided to the Authority's approval for checking the output of the current transformer on load and disconnecting the current transformer from the heater coil to enable the instrument to be used as an oil temperature indicator. A test winding shall be incorporated in the current transformer and the connection brought out to suitable terminals to enable the operation of the instrument to be checked electrically.

### 13.2 Oil Temperature Indicators

The transformer shall be provided with an oil temperature indicator of approved design incorporating contacts and relay(s) for initiating alarms and trips. The indicator shall be fitted with a dial calibrated in degrees Celsius, with a hand reset pointer to register the highest temperature attained.

The oil temperature indicator shall be mounted in the transformer marshalling kiosk so that the dial is not more than 1500 mm from the ground level and the cover shall be equipped with a viewing aperture of adequate size, fitted with clear, reinforced glass. If the temperature measuring device makes use of a capillary tube, mechanical protection shall be provided for the tube and sharp bends shall be avoided (e.g. where the tube enters the marshalling kiosk).

### 13.3 Oil and Winding Temperature Operated Relay Contacts

An independent pair of voltage-free contacts shall be provided for each function specified and shall be suitable in all respects for the remote operation of auxiliary relays. The contacts shall be changeable from normally open to normally closed. Mercury type switches are preferred and reed relays shall not be used.

The operating voltage for the coils of any associated auxiliary relays shall be as specified in the Schedule of Requirements.

Independent adjustment of the relay operating temperature settings shall be provided over the temperature range 60 deg to 150 deg for winding temperature indicators and 50 deg to 120 deg for oil temperature indicators.

Setting of the relays shall be a simple operation not requiring the use of special tools, and the setting scale for each adjustment must be clearly indicated.

A flag or similar indication is required on each relay to register its operation.

### 13.4 Buchholz Devices

Each oil containing equipment shall be fitted with an approved vibration-proof, gas and oil actuated relay device of the Buchholz type, having alarm and tripping contacts, which close following the accumulation of gas, loss of oil or oil surge. Buchholz devices, which do not alarm due to gradual accumulation of gas may be considered if they are used for on load tap changing compartments containing arcing contacts.

Each gas and oil actuated relay shall be provided with a test cock to which a flexible pipe can be connected for checking the operation of the relay.

Each relay shall be fitted with a calibrated glass window for indication of gas volume.

To allow gas to be collected at ground level, a small bore pipe shall be connected to the gas release cock of the gas and oil actuated relay and brought down to a point approximately 1400 mm above ground level, where it shall be terminated by a cock which shall have provision for locking to prevent unauthorized operation.

A machined surface shall be provided on the top of each relay to facilitate setting and checking the mounting angle in the expansion pipe.

Oil pipe work shall be provided in compliance with the recommendations of the manufacturer of the device.

The design of the relay mounting arrangements and the associated pipe work shall be such that maloperation of the relays will not take place under service conditions as specified.

The oil circuit through the relays shall not form a delivery path in parallel with any circulating oil pipe.

The Tenderer shall submit full details, including pipe sizes, oil operating velocities etc., and the size and type of each proposed relay with his tender.

### 13.5 Breathers

Each transformer and tap changer conservator shall be provided with a silica gel breather of an approved type complete with oil seal, oil level indication window and a sight glass for inspection of the silica gel. Due to the climatic conditions at site, this breather shall be liberally sized and one size larger than would be fitted for use in a temperate climate.

A visual indication of the extent to which the drying agent has absorbed moisture is preferred, showing how much active material remains effective. The unit must allow simple cleaning and replacement of the dessicator and sealing oil without the use of tools, by using wing nuts or similar forms of corrosion resistant hand tightening devices.

The breather should be mounted at approximately 1400 mm from ground level and must together with its connecting pipe, be firmly fixed to the main tank by means of substantial brackets.

One spare charge of silica gel shall be provided in a sealed container with each transformer.

### 13.6 Rating, Diagram and Valve Plates

The following plates, or an approved combined plate, shall be fixed to each transformer tank at an average height of 1500 mm above the ground level:

- a) A rating plate bearing the data specified in IEC 76 Part 1. This plate shall also include the short circuit current rating and time factor for each winding.
- b) A diagram plate showing in an approved manner, the internal connections and the voltage vector relationship of the several windings, in accordance with IEC 76 Part 1 with the transformer voltage ratio for each tap and, in addition, a plan view of the transformer giving the correct physical relationship of the terminals.

- c) A plate showing the location and function of all valves and air release cocks or plugs. This plate shall also if necessary warn operators to refer to the Maintenance Instructions before applying vacuum.

Plates are to be of stainless steel or other approved material capable of withstanding the rigours of continuous outdoor service at site.

#### 14 VALVES AND FLANGES

The transformer shall be fitted with the following as a minimum requirement:-

- a) One filter valve located near the top of the tank.
- b) One filter valve located near the bottom of the tank, and diagonally opposite to the valve specified in (a).
- c) One valve of adequate size together with such arrangements as may be necessary inside the tank to ensure that the tank can be completely drained and/or the oil can be sampled from the bottom of the tank.
- d) One valve in the oil actuated relay connection, for the main and where appropriate for the tap change diverter switch tank.
- e) One drain valve so arranged on the conservator tank that it can be completely drained of oil.
- f) Buchholz relay shall be fixed with isolating valve on both sides, i.e. towards the main tank as well as the conservator tank.

##### Tap Changer

- g) 50 mm filter and 50 mm drain valve where selector switches are contained in a separate tank.

##### Diverter Switch

- h) One drain valve to be fitted to each tank.

Blank flanges, plates or captive screw caps shall be fitted to all valves and pipe ends not normally connected in service.

##### Radiators and Cooler Banks

Valves at each point of connection to the tank and in accordance with Clauses 10.2 and 10.3.

The omission of any, or the provision of alternative arrangements to the above requirements, will not be accepted unless approved in writing by the Authority before manufacture.

Valve sizes shall be to the Authority's approval and compatible with those on other transformers of this size already in service on the FEWA system.

15 BONDING

Substantial bonding connection studs shall be provided to all parts of the transformer, ancillary equipment and housing not forming an integral part of the main transformer tank. Bonding straps shall be provided to form an adequate and substantial connector capable of carrying prospective earth fault currents to the main earth terminals provided with the transformer.

16 CABLE TERMINATIONS AND GLANDS

16.1 Cable Boxes

The transformers shall be provided with cable boxes with all necessary fittings and attachments.

Cable boxes shall be of adequate proportions and designed in accordance with BS 6435 in such the manner that they can be opened for inspection without disturbing the gland plate or incoming cable(s).

Cable boxes shall be designed for ease of access for jointing and connecting the cable. They shall be constructed to minimize the danger of fragmentation; cast iron boxes shall not be used.

The cable box shall be of such a design as to prevent ingress of moisture. Where blind tapped holes have to be provided, studs shall be used and not bolts or set screws.

All gaskets, unless otherwise approved, shall be in one continuous piece without joints. Gaskets shall not be compressed before use.

Provision shall be made for earthing the body of each cable box.

Removable blank gland plates and suitable type and size of cable glands shall be supplied and fitted for termination of the cables.

Dehydrating breather and draining holes protected by 1 mm aperture mesh shall be incorporated at the base of the box to avoid moisture condensation within cable box and ensure drainage of condensation respectively.

Cable boxes shall be provided with suitable means for clamping the armour wires of the cables.

Gland plates for single core cable shall be made from non-ferrous metal.

The contractor shall guarantee (test certificate shall be supplied to prove) that the air clearances and the creepage path on the bushing connecting to the associated switchgear or transformers shall be such that the completed installation shall withstand in air the impulse and power frequency voltages appropriate to the plant. The cable box clearances would meet the requirements for BS 6435 for partially insulated cable boxes.

An earthing terminal shall be provided in each sealing end chamber to which the connections from the transformer winding can be earthed during cable testing.

Cable boxes shall be provided on 33kV/11kV sides suitable for air insulations terminations of XLPE Copper Conductor cables of minimum sizes as mentioned below:

## 20/28 MVA Power Transformers :

33kV cable box - Suitable for three single core 500 mm<sup>2</sup> copper XLPE/PE cables or as approved by the Authority.

11kV cable box - Suitable for 7 single core x 630 mm<sup>2</sup> copper XLPE/PVC cables (2 for each phase and one for neutral) or as approved by the Authority.

Cable boxes shall be designed for air insulated terminations and shall accommodate all cable joint fittings, heat shrink insulation sleeves, stress cones etc., as required by the cable manufacturer. Suitable vermin proof breathing arrangements shall be provided. Electrical clearances shall be such that the cable boxes will not reduce the insulation levels and type and routine insulation tests of the transformer shall be performed with all cable boxes and disconnecting chambers installed on the transformer. Creepage distances on bushings inside cable boxes shall not be less than that specified in the relevant standards for outdoor bushings.

### 17 DISCONNECTING CHAMBERS

Where cables are to be terminated on the transformer, air insulated disconnecting chambers shall be provided having removable links for cable testing purposes.

The disconnecting chamber is to have a removable cover and the design of the chamber is to be such that ample clearances are provided to enable either the transformer or each cable core to be subjected separately to high voltage tests.

An earthing terminal is to be provided in each chamber to which the connections from the transformer winding can be earthed during cable testing.

The disconnecting chambers are to be capable of withstanding for 15 minutes between each phase and earth the specified DC test voltage. During these tests, the links will be withdrawn and the transformer windings will be earthed. Creepage distances for all support insulators shall not be less than that specified in the relevant standards for outdoor types.

### 18 MARSHALLING KIOSKS AND BOXES

The kiosk shall accommodate the following equipment:-

- a) Temperature indicators, test links and an ammeter for the winding temperature indicator circuits, interposing repeat relays etc.
- b) Control and protection equipment for the tap changer gear including an isolating switch in the incoming circuit capable of carrying and breaking the full load current of the tap changer motor and of being locked in the open position, and interposing relays for supervisory control equipment if required. This equipment may be mounted in the local tap change panel if it is part of a standard manufacturer's design for the tap changer mechanism box. Any alternative arrangement shall be to the approval of the Authority.
- c) Control and protection equipment for any cooling plant including an isolating switch in the incoming circuit capable of carrying and breaking the full load current of all cooling plant motors and of being locked in the open position, together with approved means of isolating each motor circuit or group of motor circuits when a multi-fan arrangement is adopted.

- d) Terminal boards and gland plates for incoming and outgoing cables to the transformer including secondary CT connections.

Facilities shall be provided to permit the temperature indicators to be removed from the kiosk without the necessity of passing the capillary tubing and bulbs through the various compartments.

To prevent internal condensation an approved type of metal clad heater shall be provided controlled by a switch mounted on the outside of the kiosk and a 5 amp fuse and neutral link inside the kiosk.

All three phase relays, contactors, isolators switches and thermal devices shall be marked with the appropriate phase colours. Apparatus in which the phase elements are mounted horizontally shall be coloured red, yellow, blue from left to right when viewed from front of panel and when mounted vertically they shall be coloured red, yellow blue from top to bottom.

Unless otherwise specified the kiosk shall be fitted with the following switch plug, mounted externally to provide auxiliary supply points for portable tools and emergency hand lamps:

- 1 weatherproof 16A 3 pin switch plug for 240 volt supply for portable tools.

## 19 PERFORMANCE REQUIREMENTS

### 19.1 Losses and Evaluation of Losses

The tenderer shall state in the Schedule of Particulars and Guarantees, the guaranteed values for component losses (i.e. no-load loss and load loss at C.M.R.).

The maximum acceptable losses at 75 deg.C and at rated voltage, full site rated load and principal tap shall be as stipulated in the following table. Tenderers quoting for transformers with losses exceeding the following figures shall not be evaluated.

<u>Sl.No.</u>	<u>Site Rating</u>	<u>Losses Watts</u>	
		<u>No.load-loss</u> (Iron loss)	<u>load loss</u> (Copper loss)
1.	20/28 MVA	12000/14000	80000/100000

#### Rejection:

Offers without guaranteed particulars filled in will be rejected. Transformers for which the actual losses at the time of testing exceed 15% of individual losses and 10% of total loss will be rejected. In the event of transformers yielding component and total losses, which are, either equal to or below the guaranteed values, the tenderer will not be entitled to any premium in respect of reduction in losses below the guaranteed values.

### 19.2 Noise

Vibration and noise levels of all transformers and auxiliary plant shall be in accordance with the best commercial practice and any special conditions stated in the Schedule of Requirements.

If a flat base is specified, anti-vibration pads shall be provided between the transformer and its foundation.

Every care shall be taken to ensure that the design and manufacture of all transformers with their accessories shall be such to reduce noise and vibration to acceptable level.

The transformer shall be subjected to noise measurement as per IEC 551. The tenderer is required to furnish noise measurement test certificate along with the offer.

## 20 INSTRUMENT CABLES AND ACCESSORIES

Instrument cables mounted on the transformer are to be stood off from the transformer tank mounted on cable tray and well supported mechanically and protected from obvious possible damage. Cables are to be of MICS or Heat and Fire Resistant armoured types routed to the marshalling kiosk. PVC/PVC will not be accepted.

Glands are to be of brass compression types of MICS type fully weatherproof and giving long life (rubber grommets will not be accepted).

All cables and accessories provided by the transformer manufacturer and fitted on to the transformer at the transformer works are subject to these requirements.

## 21 NEUTRAL TERMINAL

The neutral of the star connected windings shall be brought out to separate bushings mounted on the transformer tank in such a manner that cable termination can be readily made for connection to an 11kV Neutral Earthing Resistor.

## 22 TRANSPORTATION

Before shipment, the core and winding shall be completely dried and assembled in the tank and then filled with oil. If the transportation of the power transformers with complete oil fillings is not practicable, then the transformers shall be transported with drawing nitrogen cushion and filling arrangement. The automatic nitrogen filling arrangement shall be fitted with nitrogen bottles, regulators etc. to maintain a constant pressure within the tank. The nitrogen pressure shall be indicated by a suitable gauge to check that the nitrogen pressure is maintained all the time during the shipment and storage at site.

All delicate instruments and devices shall be either securely fastened on the transformers with a cautionary note or separately packed and shipped to avoid damage to such devices.

However, butterfly valve and other isolating valves mounted directly on the tank shall not be removed in order to avoid ingress of humidity during transportation and installation at site. All the removed devices shall be fitted again at site only after site filling of the oil to cover the core and windings fully.

## 23 IMPACT RECORDERS FOR TRANSPORT

One impact recorder shall be rigidly attached to each transformers in order to record all horizontal and vertical impacts suffered during transport from factory at site. The recorder is to be operative from time of packing and to unpacking on site in order to provide an uninterrupted record of all registered date. The recorder is to be suitably sealed and the seal shall only be broken by the Authority on arrival at site in order to release the registered data. An appropriate instruction book shall be supplied to the Authority.

## SCHEDULE 'A'

### SCHEDULE OF RECOMMENDED SPARE PARTS

The tenderer shall enter in this schedule the recommended spares and its prices which he recommends for 3 years operation with individual quantities and prices.

Authority may order all or any of the spares so recommended at his discretion.

The prices for spare parts shall not be included in the Tender Price.

Item No.	Description	Unit	Qty.	Unit price in UAE Dhs. upto FEWA Stores	Total price in UAE Dhs. Upto FEWA Stores
	Total .....				

Signature of Tenderer : \_\_\_\_\_

SPECIFICATION NO. NER  
(Revised in December 2003)

SPECIFICATION FOR 11KV NEUTRAL EARTHING RESISTORS

1. Standard Specifications

The neutral earthing resistors shall conform to the latest edition IEC 60129 & IEC 60694 or any other equivalent international standard, which shall be subject to the approval of Federal Electricity & Water Authority.

2. Climate and site conditions

It is generally hot and humid desert climate. The contractor shall fully acquaint himself with the detailed climatological particulars which are summarized as follows :

Maximum ambient temperature	50 Deg. C.
Minimum ambient temperature	1 Deg. C.
Maximum surface temperature	85 Deg. C.
Maximum relative humidity	100 %
Site altitude	Below 1000 M
Isokeraunic level	less than 30 days P.A.

Rainfall is very erratic and the amount of precipitation under normal circumstances is of no significance but attention should be paid to the fact that during winter period sudden heavy rainfalls can occur for short periods and this causes run off from the steep mountains.

Strong winds are very common reaching velocities well over 100 Km/h. Sand storms and dust storms are very frequent.

Particular attention shall be paid to the prevailing severely corrosive conditions. A considerable amount of salt is contained in the atmosphere, thus producing severe corrosion attack which is exacerbated by the high ambient humidity.

In the design of all plant and equipment for incorporation in the works it is to be recognized that the site is within an area of minimal seismic activity.

3. Scope and Nature of Work

The specification provides for design, manufacture, test at manufacturer's works in presence of FEWA representatives, suitable packing, transportation and off-loading at site of works or FEWA Stores in satisfactory condition and proper stacking as directed by FEWA.

4. Equipment Manufacturers

The neutral earthing resistors must be manufactured by quality manufacturer in Europe, North America or Japan only.

5. Insulation Levels and Clearance

Where non-solidly earthed systems are specified, the insulation levels, insulator creepage distances and clearances of the neutral earthing equipment are to be identical to the corresponding insulation levels, insulator creepage distances and clearances of the phase conductors of the system being earthed.

## 6. Neutral Earthing Resistor

Earthing resistors shall be of the stainless steel metal grid type, be drip-proof and suitable for outdoor service on 11kV three phase systems as appropriate. The resistors shall be rated for 10 seconds and the current ratings and ohmic value shall be as per Schedule of Requirement. The continuous current ratings shall be indicated in the Technical Schedules based on IEC and site ambient conditions. The neutral earthing arrangement shall be as per requirement indicated in the attached drawing No. FEWA/E/GEN/283/2003. The earthing resistor should be supplied with two Nos. of disconnectors to facilitate solid earthing also, in addition to the disconnector in the transformer neutral circuit. All disconnectors shall be provided with interlocking contacts so that 33kV and 11kV transformer breakers can be switched on only when disconnector S1(Q61) is closed and either of disconnectors S2(Q62) or S3(Q63) is also closed. The other point of earthing resistor shall be connected to earth. Facility for an alarm in remote control panel i.e. Auxiliary contacts, switches etc. shall be provided when both disconnectors of Neutral Earthing Resistor (S2) and solid earthing (S3) are in closed condition simultaneously.

The framework of Neutral Earthing Resistor shall be of galvanized steel and totally enclosed by galvanized expanded metal or perforated sheeting. The grids shall be of stainless steel alloy and be adequately supported on steel rods and porcelain insulators and be designed to withstand the currents flowing under fault conditions. Adequate insulating barriers shall be provided to prevent internal flashover.

The resistor shall be complete with lifting and jacking lugs, access manhole, holding down bolts or clamps, earth terminals, connectors and connections and bushings suitable for the system phase to neutral voltage.

The specified resistance is to be that at the design ambient temperature and it shall be capable of passing the specified current for 10 seconds with a maximum temperature rise as stated in the relevant section in the Schedule of requirements. The coefficient of resistance with respect to operating temperature shall also be stated.

## 7. Neutral Earthing Disconnectors

Isolating switches shall be arranged for manual operation and shall be of the airbrush, metal enclosed type. Mechanisms shall be so designed that the disconnector cannot be opened by forces due to fault currents and shall be self locking in both the open and closed position.

Service conditions require that isolating switches shall remain alive and in continuous service for periods of up to two years in the climatic conditions specified and without operation or maintenance.

Disconnecting devices shall be interlocked with the other disconnection in each circuit to ensure safe operation of the equipment under all service conditions.

Disconnector operating mechanisms shall be robust construction carefully fitted to ensure free action shall be unaffected by the climate conditions at site. Mechanisms shall be as simple as possible and comprise a minimum of bearing and wearing parts. The mechanisms shall be complete with auxiliary switch, terminal blocks and removable cable gland plates.

Mechanical interlocks where employed shall be effective at the point where hand power is applied so that stresses cannot be transferred to parts remote from that point.

Locking facilities shall be provided on disconnecting switch mechanisms in both the open and closed positions.

Locks & keys shall be arranged by FEWA.

Neutral earthing disconnectors shall be provided with suitably rated auxiliary switches and contactors, to relay circuit information for the purpose of control and circuit supervision.

8. Neutral Resistor Cable Sealing Ends

The cubicle shall be suitable for the termination of 11kV single core 630 sq.mm Cu. XLPE cable by porcelain bushing 7.2kV type inside a cable box.

9. Tests

All neutral earthing resistors shall be subjected to routine tests according to the relevant approved specifications in presence of FEWA representatives at manufacturer's works.

The supplier shall make provision in his offer to bear all costs that are incurred in carrying out these tests to the satisfaction of FEWA. However, the costs towards travel, accommodation etc. of FEWA representatives shall not be included in the quoted price.

10. Protection Class

The protection class for neutral earthing resistors shall be IP23 for indoor use and IP54 for the NERs to be used outdoors. The specific requirement of protection class shall be as detailed in the Bill of Quantities.

11. Neutral Current Transformers

Current transformers for REF and Standby Earth fault protection of specified/required ratio, accuracy class and accuracy limit factor shall be provided in the neutral circuit. The location of C.T.s shall be such that it will facilitate easy primary and secondary injection testing and is subject to the approval of the Authority. The CT data shall be as per the protection requirement and subject to FEWA approval.

## 1.2 GENERAL SCHEDULE OF REQUIREMENTS

### MAIN POWER TRANSFORMERS

The power transformers to be supplied new shall conform to the following requirements :

SL. No.	DESCRIPTION	REQUIREMENT 20 /28 MVA, 33/11KV
1.	a) Continuous site rating MVA	20 /28
	b) Type of Cooling	ONAN /ONAF
2.	No. of phases	3
3.	No. of windings	2
4.	No-load voltage ratio at principal tapping	33/11
5.	Highest system voltage	KV 36/12
6.	Minimum withstand voltages lightning impulse	KV 170/75
7.	Service Conditions	
	Altitude not exceeding M	1000
	Air Temperature Deg. C	50
8.	Winding hot spot temperature on emergency overload not exceeding Deg. C	140
9.	maximum hot spot temperature when loaded in accordance with IEC 354 Deg. C	118
10.	Permitted temperature rise :	
	Winding by resistance Deg. C	50
	Top oil Deg. C	45
11.	Phase connections :	
	Vector Group	Dyn11

Signature of Tenderer : \_\_\_\_\_

**GENERAL SCHEDULE OF REQUIREMENTS**

**POWER TRANSFORMERS**

SL. No.	DESCRIPTION	REQUIREMENT 20 /28 MVA, 33/11KV
12.	System Symmetrical fault level on 33kV side System Symmetrical fault level on 11kV side	40 KA 31.5 KA
13.	Duration of the symmetrical short circuit current for which the transformer is to be designed (calculation as per IEC to be furnished).	2 Sec.
14.	Impedance voltage at 75 Deg. C and C.M.R. at principal tap and on HV base.	12.50% / 14%
15.	Max. flux density in tesla in any part of the core and yokes at principal tap, rated voltage, nominal frequency.	1.6
16.	Taping range (taps located on the HV side)	+10% to - 15%
17.	Tap step size	1.25%
18.	Type of tap changer	On-load
19.	Type of control - Local	Manual electric/ handle
	Type of control - Remote	Non auto - Auto
20.	Automatic voltage regulator	Required
21.	Parallel operation	Required
22.	Automatic tap change control through AVR & Master follower	Required
23.	Remote control panel	Required
24.	No. of transformer for which automatic control shall be suitable	3
25.	Marshalling kiosk	Required

Signature of Tenderer: \_\_\_\_\_

**GENERAL SCHEDULE OF REQUIREMENTS**  
**POWER TRANSFORMERS**

SL. No.	DESCRIPTION	REQUIREMENT 20 /28 MVA, 33/11KV
	<u>TERMINATIONS :</u>	
26.	HV side line terminals	Air insulated cable box
27.	LV side line terminals	"
28.	For neutral earthing	"
	<u>GENERAL :</u>	
29.	Type of breather	SilicaGel breather consisting of 5 stacks
30.	Hydro compensator in conservator tank	Not Required
31.	Transformer mounting	Skids
	<u>MAX. PERMISSIBLE LOSSES :</u>	
32.	No load losses	As per Spec.
33.	Load losses watts	As per Spec.
34.	Noise level maximum at a distance of two meters with all accessories operating	65 dB

Signature of Tenderer: \_\_\_\_\_

Transformers are to be complete with all accessories as specified in the detailed technical specification in the tender. The accessories shall include the following:

- (i) Double element gas and oil-actuated relays for main transformer.
- (ii) Single element gas and oil-actuated relays for transformer tap changers.
  - (i) 2x50% radiator bank including cooling fans and related control gear associated with a forced air-cooling system. The fan motors shall be provided with individual thermal overload latched tripping and auxiliary contacts shall initiate alarms. Each motor shall be provided with individual isolation.
- (iii) Winding temperature indicator, for each winding with 100mm diameter dial, four sets of contacts for the initiation of forced cooling where applicable, alarm and trip, maximum reading slave pointer and hand resetting device.
- (iv) Oil temperature indicator with 100mm diameter dial, four sets of contacts for initiation of forced cooling, where applicable, alarm and trip, maximum reading slave pointer and hand resetting device.
- (v) Transformer mounted local marshalling kiosk(s) to accommodate the cooling system control equipment and the winding temperature and oil temperature indications, together with all necessary panel wiring, terminations, fuses, sockets gland plates and glands for multicore cables, including: -
  - (a) One kiosk heater and switch with combined lamp indication "supply on" controlled from a thermostat.
  - (b) One set of padlocks and keys
- (vi) Motor drive unit complete with:
  - Tap operation counter
  - Tap change raise/lower pushbuttons
  - Key operated selector switch local/remote
  - Hand operation
- (vii) Fitted access ladder with handrails and guard to provide easy access to top of transformer and buchholz relays etc.
- (viii) All necessary padlocks and keys for the locking of transformer oil valves, control panels and marshalling kiosk(s)
- (ix) Accommodation is to be provided for mounting neutral current transformers and neutral connections to earth.
- (x) Pressure relief device with 2 nos. of NO auxiliary contacts for tripping of transformer to protect the tank and each individual tap changer diverter chamber.
- (xi) Silica gel type breathers for the main transformer and for the tap changer.
- (xii) Minimum oil level gauges of magnetic type and prismatic type one each. This is applicable for conservator for tap changer also.

- (xiii) One set of tap-changer control (RTCC) equipment consist of one local operation cubicle- for local manual and electrical operation- and remote control panel- with manual/auto control facility- for operation from control room and remote LDC. (Note: The following automatic tap change control equipment shall be placed in a separate sheet steel cubicle):
- (i) One lockable Manual/Auto/LDC Selector switch for tap change controls.
  - (ii) One lockable Master/Follower/Independent control selector switch.
  - (iii) One set of "Tap Raise" and "Tap Lower" push buttons/ Piston grip selector switch with neutral position.
  - (iv) One automatic voltage-regulating relay.
  - (v) One tap change out of step relay.
  - (vi) One timing relay for "Tap change incomplete" alarm.
  - (vii) One timing relay for "Tap change out of step" alarm.
  - (viii) One digital tap position indicator in the remote panel and LDC and mechanical type in local panel.
  - (ix) One indication lamp for "Tap change in progress".
  - (x) One indication lamp for "Tap change out of step".
  - (xi) One indication lamp each for transformer in "Independent" Follower" or "Master" mode of operation.
  - (xii) One remote winding & oil temperature indicator of each type (OTI, WTI-HV, WTI-LV).
  - (xiii) Necessary transducers for remote LDC indication of tap position, oil & winding temperatures
  - (xiv) One emergency stop push button for cut off OLTC motor supply
  - (xv) All other meters/ indications/ relays as detailed in the technical specification.

The Losses of the 33/11kV Transformers are fixed and no positive tolerance is allowed and transformers with higher values than specified in the detailed technical specification may not be considered for evaluation. Each transformer shall fulfil the above requirements and no rebate will be given to the tenderer if the losses are less than the guaranteed values.

Final parameters of CT requirement are based on the detailed design and shall be provided within the quoted price. The CTs are to be mounted in the transformer and the CT terminals shall be protected with covers subject to FEWA approval. But considering the easiness to access and testing FEWA prefers to accommodate the NCTs in the NER Unit enclosure. The contractor shall study the feasibility and finalize with FEWA approval.

All multicore control Cables/LV power cables and accessories required for the entire works shall be supplied and installed by the contractor. The contractor shall arrange all accessories, tools and tackles, test instruments etc required for the entire installations, testing and commissioning. Any foundations bolts, channels, anchoring etc required for the proper installation shall be supplied and installed by the contractor. Touch up paints wherever required shall be applied after installation.

#### **1.4 11kV Neutral Earthing Resistor & disconnectors (Combined)**

All work related to supply of 11kV, 1000A, 6.35 ohms, 10 sec. including the disconnectors etc. as a combined unit for installing at the 11kV neutral side of 20 /28MVA 33/11kV transformer complying with detailed technical specifications and diagrams. The authority prefers to fix the neutral CTs for the transformer along with NER as shown in the 33 kV SLD for easy access and testing. The contractor shall study the feasibility and finalize the scheme only after getting approval from FEWA.

The scope of supply will be for supply of the equipments/materials complying with the specifications and requirements, but not limited to, the complete engineering and design, supply, manufacture, inspection and testing, packing for export, shipment, insurance, clearing from UAE port, delivery to FEWA store at Sharjah or site, unloading, stacking at store or site, proper handing over to FEWA, warranty against design defects, bad workmanship, defective material etc. for 30 months from the date of acceptance certificates issued by FEWA or 24 months from date of commissioning which ever is earlier.

All multicore control Cables/LV power cables and accessories required for the entire works shall be supplied and installed by the contractor. All foundations, footings, supporting structures, special tools, tackles, equipment consumables etc. required for proper installation, operation and maintenance and testing is included in the scope of supply.

#### 1.4.1 Neutral Current Transformers

Current transformers for REF(Cl. PX) and Standby Earth fault protection(Cl. 5P 20) of specified/required ratio, accuracy class and accuracy limit factor shall be provided in the neutral circuit. The location of C.Ts shall be such that it will facilitate easy primary and secondary injection testing and is subject to the approval of the Authority. The CT data shall be as per the protection requirement and subject to FEWA approval.

Signature of Tenderer: \_\_\_\_\_

### **GENERAL SCHEDULE OF REQUIREMENTS**

#### **POWER TRANSFORMERS**

SL. No.	DESCRIPTION	REQUIREMENT 20 /28 MVA, 33/11KV
12.	System Symmetrical fault level on 33kV side System Symmetrical fault level on 11kV side	40 KA 31.5 KA
13.	Duration of the symmetrical short circuit current for which the transformer is to be designed (calculation as per IEC to be furnished).	2 Sec.
14.	Impedance voltage at 75 Deg. C and C.M.R. at principal tap and on HV base.	12.50% /14%
15.	Max. flux density in tesla in any part of the core and yokes at principal tap, rated voltage, nominal frequency.	1.6
16.	Taping range (taps located on the HV side)	+10% to - 15%
17.	Tap step size	1.25%

18.	Type of tap changer	On-load
19.	Type of control - Local	Manual electric/ handle
	Type of control - Remote	Non auto - Auto
20.	Automatic voltage regulator	Required
21.	Parallel operation	Required
22.	Automatic tap change control through AVR & Master follower	Required
23.	Remote control panel	Required
24.	No. of transformer for which automatic control shall be suitable	3
25.	Marshalling kiosk	Required

Signature of Tenderer: \_\_\_\_\_

1.4.2 **GENERAL SCHEDULE OF REQUIREMENTS**

2 **NEUTRAL EARTHING RESISTOR**

The neutral earthing resistor shall be metal sheet clad, outdoor type stainless steel grid type, suitable for dry type termination for XLPE cable and earthing facilities for the system voltages/ratings as specified below:

SL. NO.	DESCRIPTION	11KV SYSTEM
1.	Resistance at 40 Deg. C	6.351 OHMS
2.	Fault current	1200 A
3.	Fault current duration	10 Sec.
4.	Resistor grid material	Stainless steel
5.	Temp. rise after 10 sec. at rated voltage	545 Deg. C
6.	Cooling time (to 45 Deg. C)	90 Minutes
7.	Protection class	As specified
8.	Application	Power Transformer Neutral earthing
9.	Neutral C.T's	1600 /1/1A
	a) Core 1 for S.B.E.F	5P10, 15 VA
	b) Core 2 for R.E.F	CLX
	<u>Note</u> Secondary current may be changed to 5 Amps for some CT's.	

Signature of Tenderer: \_\_\_\_\_

## 1.1

**SCHEDULE OF TECHNICAL PARTICULARS & GUARANTEES  
FOR POWER TRANSFORMERS**

All values set in these particulars should be corrected to ambient temperature of 50 Deg. C. and 100 % humid weather of U.A.E. system frequency is 50 Hz.

SL. NO.	DESCRIPTION	PARTICULARS OF TRANSFORMERS
1.	Name of Manufacturer	
2.	Country of Origin	
3.	Applicable Standards	
4.	Continuous rating under UAE conditions	MVA
5.	Equivalent IEC continuous rating	MVA
6.	System highest voltage	KV
7.	Primary side rated voltage at normal tap	KV
8.	Secondary side rated voltages at normal tap	KV
9.	No. of phases & rated frequency	
10.	a) Type of tap changer b) No. of steps and size of each step c) Voltage range	
11.	Vector Group	
12.	Manufacturer of tap changer	
13.	Facility of local remote tap changer including AVR & Master follower scheme. Tap changer nominal supply voltage	V
14.	Transformer local & remote tap changer control panel (drawing and circuit diagram showing all connections to be attached).	
15.	Method of cooling	

SIGNATURE OF TENDERER : \_\_\_\_\_

Schedule 'D' cont'd

SL. NO.	DESCRIPTION	PARTICULARS OF TRANSFORMERS
16.	Maximum temperature rise at rated full load	
	a) Oil	Deg. C
	b) Winding	Deg. C
	c) Max. winding hot spot temperature on emergency overloads	Deg. C
17.	Percentage impedance voltage at rated frequency :	
	a) At principal tapping	%
	b) At highest tapping	%
	c) At lowest tapping	
18.	Power frequency test voltage for 1 minute	
		HV side KV
		LV side KV
19.	Impulse level :	
	a) 1/50 micro sec. Full wave HV side	KV
	LV side	KV
	b) 1/50 micro.sec. Chopped wave HV side	KV
	LV side	KV
	c) Induced over voltage HV side	
	LV side	KV
20.	Maximum flux density in core at normal voltage and frequency in tesla (weber/m <sup>2</sup> )	
21.	Maximum flux density in yoke at normal voltage and frequency in tesla (weber/m <sup>2</sup> )	
22.	Current density at rated output	
	a) Primary winding	Amp/sq.mm
	b) Secondary winding	Amp/sq.mm
23.	Cross sectional area of windings	
	a) Primary winding	mm <sup>2</sup>
	b) Secondary winding	mm <sup>2</sup>

SIGNATURE OF TENDERER : \_\_\_\_\_

Schedule 'D' cont'd

SL. NO.	DESCRIPTION	PARTICULARS OF TRANSFORMERS
24.	Resistance of windings per phase at 75 Deg. C	
	a) Primary HV winding	Ohms
	b) Primary LV winding	Ohms
25.	No. of turns in windings per phase	
	a) Primary winding	Nos.
	b) Secondary winding	Nos.
26.	Mean length of windings per phase	
	a) Primary winding	m
	b) Secondary winding	m
	c) Tertiary	m
27.	Length of lead between windings & bushing	
	a) Primary winding	m
	b) Secondary winding	m
	c) Tertiary	m
28.	Copper loss at full load at 75 Deg. C	
	a) At rated voltage & tap	KW
	b) At tapping having highest losses	KW
29.	Iron loss	
	a) At normal voltage & frequency	KW
	b) At 110% rated voltage & frequency	KW
	c) Weight of core/1 Kg.	KW
30.	Magnetizing current as % of full load current	
	a) At rated voltage & tap	%
	b) At 110% rated voltage & frequency	%
31.	Efficiency	
	125 % load at 0.8 p.f.	
	100 % load at 0.8 p.f.	
	100 % load at unity p.f.	
	75 % load at 0.8 p.f.	
	50 % load at 0.8 p.f.	
	50 % load at unity p.f.	

SIGNATURE OF TENDERER : \_\_\_\_\_

Schedule 'D' cont'd

SL. NO.	DESCRIPTION	PARTICULARS OF TRANSFORMERS
32.	Regulation	
	a) at 0.8 p.f. lagging	%
	b) at unity p.f.	%
33.	Presence of trip & alarm contacts on buchholz relay on Trans. & Tap changer	Yes/No
34.	Basic insulation level	
	a) 33kV side	KV
	b) 11kV side	KV
	c) 433V side	KV
35.	Tank	
	a) Thickness of top plate	mm
	b) Thickness of bottom plate	mm
	c) Thickness of radiator fins	mm
	d) Thickness of sides	mm
	e) Maximum pressure tank can sustain	Kg/sq.mm
	f) Working pressure in tank	Kg/sq.mm
	g) Setting of pressure on over pressure device	Kg/sq.mm
36.	a) No. of radiators	
	b) Way of connection of radiators to main body	
	c) Rating of cooler bank as % of total loss at CMR	%
37.	Provision for tank earthing	Nos.
38.	Core type construction	
39.	No. of limbs	
40.	Thickness of lamination	
41.	Harmonics	
	a) R.M.S. value of the fundamental current	Amp.
	b) R.M.S. value of 3rd harmonics current	Amp.
	c) R.M.S. value of 5th harmonics current	Amp.
42.	Total oil required	Litres

SIGNATURE OF TENDERER : \_\_\_\_\_

Schedule 'D' cont'd

SL. NO.	DESCRIPTION	PARTICULARS OF TRANSFORMERS
43.	Weights	
	a) Core	Kg
	b) Windings	Kg
	c) Complete transformer including oil	Kg
	d) Complete transformer excluding oil	Kg
	e) Transformer arranged for shipment	Kg
44.	Insulation materials	
	HV windings	
	LV windings	
	Core bolt	
	Core lamination	
	Tapping leads	
	Side plates	
45.	Overall dimensions	
	a) Height	cm
	b) Length	cm
	c) Width	cm
46.	Type of paint applied internally	
47.	Type of paint applied externally	
48.	Type of weatherproof anti rust material primer	
49.	Applicable standard for painting process	
50.	Noise level	db
51.	i) Short circuit withstand fault level at terminals of :	
	33 KV bushings	KA
	11 KV bushings	KA
	ii) Duration of symmetrical short circuit it can stand	Sec.
52.	Anti-vibration pad provided	Yes/No.

SIGNATURE OF TENDERER : \_\_\_\_\_

Schedule 'D' cont'd

SL. NO.	DESCRIPTION	PARTICULARS OF TRANSFORMERS
53.	Transformer bushing (HV/LV) : (Inside the cable boxes)	
	a) Name of manufacturer	
	b) Country of origin	
	c) Manufacturer's type No.	
	d) Material of Insulator	
	e) Rated voltage	KV
	f) Rated current	A
	g) Dry P.F. withstand voltage	KV
	h) Wet P.F. withstand voltage	KV
	i) Impulse flashover voltage (Positive 1/50 wave)	KV
	j) Impulse flashover voltage (Negative 1/50 wave)	KV
	k) Total creepage distance	mm
	l) Protected creepage distance	mm
	m) Diameter of stem	mm
	n) Current rating stem	A
	o) Applicable standard	

SIGNATURE OF TENDERER : \_\_\_\_\_

DESIGNATION : \_\_\_\_\_

NAME OF TENDERER : \_\_\_\_\_

DATE : \_\_\_\_\_

**SCHEDULE OF TECHNICAL PARTICULARS AND  
GARANTEES FOR NEUTRAL EARTHING RESISTORS**

SL. NO.	DESCRIPTION		PARTICULARS OF NER
1.	Neutral Earthing Resistor (11kV side)		
a)	Manufacturer & country of origin		
b)	Type		
c)	Applicable international standard		
d)	Rated voltage	KV	
e)	Rated fault current	A	
f)	Max. Operating time	Sec	
g)	Resistor material Resistance cold (initial value at 40 Deg. C)	Ohm	
h)	Temperature rise after 10 sec. at rated voltage	Deg.C	
i)	Cooling time	Sec	
j)	Permissible continuous current for temperature rise of 100 Deg.	A	
k)	Protection class		
l)	Installation : Indoor/Outdoor		
m)	Material of enclosure		

2.	Neutral Current Transformer		LV Neutral	
			Core 1	Core 2
a)	Type			
b)	Applicable international standard			
c)	Manufacturer			
d)	Ratio			
e)	Rated current	A		
f)	Short time current and time	KA/Sec		
g)	Class			
h)	Rated output	VA		
i)	Secondary circuit resistance	Ohms		
j)	Accuracy			
k)	Knee point voltage			
l)	Turns ratio			
m)	Type test certificate No.			
n)	Location and Mounting of CT			
o)	Accessibility of secondary terminals	Yes/No		
3.	Neutral Earthing Isolator			
a)	Manufacturer & country of origin			
b)	Normal rated current	A		
c)	Short time current (rms) for 3 sec.	KA		
d)	Rated voltage	KV		
e)	Power freq. dry withstand voltage(1minute)	KV		
f)	Creepage distance of insulators	mm		
g)	Auxiliary contacts	Yes/No		

## Contents

- Schedule 1.1 : Details of Past Experience of Manufacturer of Main Equipment.
- Schedule 1.2 : List of Sub-manufacturers and their experience
- Schedule 1.3 : Programme of Supply
- Schedule 1.4 : Place of Manufacture of Equipment/Materials offered.
- Schedule 1.5 : Schedule of Drawing/Document Submissions
- Schedule 1.6 : Details of Type Test Report
- Schedule 1.7 : Organization Chart for Supply Contract
- Schedule 1.8 : Deviation Schedule
- Schedule 1.9 : Details of Manufacturers Execution Proposal
- Schedule 1.10: Declaration Sheet

**SCHEDULE 1.1**

**DETAILS OF PAST EXPERIENCE OF MANUFACTURER OF MAIN EQUIPMENT  
(To be completed by the Tenderer)**

Name and Address of the Client	Quantity Supplied	Year of Supply	Remarks

Name of Tenderer: .....Signature & Stamp: ..... Date : .....

**SCHEDULE 1.2**

**LIST OF SUB-MANUFACTURER AND THEIR EXPERIENCE**

Sl. No	Name and Address of Sub-manufacturer	Job to be assigned		Remarks
		Description	Quantity	

Name of Tenderer: .....Signature & Stamp: ..... Date : .....

**SCHEDULE 1.3**

**PROGRAMME OF SUPPLY  
(To be completed by Tenderer)**

Months	1	2	3	4	5	6	7	8	9	10	11	12
<b>1) 20MVA</b> – Design – Manufacturing – Inspection / Testing – Shipping – Delivery												
<b>2) 11KV NER</b> – Design – Manufacturing – Inspection / Testing – Shipping – Delivery												

Name of Tenderer: .....

Signature & Stamp : .....

Date : .....

**SCHEDULE 1.4**

**PLACES OF MANUFACTURER OF EQUIPMENT / MATERIALS OFFERED**

A- Electrical Equipment

Sl.No	Item	Manufacturer - First			Manufacturer – Second		
		Manufacturer	Place of Manufacture	Place of Testing or Inspection	Manufacturer	Place of Manufacturer	Place of Testing or Inspection
1	i) 20MVA, 33/11kV Transformer						
	ii) 11kV NER's						
	iii) RTCC Panels						

Name of Tenderer: .....

Signature & Stamp : .....

Date : .....

**SCHEDULE 1.5**  
**DRAWING/DOCUMENT SUBMISSION SCHEDULE**

Sl. No.	Description	Submission for Approval in Weeks after award of contract
1.	Equipment general arrangement, layout, and clearances for substation design.	....th week
2.	RTCC Drawings	....th week
3.	Electrical Schematic Diagram with complete control schematic.	....th week
4.	Detailed engineering calculations and conceptual design for all equipments.	....th week
5.	Dimensional General Arrangement drawing of various equipment along with cross-section, foundation/fixing details and bill of materials.	....th week
6.	Complete wiring diagram, cable schedule and cable termination schedule.	....th week
7.	Detailed engineering calculations and conceptual design for all equipments.	....th week
8.	Detailed list of components and accessories.	....th week
9.	Interfacing and co-ordination drawings.	....th week
10.	Final Technical Particulars	....th week
11.	Manufacturers Quality Assurance Manual.	....th week
12.	Quality Control and Inspection Programme.	....th week
13.	Installation Manual.	....th week
14.	Equipment storage requirement at store/site.	....th week
15.	Check list for receiving the equipment at store/site.	....th week
16.	Packing/component list.	....th week
17.	As manufactured as built drawing.	....th week
18.	Overall co-ordinated schematic drawings.	....th week
19.	Operation, maintenance and Instruction Manual	....th week
20.	Working sets of Contract Document	....th week
21.	Contract Procedure Manual (Draft)	....th week
22.	Detail program, charts and progress reports	....th week

Name of Tenderer : .....

Signature & Stamp : .....

**SCHEDULE 1.5**

**DRAWING/DOCUMENT SUBMISSION SCHEDULE**

Sl. No.	Description	Submission for Approval in Weeks after award of contract
23.	Contractor's standard QA Manual with particulars applicable to the Contract	....th week
24.	Project Quality Plan	....th week
25.	Drawing schedule and drawing list	....th week
26.	Shipment schedule	....th week
27.	Factory Inspection Schedule	....th week
28.	Project Completion Report	....th week

Name of Tenderer : ..... Signature & Stamp : .....

**SCHEDULE – 1.6**  
**LIST OF TYPE TEST CERTIFICATES TO BE ENCLOSED WITH OFFER**

**EQUIPMENT/MATERIAL: .....**

OFFERED IN TENDER	MAKE	
	TYPE	
	RATING	
DETAILS OF TYPE TEST REPORT ENCLOSED	MAKE	
	TYPE	
	RATING	
	TYPE TEST CERTIFICATE NO.	
	DATE OF TEST	
	TYPE OF TEST CONDUCTED	
	DEVIATION IN DESIGN (IF ANY) BETWEEN OFFERED & TESTED EQUIPMENT	
	LABORATORY  WHERE  TESTED	

Name of Tenderer : ..... Signature & Stamp : .....

**Notes:**

1. Ratings such as Current/Voltage, Short Circuit Current, Temperature, Time, etc. assigned to Equipment/ Materials to be mentioned.
2. List of Tests conducted with Respective details of date/laboratory to be stated.
3. The exact deviation (if any) in design between offered Equipment/Materials and Type Tested as per details stated shall be listed or clearly state "NIL".
4. Additional sheet to be attached, if necessary (for each equipment).
5. The above schedule shall be filled separately for each equipment/material.

**SCHEDULE- 1.7**

**ORGANIZATION CHART FOR SUPPLY CONTRACT**

Note: The Tenderer shall furnish the relevant information on Organization Chart For Design, engineering and manufacturing of equipments included in the contract. Experience and Qualification of Key Personnel, responsible for the above for all equipments included in the contract shall be furnished.

Name of Tenderer : .....

Signature & Stamp : .....

**SCHEDULE – 1.8**

**DEVIATION FROM TENDER SPECIFICATION**

Normally, the tenderer shall quote for all the items and quantities in the price schedule based on tender specification requirements. The basis of the offer submitted by the tenderer to arrive at the quoted price should comply with specification requirements. However, if the equipment offered with any deviations, from the specification shall be brought out and tabulated in the table given below. The extra cost, if any, required by the tenderer to fully comply with the specification shall be indicated against each deviations. If extra cost is not indicated in the table given below, against the deviation, it shall be deemed that either the tenderer is not in a position to comply with the specification or the deviation is proposed for improvement of design.

The Authority shall neither accept nor agree on any deviations requested by the tenderer against any article of General Conditions of Contract. The conditional offer having conditions contradicting to special conditions of contract requirements shall be rejected if not withdrawn during tender opening or during evaluation of the tender.

Deviations other than those listed below shall not be considered under any circumstances. (Additional pages shall be used, if required).

SI No. (1)	Vol/Section/ Clause No. (2)	Description As per tender specification (3)	Deviation from Specification (4)	Extra cost for fully complying with specification (5)

**Note : The extra cost quoted under column (5) will be part of evaluated price of the offer.**

Name of Tenderer : ..... Signature & Stamp : .....

**SCHEDULE- 1.9**

**DETAILS OF CONTRACTORS EXECUTION PROPOSAL**

1.1 Main Contractor

a) Name : .....

Address : .....

.....

Contact Person : .....

Designation : .....

Cable address: .....

Telex No. : .....

Telefax No. : .....

Telephone No. : .....

1.2 Sub-Manufacturer (Sub-supplier)

a) Name : .....

Address : .....

.....

Contact Person : .....

Designation : .....

Cable address: .....

Telex No. : .....

Telefax No. : .....

Telephone No. : .....

b) Name : .....

Address : .....

.....

Contact Person : .....

Designation : .....

Cable address : .....

Telex No. : .....

Telefax No. : .....

Telephone No. : .....

1.3 Manufacturers/sub-Contractors

Manufacturers and sub-contractors of the main components of the works are as follows :

		<u>Manufacturer 1</u>	<u>Manufacturer 2</u>
Power Transformer	:	-----	-----
RTCC Panels	:	-----	-----
OLTC	:	-----	-----
NER	:	-----	-----
NES	:	-----	-----

1.4 Execution of Proposal

I/We..... being the duly authorized representative(s) of the Tenderer as certified in the attached Power of Attorney, confirm that all data in these Tender Documents is correct and they truly represent the materials, equipment supply covered by our formal Proposal referred to below :

Proposal No. :.....

Dated :.....

Tenderers Name :.....

Authorized Signature and Stamp :.....

Name of Signatory :.....

Designation of Signatory :.....

**SCHEDULE- 1.10**

**DECLARATION SHEET**

I, ..... certify that all the above typed-in data and information pertaining to this specification are correct and are true representation of the offer covered by our formal proposal number ..... dated .....

I hereby certify that I am duly authorized representative of the Contractor whose name appears above my signature.

Tenderer's Name : \_\_\_\_\_

Authorized Representative Signature : \_\_\_\_\_

Tenderer's Intent : The Tenderer hereby agrees fully to comply with the requirements and intent of this specification for the price indicated.

Authorized Representative's Signature : \_\_\_\_\_