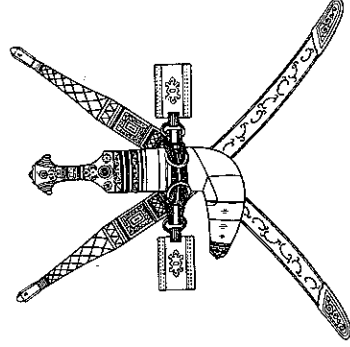


**SULTANATE OF OMAN**

**MINISTRY OF ELECTRICITY & WATER**



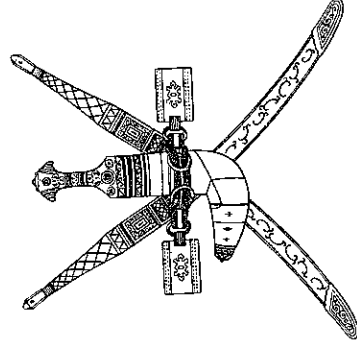
**STANDARD - OES 5, 5A AND 6**

**TRANSFORMERS**

**BRIEF SPECIFICATIONS**

**Second Edition : January 1995**

**SULTANATE OF OMAN**  
**MINISTRY OF ELECTRICITY & WATER**



**STANDARD - OES 5**  
**11KV/433V DISTRIBUTION**  
**TRANSFORMERS**  
**BRIEF SPECIFICATIONS**

**Second Edition : January 1995**

**SULTANATE OF OMAN**  
**MINISTRY OF ELECTRICITY & WATER**

**STANDARD : OES - 5**

**11KV/433V DISTRIBUTION TRANSFORMERS**

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**SULTANATE OF OMAN**  
**MINISTRY OF ELECTRICITY & WATER**

**STANDARD OES - 5**  
**11KV/433V DISTRIBUTION TRANSFORMERS**

**1.0 TYPE**

The transformer shall be of the naturally cooled outdoor oil immersed core type and shall comply with the requirements of IEC 76/BSS 171 except that the temperature rise shall not exceed 50 Deg.C of winding by resistance and 40 Deg.C of oil by thermometer.

**2.0 RATING**

The normal rating specified shall be the continuous rating under the worst temperature conditions encountered in Oman stipulated in Clause 01 of OES-11. Tenders shall state in the schedule the equivalent IEC/BSS continuous rating for the transformers offered along with the Oman continuous rating.

**3.0 VOLTAGE RATIO**

The normal voltage ratio of the transformers on normal tapping and on no load shall be 11000/433V.

**4.0 TEMPERATURE RISE**

The transformers shall be capable of carrying their full normal current continuously under the worst temperature conditions encountered in Oman and at any tapping, without the temperature rise of oil in the hottest region exceeding 40 Deg.C as measured by thermometer and of the winding not exceeding by 50 Deg.C as measured by resistance over an ambient temperature of 50 Deg.C.

**5.0 CONNECTIONS**

The transformers shall be wound to IEC/BSS vector reference Dyn11 and L.T. neutral shall be brought out.

**6.0 OFF CIRCUIT TAPPINGS**

The 11KV winding of the transformers shall have tapplings with a range of +5% to -5% in steps of 2 1/2% operated by an off circuit tapping switch, with clearly marked position indicator. Locking facilities shall be provided such that the lock can be inserted only when the switch is on a definite tap. Lock with two keys shall be supplied for each transformer. The tap switch shall preferably be mounted on the tank side.

**7.0 IMPEDANCE VOLTAGE**

The impedance voltage of the transformers shall be 4.75%.

## 8.0 DUTY UNDER FAULTS

The transformers shall be capable for sustaining a three phase symmetrical short circuit on the L.V side with power maintained on the HV side without damage or distress for 3 seconds.

Transformers shall be designed and constructed to withstand without damage the thermal and dynamic effects of external short circuits under the conditions stipulated in Clause 0.01 of OES-11.

Thermal ability to withstand short circuits is to be demonstrated by calculations as per BS 171 - Part 5 1978/IEC 76 - Part 5 1976.

The dynamic ability to withstand short circuit is to be demonstrated by test or reference to tests on transformer of similar design and rating conducted by recognised independent test laboratory.

## 9.0 CORE

The core shall be constructed of the best quality low loss, cold rolled grain oriented electrical steel laminations. The core plates shall be insulated from one another to reduce the core loss to a minimum and the core shall be held together by bolts and clamping plates all of which shall be adequately insulated. The completed core shall be provided with lifting eyes to facilitate its removal from the transformer tank and shall be adequately braced and supported to prevent movement during transit or service.

## 10.0 WINDINGS

All windings shall be fully insulated to IEC 76-3 for uniform insulated and for a system highest voltage of 12.5KV. The insulation shall be Class "A" to BSS 2757. End connection of winding to be properly insulated.

## 11.0 TANK

The tank shall be designed to house the transformer core and windings and arranged to prevent any movement of the core structure inside the tank. Provision should be made to enable the core to be lifted out and ease for maintenance and inspection.

The tank shall be mild steel welded construction of adequate dimensions with minimum plate thickness as follows :

- Bottom : 5mm
- Sides : 4mm
- Top : 5mm
- Radiator : 1.2mm
- Corrugated type : Thickness of corrugated plate : 1.2mm

## 12.0 GASKETS AND JOINTS

All gaskets used for making oil tight shall be with cork or similar material as base, bonded by oil resisting synthetic material or rubber, gaskets of plain synthetic materials not permissible.

13.0

**TERMINAL ARRANGEMENTS**

The terminal arrangements shall be as follows:

	<b>HV</b>	<b>LV</b>
a) 1000KVA 11KV/433V Transformers	Cable box to BS 2562 (min. phase to phase centres 180mm and phase to earth clearance 100mm) for 3 core XLPE SWA PVC cable 50 sq.mm copper XLPE insulated, PVC sheathed single galvanised steel wire armoured PVC served overall.	Cable box to BS 2562 (min. phase to phase centres 120mm) for single core cable core cable copper conductor 630 sq.mm XLPE insulated aluminium strip armoured PVC served overall all 2 cores per phase one neutral.

b) 500KVA  
11KV/433V  
Transformers

“DO” except 1 core per phase plus one neutral

**Note**

Cable box bushing to be on sides enabling vertical entry of cables.

c) 315KVA  
11KV/433V  
Transformers

Outdoor bushings (min. phase to phase centres 150mm) complete with nuts, lock nuts, washer and compression lugs for 50 sq.mm copper conductor. Bushing terminal connection to winding by bolt and nut not by brazing.

d) 200KVA  
11KV/433V  
Transformers

Outdoor bushings (min. phase to phase centres 150mm) complete with nuts, lock nuts, washers and compression lugs for two 4 core cables 185 sq.mm. Bushing terminal connecting to winding end shall be by bolt and nut not by brazing.

e) 100KVA  
11KV/433V  
Transformers

“DO” except lugs for one core cable 185 sq.mm copper

“ DO “

#### 14.0

#### POLE MOUNTING TRANSFORMERS

Transformers upto and including 315KVA are intended for mounting on 'H' pole structure with poles at 180 cm centres. The overall length of the transformers shall not therefore exceed 140cm. Transformers shall be provided with base channels having slotted holes to suit holes on transformer cross arm shown in Drawing No. MEW/OH/011. The maximum weight of transformer including oil shall not exceed 1600 kg.

#### 15.0

#### EARTHING TERMINALS

Each transformer shall have two earth terminals for connection to the substation earthing system.

#### 16.0

#### FITTINGS

The fittings on the transformer shall include the followings:

- i) Conservator complete with filling cap and drain valve.
- ii) Lifting lugs
- iii) Breather

- Breather container shall be vandal proof and suitable for climatic conditions of Oman. In view of the high humidity prevailing in Oman, silicagel breather should be liberally designed and shall be one size larger than normal to avoid the need for frequent replacement of the gel. On pole mounted transformers, the breather shall not be fitted on the side where bushings (11KV Or LV) are fitted and shall be located at a height 20 cm from transformer mounting channels.

- iv) Oil level gauge

- It shall be prismatic type for clear oil level indication preferably of glass and shall be replaceable and shall be located on the side of the conservator.

- v) Main tank drain valve
- vi) Conservator to main tank valve
- vii) Dial type thermometer with maximum reading pointer
- viii) Thermometer pocket
- ix) Rating diagrams plates to BS 171

- shall be in English and of stainless steel or brass with details engraved and located in easily visible position and shall contain the following informations:

- 1) Rating in KVA
- 2) Site Ambient Temperature
- 3) Temperature Rise  
Oil : °C  
Winding : °C
- 4) Voltage at no load and normal tapping  
H.V. Side  
L.V. Side

5) Current at rated load and normal tapping

H.V. Side

L.V. Side

6) Impedance voltage at normal rating

7) Number of phases

8) Diagram of connection

9) Frequency

10) Vector group ref. and diagram

11) No Load Loss

12) Load Losses

13) Weight of core and winding

14) Weight of oil

15) Total weight of transformer

16) Manufacturer's Name

17) Manufacturer's Serial Number

18) Year of Manufacture

19) Contract Number

20) Owner's Name

x) Two earth terminals

- Shall be corrosion resistance material preferably brass or stainless steel

## 17.0

### TESTS

Type and routine tests shall be carried out in accordance with BSS 171/IEC 76. The following type tests shall be performed in the presence of Purchaser's Inspector.

1) Temperature rise test on one transformer.

2) Short circuit dynamic withstandability test on the transformer or Certificate of Test carried out on a similar unit of the same design and rating.

3) Impulse withstanding test on one transformer shall be applied on one HV winding leg only and shall be in accordance with BSS 923 and 171.

4) All transformers shall be tested completely assembled with conservator etc. for oil leakage. The oil pressure shall be equivalent to a level of four meters of oil above normal oil level and shall be applied for a period not less than 6 hours.

## 18.0

### LOSSES

1) The No Load and Load Losses of Distribution Transformers shall not exceed the values given below:



**LOSSES - WATTS****S.NO.                      RATING - KVA****NO-LOAD                      LOAD**

1	100	300	2000
2	200	500	3000
3	315	700	3500
4	500	1000	4500
5	1000	1500	8000

- 2) All manufacturers/suppliers shall mention the above values on the name plate of the transformer as well as in the test certificates/literatures/technical particulars.
- 3) All vendors/suppliers are bound to appoint a third party independent inspection agency approved by MEW.

**19.0 TENDER ANALYSIS**

The transformer iron and copper losses will be capitalized and added to the Tender Price to determine the overall economic price. The capitalization will be based on the followings:

- a) No load losses                      R.O. 800/- per KW  
b) Load losses                        R.O. 300/- per KW

If the acceptance tests of the transformers show that the actual losses exceed the values stated in the Schedule of Guaranteed Particulars, then the "Excess Losses" will be capitalised according to the above assumptions and the sum thus obtained deducted from the monies due to the Supplier as a penalty. For this purpose no tolerance will be allowed on the figures stated in the Schedule of Particulars and Guarantees. In any case, if the actual losses exceed the figures stated in the schedule by more than 10% the transformer is liable to be rejected.

**20.0 PAINTING AND FINISHES**

It is to be borne in mind that the atmosphere in Oman highly corrosive. Therefore, special attention should be given to protection of all iron work. The methods proposed and the means adopted for rust proofing should be fully described.

All surfaces shall be thoroughly cleaned and free from rust, scale, grease, dirt and other foreign matter. Sharp points, weld spatters, flux or other imperfections shall be removed. The whole of the tank and fittings shall be sand blasted inside the outside to remove all scale and rust before painting.

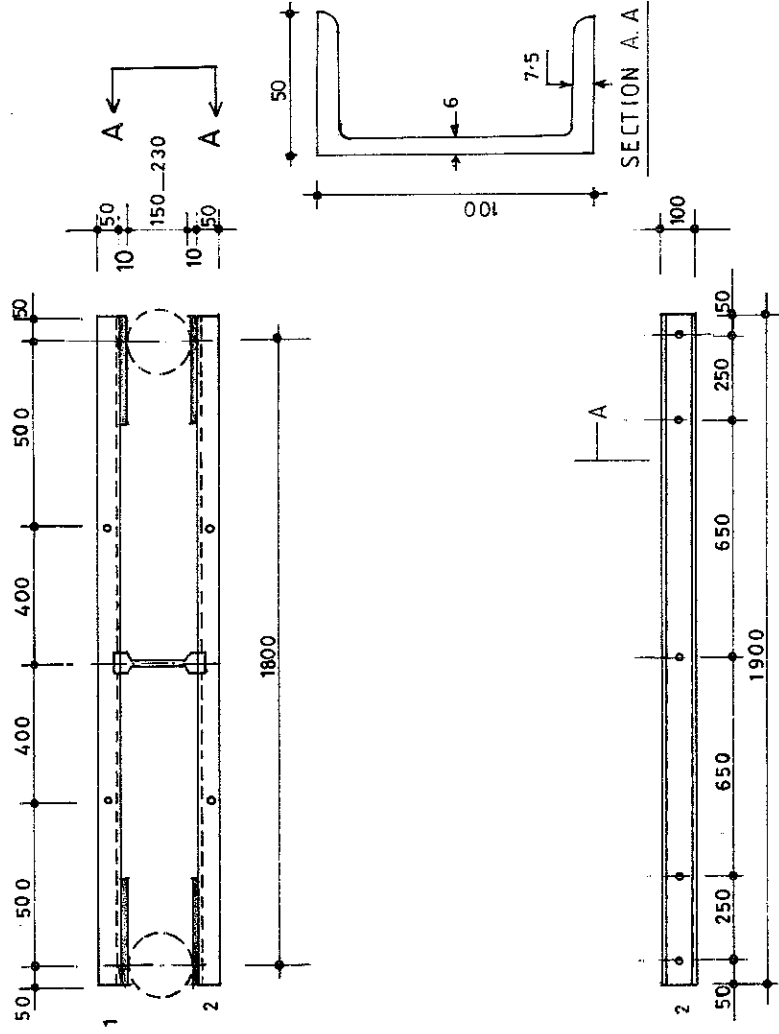
Immediately after cleaning, a primary coat of red lead or other approved primer shall be applied. After the application of the first primary coat all rough surfaces shall be rubbed down and filled and a second coat of red lead or other approved primer applied. This shall be followed by the application of two coats of an approved oil based paint.

The interior of all tanks and other oil filled chambers after necessary preparation and cleaning as described above, shall be painted with an oil resisting varnish or enamel.

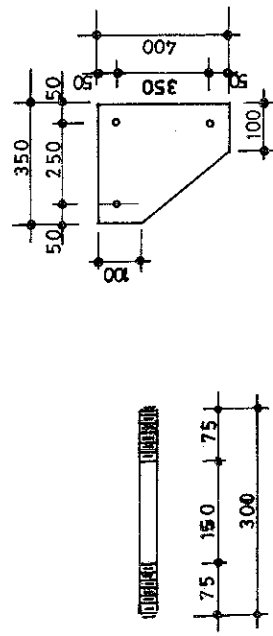
All paint and/or enamel shall be applied by brush or sprayer. Dipping shall not be permitted. A first class blemish free pleasing finishing shall be obtained. Five year guarantee for painting shall be submitted.

Any other approved method of painting is acceptable. Five year guarantee to be submitted.

**Encl. :** Drawing and Guaranteed Particulars



**TRANSFORMER CROSSARM**



**M.S. BOLT**

**GUSSET PLATE**

**SIDE VIEW A A**

**NOTE:**

1. ALL DIMENSIONS IN mm
2. CROSSARM - 30TON QUALITY M.S. CHANNEL 100x 50x 7.5 mm AS PER B.S. 4848 PART III
3. GUSSET PLATE - 10mm THICK M.S. GUSSET PLATE AS PER B.S. 1499.
4. GALVANISED TO B.S. 729 IN ACCORDANCE WITH O.E.S.11 MINIMUM THICKNESS 127 MICRONS.
5. 19mm DIA M.S. BOLT WITH NUT & WASHERS
6. ALL HOLES ARE OF 22mm DIA

A	10.11.92	Section added			
REV.	DATE	DESCRIPTION	CKD	APD	
<b>MINISTRY OF ELECTRICITY &amp; WATER</b>					
<b>TITLE TRANSFORMER CROSSARM &amp; GUSSET PLATE</b>					
DRAWN BY		CHECKED BY		APPROVED BY	
R.A. QURESHI				R. Qureshi	
DRG. NO. MEW/OH/011			DATE 17/12 / 1984		
SCALE					

## GUARANTEED PARTICULARS

The technical particulars of the 33KV/433V Distribution Transformer.

<b>Description</b>	<b>Particulars</b>
Continuous rating under Oman conditions	KVA
Equivalent BSS continuous rating	KVA
Supply Voltage	KV
Normal Voltage ratio at normal tapping	
Method of cooling	
BSS Vector Group	
Maximum temperature rise at normal loading :	
a) Oil	Deg.C
b) Winding	Deg.C
Impedance Voltage	
Impulse level :	
a) 1/50 full wave	KV
b) 1/50 chopped wave	KV
Maximum flux density in core at normal voltage and frequency Lines	sq. cm
Maximum flux density in yoke at normal voltage and frequency Lines	sq.cm
Current density at rated output	
a) Primary Winding Amps/sq.cm	
b) Secondary Winding Amps/sq.cm	
Iron loss at normal voltage and tapping	KW
Copper loss at normal full load and 75 Deg.C	KW

Description	Particulars
Magnetising current at normal voltage as percentage of full load current	%
Regulation at 0.8 P.F. lagging	%
Resistance of winding at 75 Deg.C	
a) H.V. Windings	Ohms/Phase
b) L.V. Windings	Ohms/Phase
Thickness of Tank Plat	
a) Sides	mm
b) Bottom	mm
c) Top	mm
d) Radiator tube/corrugated fins	
Total oil required	Litres
Weights	
a) Core and Weights	Kgs
b) Complete transformer including oil	Kgs
c) Transformer arranged for shipment	Kgs
d) Transformer excluding oil	Kgs
Overall dimensions:	
a) Height	cms
b) Length	cms
c) Width	cms

**SULTANATE OF OMAN**  
**MINISTRY OF ELECTRICITY & WATER**

**STANDARD : OES - 5A**

**33KV/433V DISTRIBUTION TRANSFORMERS**

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**SULTANATE OF OMAN**  
**MINISTRY OF ELECTRICITY & WATER**

**STANDARD OES - 5A**  
**33KV/433V DISTRIBUTION TRANSFORMERS**

**1.0 TYPE**

The transformer shall be of the naturally cooled outdoor oil immersed core type and shall comply with the requirements of IEC 76/BSS 171 except that the temperature rise shall not exceed 50 Deg.C for winding by resistance and 40 Dec.C of oil by thermometer.

**2.0 RATING**

The normal rating specified shall be the continuous rating under the worst temperature conditions encountered in Oman stipulated in Clause 01 of OES-11. Tenders shall state in the schedule the equivalent IEC/BSS continuous rating for the transformers offered along with the Oman continuous rating.

**3.0 VOLTAGE RATIO**

The normal voltage ratio of the transformers on normal tapping and on no load shall be 33000/433V.

**4.0 TEMPERATURE RISE**

The transformers shall be capable of carrying their full normal current continuously under the worst temperature conditions encountered in Oman and at any tapping, without the temperature rise of oil in the hottest region exceeding 40 Deg.C as measured by thermometer and of the winding not exceeding by 50 Deg.C as measured by resistance over an ambient temperature of 50 Deg.C.

**5.0 CONNECTIONS**

The transformers shall be wound to IEC/BSS vector reference Dyn11 and L.T. neutral shall be brought out.

**6.0 OFF CIRCUIT TAPPINGS**

The 33KV winding of the transformers shall have tapplings with a range of +5% to -5% in steps of 2 1/2% operated by an off circuit tapping switch, with clearly marked position indicator. Locking facilities shall be provided such that the lock can be inserted only when the switch is on a definite tap. Lock with two keys shall be supplied for each transformer. The tap switch shall preferably be mounted on the tank side.

**7.0 IMPEDANCE VOLTAGE**

The impedance voltage of the transformers shall be 4.75%.

## 8.0

### **DUTY UNDER FAULTS**

The transformers shall be capable of sustaining a three phase symmetrical short circuit on the LV side with power maintained on the HV side without damage or distress for 3 seconds.

Transformers shall be designed and constructed to withstand without damage the thermal and dynamic effects of external short circuits under the conditions stipulated in Clause 0.01 of OES-11.

Thermal ability to withstand short circuits is to be demonstrated by calculations as per BS 171 - Part 5 1978/IEC 76 - Part 5 1976.

The dynamic ability to withstand short circuit is to be demonstrated by test or reference to tests on transformer of similar design and rating conducted by recognised independent test laboratory.

## 9.0

### **CORE**

The core shall be constructed of the best quality low loss, cold rolled grain oriented electrical steel laminations. The cords plates shall be insulated from one another to reduce the core loss to a minimum and the core shall be held together by bolts and clamping plates all of which shall be adequately insulated. The completed core shall be provided with lifting eyes to facilitate its removal from the transformer tank and shall be adequately braced and supported to prevent movement during transit or service.

## 10.0

### **WINDINGS**

All windings shall be fully insulated to IEC 76-3 for uniform insulated and for a system highest voltage of 36KV. The insulation shall be Class "A" to BSS 2757. End connection of winding to be properly insulated and supported.

## 11.0

### **TANK**

The tank shall be designed to house the transformer core and windings and arranged to prevent any movement of the core structure inside the tank. Provision should be made to enable the core to be lifted out and ease for maintenance and inspection.

The tank shall be mild steel welded construction of adequate dimensions with minimum plate thickness as follows :

- Bottom : 5mm
- Sides : 4mm
- Top : 5mm
- Radiator : 1.2mm
- Corrugated type : Thickness of corrugated plate : 1.2mm

## 12.0

### **GASKETS AND JOINTS**

All gaskets used for making oil tight shall be with cork or similar material as base, bonded by oil resisting synthetic material or rubber, gaskets of plain synthetic materials not permissible.



13.0

**TERMINAL ARRANGEMENTS**

The terminal arrangements shall be as follows:

	<b>HV</b>	<b>LV</b>
a) 1000KVA 33KV/433V Transformers	Cable box to BS 2562 (min. phase to phase centres 500mm and phase to earth clearance 400mm) for 3 core XLPE SWA PVC cable 50 sq.mm copper XLPE insulated, PVC sheathed single galvanised steel wire armoured PVC served overall.	Cable box to BS 2562 (min. phase to phase centres 120mm) for single core cable core cable copper conductor 630 sq.mm XLPE insulated aluminium strip armoured PVC served overall all 2 cores per phase one neutral.
b) 500KVA 33KV/433V Transformers	“ DO “	“DO” except 1 core per phase plus one neutral

**Note**

Cable box bushing to be on sides enabling vertical entry of cables.

c) 315KVA 33KV/433V Transformers	Outdoor bushings with creepage of 1320mm (min. phase to phase centres 450mm) complete with nuts, lock nuts, washer and compression lugs for 50 sq.mm copper conductor. Bushing terminal connection to winding by bolt and nut not by brazing.	Outdoor bushings (min. phase to phase centres 150mm) complete with nuts, lock nuts, washers and compression lugs for two 4 core cables 185 sq.mm. Bushing terminal connecting to winding end shall be by bolt and nut not by brazing.
d) 200KVA 33KV/433V Transformers	“ DO “	“DO” except lugs for one core cable 185 sq.mm copper
e) 100KVA 33KV/433V Transformers	“ DO “	“ DO “

#### 14.0

#### POLE MOUNTING TRANSFORMERS

Transformers upto and including 315KVA are intended for mounting on 'H' pole structure with poles at 180 cm centres. The overall length of the transformers shall not therefore exceed 140cm. Transformers shall be provided with base channels having slotted holes to suit holes on transformer cross arm shown in Drawing No. MEW/OH/011. The maximum weight of transformer including oil shall not exceed 1600 kg.

#### 15.0

#### EARTHING TERMINALS

Each transformer shall have two earth terminals for connection to the substation earthing system.

#### 16.0

#### FITTINGS

The fittings on the transformer shall include the followings:

- i) Conservator complete with filling cap and drain valve.
- ii) Lifting lugs
- iii) Breather

Breather container shall be vandal proof and suitable for climatic conditions of Oman. In view of the high humidity prevailing in Oman, silicagel breather should be liberally designed and shall be one size larger than normal to avoid the need for frequent replacement of the gel. On pole mounted transformers, the breather shall not be fitted on the side where bushings (11KV Or LV) are fitted and shall be located at a height 20 cm from transformer mounting channels.

- iv) Oil level gauge

It shall be prismatic type for clear oil level indication preferably of glass and shall be replaceable and shall be located on the side of the conservator.

- v) Main tank drain valve
- vi) Conservator to main tank valve
- vii) Dial type thermometer with maximum reading pointer
- viii) Thermometer pocket
- ix) Rating diagrams plates to BS 171

shall be in English and of stainless steel or brass with details engraved and located in easily visible position and shall contain the following informations:

- 1) Rating in KVA
- 2) Site Ambient Temperature
- 3) Temperature Rise  
Oil : °C  
Winding : °C
- 4) Voltage at no-load and normal tapping  
H.V. Side  
L.V. Side

5) Current at rated load and normal tapping

H.V. Side

L.V. Side

6) Impedance voltage at normal rating

7) Number of phases

8) Diagram of connection

9) Frequency

10) Vector group ref. and diagram

11) No Load Loss

12) Load Losses

13) Weight of core and winding

14) Weight of oil

15) Total weight of transformer

16) Manufacturer's Name

17) Manufacturer's Serial Number

18) Year of Manufacture

19) Contract Number

20) Owner's Name

x) Two earth terminals

Shall be corrosion resistance material preferably brass or stainless steel

#### 17.0 TESTS

Tye and routine tests shall be carried out in accordance with BSS 171/IEC 76. The following type tests shall be performed in the presence of Purchaser's Inspector.

1) Temperature rise test on one transformer.

2) Short circuit dynamic withstandability test on the transformer or Certificate of Test carried out on a similar unit of the same design and rating.

3) Impulse withstanding test on the transformer shall be applied on one HV winding leg only and shall be in accordance with BSS 923 and 171.

4) All transformers shall be tested completely assembled with conservator etc. for oil leakage. The oil pressure shall be equivalent to a level of four meters of oil above normal oil level and shall be applied for a period not less than 6 hours.

#### 18.0 LOSSES

1) The No Load and Load Losses of Distribution Transformers shall not exceed the values given below:

S.NO.	RATING - KVA	LOSSES - WATTS	
		NO-LOAD	LOAD
1	100	300	2000
2	200	500	3000
3	315	700	3500
4	500	1000	4500
5	1000	1500	8000

- 2) All manufacturers/suppliers shall mention the above values on the name plate of the transformer as well as in the test certificates/literatures/technical particulars.
- 3) All vendors/suppliers are bound to appoint a third party independent inspection agency approved by MEW.

#### 19.0 TENDER ANALYSIS

The transformer iron and copper losses will be capitalized and added to the Tender Price to determine the overall economic price. The capitalization will be based on the followings:

- a) No load losses R.O. 800/- per KW
- b) Load losses R.O. 300/- per KW

If the acceptance tests of the transformers show that the actual losses exceed the values stated in the Schedule of Guaranteed Particulars, then the "Excess Losses" will be capitalised according to the above assumptions and the sum thus obtained deducted from the monies due to the Supplier as a penalty. For this purpose no tolerance will be allowed on the figures stated in the Schedule of Particulars and Guarantees. In any case, if the actual losses exceed the figures stated in the schedule by more than 10% the transformer is liable to be rejected.

#### 20.0 PAINTING AND FINISHES

It is to be borne in mind that the atmosphere in Oman is highly corrosive. Therefore, special attention should be given to protection of all iron work. The methods proposed and the means adopted for rust proofing should be fully described.

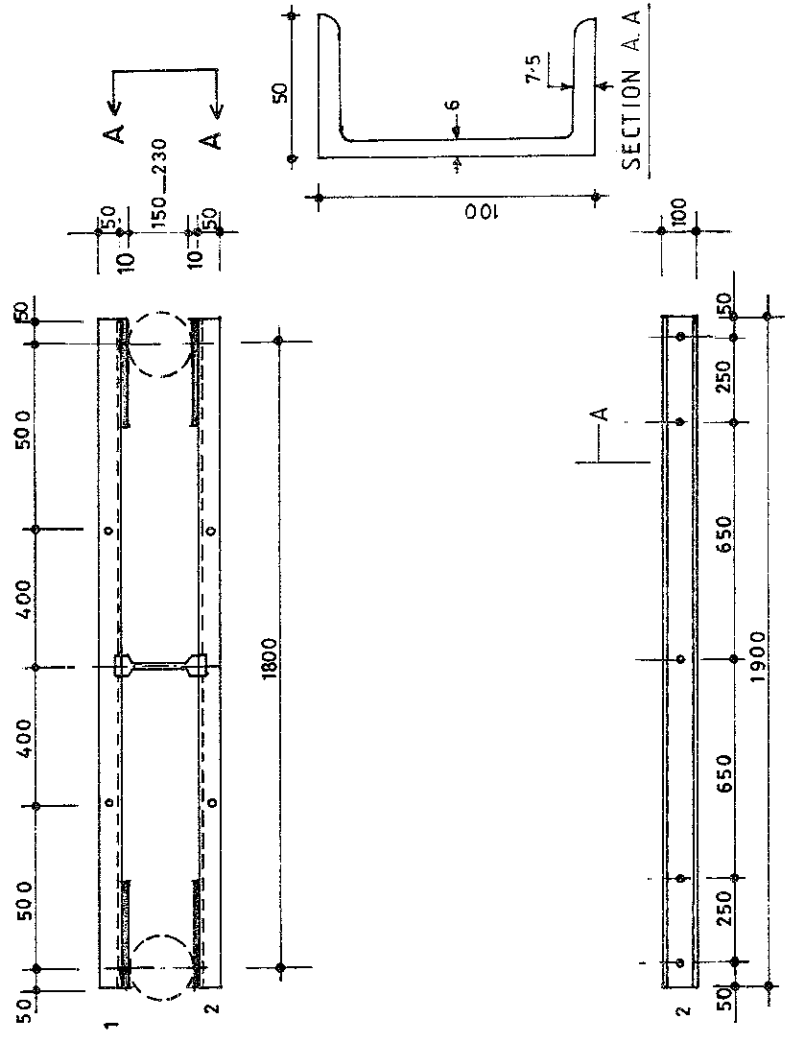
All surfaces shall be thoroughly cleaned and free from rust, scale, grease, dirt and other foreign matter. Sharp points, weld spatters, flux or other imperfections shall be removed. The whole of the tank and fittings shall be sand blasted inside the outside to remove all scale and rust before painting.

Immediately after cleaning, a primary coat of red lead or other approved primer shall be applied. After the application of the first primary coat all rough surfaces shall be rubbed down and filled and a second coat of red lead or other approved primer applied. This shall be followed by the application of two coats of an approved oil based paint.

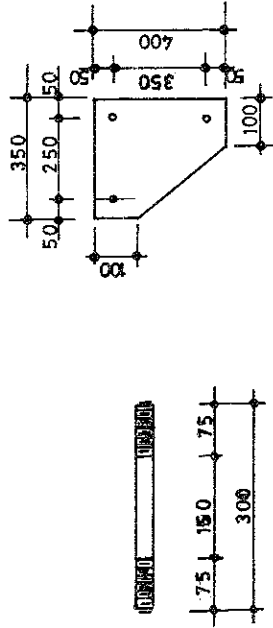
The interior of all tanks and other oil filled chambers after necessary reparation and cleaning as described above, shall be painted with an oil resisting varnish or enamel.

All paint and/or enamel shall be applied by brush or sprayer. Dipping shall not be permitted. A first class blemish free pleasing finishing shall be obtained. Five year guarantee for painting shall be submitted.

Encl. : Drawing and Guaranteed Particulars

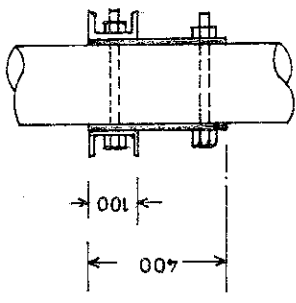


**TRANSFORMER CROSSARM**



**M.S. BOLT**

**GUSSET PLATE**



**SIDE VIEW A A**

**NOTE:**

1. ALL DIMENSIONS IN mm
2. CROSSARM, 30TON QUALITY M.S. CHANNEL 100x50x 7.5 mm AS PER B.S. 4848 PART III
3. GUSSET PLATE - 10 mm THICK M.S. GUSSET PLATE AS PER B.S. 1499.
4. GALVANISED TO B.S. 729 IN ACCORDANCE WITH O.E.S.11 MINIMUM THICKNESS 127 MICRONS.
5. 19mm DIA M.S. BOLT WITH NUT & WASHERS
6. ALL HOLES ARE OF 22mm DIA

REV.	DATE	DESCRIPTION	C KD	APD
A	10/11/92	Section added		

**MINISTRY OF ELECTRICITY & WATER**

TITLE **TRANSFORMER CROSSARM & GUSSET PLATE**

DRAWN BY **R.A. QURESHI** CHECKED BY **[Signature]** APPROVED BY **[Signature]**

DRG. NO. MEW/OH/011 DATE 17/12/1984

SCALE

## GUARANTEED PARTICULARS

The technical particulars of the 11KV/433V Distribution Transformer.

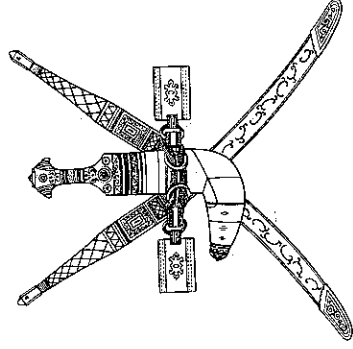
Description	Particulars
Continuous rating under Oman conditions	KVA
Equivalent BSS continuous rating	KVA
Supply Voltage	KV
Normal Voltage ratio at normal tapping	
Method of cooling	
BSS Vector Group	
Maximum temperature rise at normal loading :	
a) Oil	Deg.C
b) Winding	Deg.C
Impedance Voltage	
Impulse level :	
a) 1/50 full wave	KV
b) 1/50 chopped wave	KV
Maximum flux density in core at normal voltage and frequency Lines	sq. cm
Maximum flux density in yoke at normal voltage and frequency Lines	sq.cm
Current density at rated output	
a) Primary Winding Amps/sq.cm	
b) Secondary Winding Amps/sq.cm	
Iron loss at normal voltage and tapping	KW
Copper loss at normal full load and 75 Deg.C	KW

Description	Particulars
Magnetising current at normal voltage as percentage of full load current	%
Regulation at 0.8 P.F. lagging	%
Resistance of winding at 75 Deg.C	
a) H.V. Windings	Ohms/Phase
b) L.V. Windings	Ohms/Phase
Thickness of Tank Plat	
a) Sides	mm
b) Bottom	mm
c) Top	mm
d) Radiator tube/corrugated fins	
Total oil required	Litres
Weights	
a) Core and Weights	Kgs
b) Complete transformer including oil	Kgs
c) Transformer arrange for shipment	Kgs
d) Transformer excluding oil	Kgs
Overall dimensions:	
a) Height	cms
b) Length	cms
c) Width	cms



**SULTANATE OF OMAN**

**MINISTRY OF ELECTRICITY & WATER**



**STANDARD - OES 6**  
**33/11KV TRANSFORMERS**  
**BRIEF SPECIFICATIONS**

**Second Edition : January 1995**

**SULTANATE OF OMAN**  
**MINISTRY OF ELECTRICITY & WATER**

**STANDARD : OES - 6**  
**33/11KV TRANSFORMERS**

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**SULTANATE OF OMAN**  
**MINISTRY OF ELECTRICITY & WATER**

**STANDARD OES - 6**  
**33/11KV TRANSFORMERS**

**SECTION - 1**  
**APPLICABLE TO ALL 33/11.5KV TRANSFORMERS**

**1.1 GENERAL**

The transformers shall be of robust construction and shall be unaffected in part or whole by the forces imposed by short circuit or other fault current, operation, vibration or temperature changes. The transformers shall be suitable in all respects for operation on electrical systems in the Sultanate of Oman and in the climatic conditions obtaining at sites (clause 0.01 of OES 11).

The transformers shall be designed to carry continuously their maximum rating without exceeding the maximum temperature rise specified in Clause i.3. All transformers shall be provided with the required accessories as specified in the details of equipment. The transformers shall comply with IEC 76/BSS 171.

The temperature rise of winding shall not exceed 50 Deg.C by resistance of oil 40 Deg.C by thermometer over an ambient of 50 Deg.C.

**1.2 TRANSPORT AND DRYING OUT**

The transformers shall be shipped in their own tanks either in gas or in oil.

Approved means of ascertaining whether the windings has been exposed during transit and whether drying out at site is necessary shall be provided. Necessary oil conditioning equipment (Stream Line Filter) will be provided by the Purchaser for drying out purpose.

**1.3 CONTINUOUS MAXIMUM RATING**

The transformers shall be capable of carrying their maximum specified load continuously under the worst temperature conditions encountered in Oman and at any tapping without the temperature rise of oil in the hottest region exceeding 50 Deg.C as measured by winding resistance and 40 Deg.C of oil as measured by thermometers. If any transformer exceeds the above temperature rise limits on test, it may be rejected.

**1.4 DUTY UNDER FAULT CONDITIONS**

All transformers shall be capable of withstanding without damage or distress an external fault between phases for three seconds with the voltage on the other side of the transformers maintained at its full normal value.

The transformers shall be designed and constructed to withstand without damage the thermal and dynamic effects of external short circuit under the conditions stipulated in Clause 0.01 of OES-11.

The thermal ability to withstand short circuit is to be demonstrated by calculations as per BS 171 - Part 5 1978/IEC 76,1976.

The dynamic ability to withstand short circuit is to be demonstrated by test or reference tests on transformer similar design and rating conducted by recognised independent test laboratory.

#### 1.5 IMPULSE LEVELS

The withstand impulse levels of the transformers shall not be lower than the following when tested in accordance with BS 171 and 923 :

33KV	: 170KV
11KV	: 75KV

#### 1.6 HARMONICS

The transformers shall be designed to suppress voltage harmonics (particularly third and fifth) to a minimum to eliminate wave distortion and high frequency disturbances.

#### 1.7 VIBRATION AND NOISE

Every care shall be taken to reduce noise and vibration to the level obtained in good modern practice and special attention should be given to this point by the manufacturer.

#### 1.8 CORE

The core shall be constructed of the best quality low loss cold rolled grain-oriented electrical steel laminations. The flux density in any part of the core shall preferably not exceed 16000 lines per sq.mm at normal voltage and frequency.

The core plates shall be insulated from one another to reduce the core loss to minimum and the core shall be held together by bolts and clamping plates all of which shall be adequately insulated. The completed core shall be provided with lifting eyes to facilitate its removal from the transformer tank and shall be adequately braced and supported to prevent movement during transit or service.

#### 1.9 WINDINGS

The conductor shall be made from high conductivity electrolytic copper of best quality. All windings shall be fully insulated as defined in BS. All neutral points shall be insulated for full line voltage. The design maximum current density in the windings of the transformer shall not exceed 2.6 amperes per sq.mm at continuous maximum rating of the transformer with normal voltage plus 10% and normal frequency.

Drawings shall be submitted showing type of windings, methods of bracing and clamping; details of oil cooling ducts with dimensions and precautions taken to prevent shrinkage of insulating materials in service shall be stated. Particular attention must be given to the bracing of the winding and terminals to withstand shocks which may occur during handling and transport having regard to the rough handling to be expected during unloading at site.

The transformers shall be designed to withstand the impulse voltage levels specified in Clause 1.5 and shall withstand the power frequency voltage tests specified in the Schedule of Tests.

#### 1.10 INSULATION

All insulation of the transformers shall be class A in accordance with BS No. 2757. The windings shall be insulated with best quality paper and treated to prevent the formation of acid in the insulating oil. The transformer will be connected to 33KV system, the neutral of which will be earthed through resistance of 12.5 ohms. The 11KV neutral will be solidly earthed. the insulation shall withstand over voltage due to exposure of system to lightning surges as well as switching surges. The neutral shall be insulated for system line to line voltage.

#### 1.11 INTERNAL EARTHING ARRANGEMENT

The following provisions shall be made for internal earthing :

- a) The main core clamping structure and its clamping bolts, and the coil clamping rings (if at earth potential) shall be bonded together and to the transformer tank by copper strip.
- b) The magnetic circuit shall be electrically bonded to the main clamping structure at one point only by means of a removable link, which shall be located on the same side of the core as the main earth connection, and shall be accessible from the manhole in the tank cover after lowering the oil to the level of the top yoke. Coil clamping rings at earth potential shall be connected to adjacent core clamping structure on the same side of the transformer as the main earth connection.

Earthing connection is to have a cross are of not less than 400 sq.mm.

#### 1.12 MAIN TANK

The main tank shall be designed to house the transformer core and winding and arranged to prevent any movement of the core structure inside the tank. Provision shall be made to enable the core to be lifted out with ease for maintenance and inspection.

The tank shall be of mild steel welded construction of adequate dimensions and braced and reinforced as necessary with rolled steel sections to prevent any distortion due to transportation, lifting, internal pressures and temperature variations.

The top tank shall have provision to give access to terminations of windings and earthing point etc. without completely draining the tank of oil. Suitable lifting lugs designed to carry the whole weight of the transformer including the fittings and oil, shall be welded to the tank.

Transformer tank shall be flat bottomed, designed and reinforced so that the complete equipment may be skidded in any direction. The tenderers shall describe the means to be used to protect the tank bottom when in service. The design of the tank, the tank cover, and the undercarriage, the radiator tank etc. of the transformer shall be such that :

- a) Internally there are no pockets in which oil can remain when draining the tank, or in which air can be trapped when fitting the tank.

- b) Externally there are no pockets in which water can lodge.
- c) It shall be possible to gain easy access to all external surfaces for painting.

Pockets shall be provided on each transformer tank for a stem type thermometer and the bulb of a temperature indicator. These pockets shall be located in the position of maximum oil temperature at continuous maximum rating and it shall be possible to remove any bulb without lowering the oil level in the tank. The stem type thermometer pockets shall be provided with captive screw-caps to exclude water and dirt. A flange type air release plug shall be provided at the highest point in the tank cover. The tank shall be designed to withstand when empty a vacuum of 50 cm of mercury or the vacuum required during drying out, whichever is greater.

The whole of the tank and fittings shall be sand blasted inside and outside to remove all scale and rust before paintings. The inside of the tank shall be painted with an approved oil resisting varnish.

### 1.13 JACKING LUGS

The transformer shall be provided with at least four jacking lugs located at the four corners of the transformer tank. The lugs shall be approximately 50 cm above the ground level.

### 1.14 CONSERVATOR

A conservator tank shall be located conveniently on the top of the tank. Suitable oil gauges shall be provided at each end which can be easily read from the ground level. The temperature range to be expected under Oman conditions in the open is 0 Deg. to 90 Deg.C.

The conservator tank shall be provided with filling cap, drain plug, oil sampling valve.

The pipe connections from the conservator to the main tank shall be designed to have smooth run without sharp bends. All pipes connected to the conservator tank shall protrude at least two inches above the bottom plate.

### 1.15 RADIATOR TANKS

The banks of radiators of the transformers shall be designed and arranged so that they are detachable from the main tank for purposes of transport. Valves shall be provided to shut off the oil leaving the main tank into the cooling radiator bank. Air vent holes shall be provided on the banks of facilitate filling of the bank at site. The radiator shall be connected to the main tank of bolted flange joints.

### 1.16 VALVES

Drain valves shall be provided to completely drain the main tank, the conservator tank and radiator banks.

Stop valves with clearly marked position indicators and pad locking facilities shall be provided between :

- a) The main tank and conservator
- b) Between main tank and radiator banks

Oil sampling valve devices shall be provided at suitable points on the main tank, radiator banks and conservator tank.

#### **1.17 PRESSURE RELIEF DEVICE**

An approved pressure relief device of sufficient size for the rapid release of any pressure that may be generated in the tank and designed to operate at a static pressure lower than the specified hydraulic test pressure shall be provided.

The relief device is normally to be mounted on the tank, but if mounted on the cover, it is to be provided with a skirt to project at least 25mm into the tank to prevent gas accumulation.

If a diaphragm is used, it shall be approved design and material and located above the maximum oil level.

A pressure equalising pipe shall be provided between the pressure relief device and the oil conservator.

#### **1.18 BREATHER**

The conservator vessel shall be fitted with silicagel breather with replaceable elements. The breather shall be arranged at such a height that it may be readily accessible from ground level and shall be provided with suitable observation window. In view of the high humidity prevailing in Oman, silicagel breather shall be one size larger than the size for a temperate climate to avoid frequent replacement of the gel. Container shall be of vandal proof and suitable for climatic conditions of Oman.

#### **1.19 EARTHING TERMINALS**

Two earthing, terminals of corrosion resistance material preferably brass or stainless steel, for earthing the tank structure shall be fitted one on either side near to the bottom of the transformer, shall be provided to facilitate connection to the station earthing system.

#### **1.20 GASKETS AND JOINTS**

All gaskets used for making oil-tight joints shall be with cork or similar material as base, bonded by oil resisting synthetic material or rubber. Gaskets of plain synthetic material are not permissible.

#### **1.21 RATING AND DIAGRAM PLATES**

Each transformer shall be provided with substantial diagram and rating plates and shall give all the information relating to the transformer and cooling medium. The following information shall be included :

- rating in MVA
- site ambient temperature 50 Deg.C
- temperature rise by oil Deg.C
- temperature rise by winding resistance Deg.C
- volts at no load and normal tapping : H.V. side  
L.V. side

- current at rated load and normal tapping : H.V. side  
L.V. side
- Impedance voltage at normal rating
- number of phases
- diagram of connections
- frequency
- vector group reference and diagram
- weight of core and winding
- weight of oil
- total weight of transformer
- manufacturer's name
- manufacturer's serial number
- year of manufacture
- contract number
- owner's name and address

The plate shall not be less than 2.5mm in thickness and the marking shall be engraved thereon. The dimensions shall be to approval of the Purchaser. The plates shall be of stainless steel, bronze or brass.

#### 1.22 CAPITALIZATION OF LOSSES

The transformer iron and copper losses and input to cooling plant will be capitalized and added to tender price. The capitalization will be based on the following :

- a) no load losses : R.O. 800/- per KW
- b) load losses : R.O. 300/- per KW
- c) cooling plant : R.O. 200/0 per KW

If the acceptable tests of the transformer show that the actual losses exceed the values stated in the Schedule of Technical Particulars, then the "Excess Losses" will be capitalised according to the above assumption and sum thus obtained deducted from the monies due to the Contractor as a penalty. For this purpose, no tolerance will be allowed on the figures stated in the Schedule of Particulars and Guarantees.

In any case, the actual losses shall not exceed the figures stated in the Schedule of Technical Particulars by more than 10%.

The losses to be stated in the Schedule of Particulars and Guarantees shall be given without tolerances.

#### 1.23 TESTS ON POWER TRANSFORMERS

All tests shall be carried out as per the requirements of IEC/BS Standards. The manufacturer shall carry out any tests in addition to type and routine tests called for in this clause that are, in the opinion of the Purchaser or the Inspector, deemed necessary to determine compliance with this specification.



**a) Routine Tests**

The following routine tests shall be applied to all transformers in accordance with IEC/BS 171.

- i) Measurements of winding resistance on all tap positions and phases
- ii) Ratio, polarity and phase relationship
- iii) Impedance voltage
- iv) Load losses and cooling plant load
- v) No load losses and no load current
- vi) Insulation resistance
- vii) Induced over voltage withstand including partial discharge measurements to IEC 270
- viii) Separate source voltage withstand
- ix) Oil leakage test shall be applied as routine test on all transformers utilising hot transformer oil. The tank and all parts designed to contain oil (conservators and oil filled compartments), shall be tested at a pressure of 69 KN/m<sup>2</sup> or the normal pressure plus 34 KN/m<sup>2</sup> in excess of normal operating pressure whichever is greater. The test pressure shall be maintained for a period of one hour, with no leakage or oil ingress into normally oil free spaces.

**b) Type Tests**

The contractor should carry out the following type tests on one transformer of each size and type.

**i) Impulse Voltage Withstand Test**

This shall be applied in turn on one leg of the HV winding and one leg of the LV winding of the transformer. The test procedure shall be as laid down in BSS 171 and 923. The test voltage shall be in accordance with Table 10 of BSS 171. At the conclusion of the impulse voltage application, the transformer shall be subjected to iron loss measurement and to power frequency applied and induced voltage tests.

**ii) Temperature Rise Test**

A temperature rise test shall be carried out on one transformer in accordance with BSS 171. The transformer shall be tested with its voltage control and cooling system. The test shall be carried out with the transformer on the tap position giving the highest losses.

**c) Rejection of Plant**

Any item of plant or component which fails to comply with the requirements of this specification and cannot be fulfilled by adjustment or modification, shall be replaced by the Contractor at his own expense and to the satisfaction of the Purchaser.

**SECTION II A**  
**PARTICULAR REQUIREMENTS FOR 3MVA 33/11.5KV TRANSFORMER**

2.1	Type of cooling	ONAN
2.2	Voltage ratio	33/11.5KV
2.3	Connections	Delta/Star Vector Group Dyn 11
2.4	Tappings on HV winding	+5% to - 10% in steps of 2.5% off circuit tap switch with operating handle mounted externally on transformer tank side and having tap position indication and facility for padlocking in definite tap position. Padlock with two keys to be supplied.
2.5	Impedance voltage	6% on normal tapping and maximum continuous rating
2.6	Terminations	33KV side outdoor bushings complete with bi-metallic terminal clamps suitable for ACSR Or AAC conductor (overall diameter 20mm) creepage 40mm/KV. Phase to phase clearance (between bushing centres) 700mm. 11KV side outdoor bushings complete with bimetallic terminal clamps suitable for ACSR or AAC conductor to be brought out through external bushing mounted on tank. Phase to phase clearance (between bushing centres) : 450mm.
2.7	Fittings	1) Conservator tank (Cl. 1.14) 2) Silicagel breather (Cl. 1.18) 3) Ammeter scaled 0-400 amps with hand reset maximum demand indicator fitted inside a weather proof metal box with glass window. The maximum demand element to be calibrated for 55 Deg. C. The box to be mounted on the transformer. 4) Pressure relief device (Cl. 1.17) 5) Valves (Cl. 1.16) 6) Oil temperature indicator (Cl. 2.9) 7) Lifting and jacking lugs (Cl. 1.13) 8) Thermometer pocket (Cl. 1.12) 9) Earthing terminals (Cl. 1.19) 10) Rating and diagram plates (Cl. 1.21) 11) One single phase current transformer 400/1 A (Class 1, Border, 15VA) fitted on 11KV Y phase for ammeter service.
2.8	Oil wastage on site.	The oil for the first filling of the transformer shall be to BSS 148 of approved manufacture and shall include 10 percent spare for

The oil shall be shipped in non returnable steel drums to BSS 814 Table 1 nominal capacity 40 to 45 imperial gallons. The price of oil and drums shall be included in the price of the transformer.

### 2.9 Oil Temperature Indicator

A dia type instrument together with capillary tube to indicate the temperature of oil in the hottest region of the main tank shall be provided.

A maximum temperature pointer shall be provided to show the highest temperature reached and shall be arranged for hand resetting.

### 2.10 Main Tank

The minimum plate thickness shall be as follows :

Top	:	15 mm
bottom	:	15 mm
Sides	:	8 mm
Radiator	:	1.2 mm

**SCHEDULE OF TECHNICAL PARTICULARS**  
**FOR 3MVA 33/11.5KV TRANSFORMERS**

S.No.	Description	Particulars
01	Continuous rating under Oman conditions	KVA
02	Equivalent BSS continuous rating	KVA
03	Supply voltage	KV
04	System highest voltage	KV
05	Normal voltage ratio at normal tapping	
06	BSS vector group	
07	Type of cooling	
08	Maximum temperature rise at CMR under site service conditions (50 Deg.C ambient)	
	a) Oil	Deg.C
	b) Winding	Deg.C
09	Hot spot temperature at CMR under site service conditions (50 Deg.C ambient)	
10	Impedance voltage at 75 Deg.C and CMR between :	
	a) HV & LV windings at highest transformation ratio	%
	b) HV & LV windings at normal voltage and tapping	%
	c) HV & LV windings at lowest transformation ratio	%
11	Impulse level	
	a) 1/50 full wave	KV HV LV
	b) 1/50 chopped wave	KV KV KV LV LV

S.No.	Description	Particulars
12	Quality of sheet steel stamping	
13	Maximum flux density in iron at normal voltage and frequency and at normal ratio a) Core Tesla b) Yoke Tesla	
14	Magnetising current at normal voltage as percentage of full load current	%
15	No-load at rated voltage, ratio and frequency	KW
16	Load losses at 75 Deg.C and normal ratio	KW
17	Total losses at 75 Deg.C and normal ratio	KW
18	Efficiency 125% load at 0.8 P.F. 100% load at 0.8 P.F. 75% load at 0.8 P.F. 50% load at 0.8 P.F.	%
19	Regulation at 75% Deg.C and normal ratio a) At unity power factor lagging b) At 0.8 lagging power factor	%
20	Maximum current density in windings at CMR a) H. V. Windings/sq.mm b) L. V. Windings/sq.mm	Amps
21	Off-circuit tap switch a) Type b) Range of taps c) Size of tapping step d) Number of tapping steps	Amps

S.No.	Description	Particulars
22	Type of windings:	
	a) H.V.	
	b) L.V.	
23	Insulation of :	
	a) H.V. winding	
	b) L.V. winding	
24	Insulation of tapping connections	
25	Insulation of :	
	a) Core bolts	
	b) Side plates	
	c) Core laminations	
26	Thickness of transformer tank	
	a) Sides	mm
	c) Bottom	mm
	c) Top	mm
27	Thickness of radiator plates and/or cooling tubes	
28	Oil volumes	
	a) Total requirements including radiators	Ltrs.
	b) Conservator volume	Ltrs.
	c) Oil volume in tapchanger	Ltrs.
29	Weights	
	a) Core and winding	Kgs
	b) Tap changer gear	Kgs
	c) Conservator tank	Kgs
	d) Complete transformer including oil	Kgs
	e) Complete transformer excluding oil	Kgs
	f) Transformer arranged for transport	Kgs

S.No.	Description	Particulars
30	Overall dimensions	
	a) Width	mm
	b) Length	mm
	c) Height	mm
31	Current transformer for ammeter service	
	a) Make	
	b) Type	
	c) Class	
	d) Ratio	
	e) Burden	VA

**SECTION II B**  
**PARTICULAR REQUIREMENTS FOR 6MVA 33/11.5KV TRANSFORMER**

2.1	Type of cooling	ONAN
2.2	Voltage ratio	33/11.5KV
2.3	Connections	Delta/Star Vector Group Dyn 11
2.4	Tappings on HV winding	+5% to - 10% in steps of 2.5% off circuit tap switch with operating tap handle mounted externally on transformer tank side and having tap position indication and facility for padlocking in definite tap position. Padlock with two keys to be supplied.
2.5	Impedance voltage	6% on normal tapping and maximum continuous rating
2.6	Terminations	33KV side outdoor bushings complete with bi-metallic terminal clamps suitable for ACSR Or AAC conductor (overall diameter 20mm) creepage 40mm/KV. Phase to phase clearance (between busing centres) : 700mm.  11KV side outdoor bushings complete with bimetallic terminal clamps suitable for ACSR or AAC conductor (overall diameter 20mm) to be brought out through external bushing mounted on tank. Phase to phase clearance (between bushing centres) : 450mm.
2.7	Fittings	<ol style="list-style-type: none"><li>1) Conservator tank (Cl. 1.14)</li><li>2) Silicagel breather (Cl. 1.18)</li><li>3) Ammeter scaled 0-400 amps fitted inside a weather proof metal box with glass window. (The maximum demand element to be calibrated for 55 Deg. C). The box to be mounted on the transformer.</li><li>4) Pressure relief device (Cl. 1.17)</li><li>5) Valves (Cl. 1.16)</li><li>6) Oil temperature indicator (Cl. 2.9)</li><li>7) Lifting and jacking lugs (Cl. 1.12)</li><li>8) Thermometer pocket (Cl. 1.12)</li><li>9) Earthing terminals (Cl. 1.19)</li><li>10) Rating and diagram plates (Cl. 1.21)</li><li>11) One single phase current transformer 400/1 A (Class 1, border 15VA) fitted on 11KV Y phase for ammeter service.</li></ol>
2.8	Oil wastage on site.	The oil for the first filling of the transformer shall be to BSS 814 of approved manufacture and shall include 10 percent spare for



The oil shall be shipped in non returnable steel drums to BSS 814 Table 1 nominal capacity 40 to 45 imperial gallons. The price of oil and drums shall be included in the price of the transformer.

2.9 Oil Temperature Indicator : A dia type instrument together with capillary tube to indicate the temperature of oil in the hottest region of the main tank shall be provided.

A maximum temperature pointer shall be provided to show the highest temperature reached and shall be arranged for hand resetting.

#### 2.10 Main Tank

The minimum plate thickness shall be as follows :

Top	:	15 mm
bottom	:	15 mm
Sides	:	8 mm
Radiator	:	1.2 mm

**SCHEDULE OF TECHNICAL PARTICULARS**  
**FOR 6MVA 33/11.5KV TRANSFORMERS**

S.No.	Description	Particulars
01	Continuous rating under Oman conditions	KVA
02	Equivalent BSS continuous rating	KVA
03	Supply voltage	KV
04	System highest voltage	KV
05	Normal voltage ratio at normal tapping	
06	BSS vector group	
07	Type of cooling	
08	Maximum temperature rise at CMR under site service conditions (50 Deg.C ambient)	
	a) Oil	Deg.C
	b) Winding	Deg.C
09	Hot spot temperature at CMR under site service conditions (50 Deg.C ambient)	
10	Impedance voltage at 75 Deg.C and CMR between :	
	a) HV & LV windings at highest transformation ratio	%
	b) HV & LV windings at normal voltage and tapping	%
	c) HV & LV windings at lowest transformation ratio	%
11	Impulse level	
	a) 1/50 full wave	KV HV LV
	b) 1/50 chopped wave	KV KV KV LV

S.No.	Description	Particulars
12	Quality of sheet steel stamping	
13	Maximum flux density in iron at normal voltage and frequency and at normal ratio a) Core Tesla b) Yoke Tesla	
14	Magnetising current at normal voltage as percentage of full load current	%
15	No load losses at rated voltage, ratio and frequency	KW
16	Load losses at 75 Deg.C and normal ratio	KW
17	Total losses at 75 Deg.C and normal ratio	KW
18	Efficiency	
	125% load at 0.8 P.F.	%
	100% load at 0.8 P.F.	%
	75% load at 0.8 P.F.	%
	50% load at 0.8 P.F.	%
19	Regulation at 75% Deg.C and normal ratio	
	a) At unity power factor lagging	%
	b) At 0.8 lagging power factor	%
20	Maximum current density in windings at CMR	
	a) H.V. Windings/sq.mm	Amps
	b) L.V. Windings/sq.mm	Amps
21	Off-circuit tap switch	
	a) Type	%
	b) Range of taps	%
	c) Size of tapping step	%
	d) Number of tapping steps	%

S.No.	Description	Particulars
30	Overall dimensions	
	a) Width	mm
	b) Length	mm
	c) Height	mm
31	Current transformer for ammeter service	
	a) Make	
	b) Type	
	c) Class	
	d) Ratio	
	e) Burden	VA

**SECTION II C**  
**PARTICULAR TECHNICAL REQUIREMENTS FOR 10MVA 33/11.5KV**  
**TRANSFORMER WITH ON-LOAD TAP CHANGER**

<b>2.1</b>	<b>Type</b>	: ONAN
<b>2.2</b>	<b>Voltage ratio</b>	: 33/11.5KV
<b>2.3</b>	<b>Electrical Connections</b>	: Delta/Star Vector Group Dyn 11

**2.4 Tappings**

The higher voltage winding shall have tappings in steps of 1.667 from + 5% to - 15% with on-load tap changer (Cl 2.9).

**2.5 IMPEDANCE VOLTAGE**

7.5% on normal tapping and maximum continuous rating.

**2.6 TERMINATIONS**  
**33KV SIDE**

Cable box to BS 2562 for three core 300 sq.mm copper XLPE/PVC/SWA/PVC minimum phase to phase clearance 500 mm, phase to earth 400 mm, creepage of 805. mm.

**11KV SIDE**

Cable box to BS 2562 for three single core 500 sq.mm copper XLPE/PVC/AL STRIP/PVC cables minimum phase to phase clearance (bushing centre to centre) 300mm, phase to earth 170mm and minimum creepage of bushing 295mm.

Neutral shall be brought out through an external bushing with creepage of 440mm.

Dry type terminations shall be provided. The cable boxes shall include compression type cable glands with earth tags, earth bonding tinned copper straps, crumping type lugs, and all necessary terminations material and shall be arranged for bottom entry of cables. Insulated cable glands shall be used for single core cables.

**2.7 CURRENT TRANSFORMERS**

The following current transformers shall be fitted on the transformer :

**33KV SIDE**

Three phase set of CT's for differential protection of the transformer class X ratio 200/1A.

Three phase set of CT's for over-current and earth fault protection and metering class 5P10 ratio 200/1A.

## **11KV SIDE**

One neutral CT class X ratio 600/1A for restricted earth fault protection.

One neutral CT class 5P10 ratio 600/1A stand-by protection.

### **2.8 MAIN TANK**

The minimum plate thickness shall be as follows :

Top	: 20mm
Bottom	: 20mm
Sides	: 10mm
Radiators	: 1.2mm

### **2.9 BUCHHOLZ PROTECTION**

Each transformer shall be fitted with a gas and oil-actuated relay of approved make and type, having alarm contacts which close on collection of gas and tripping contacts which close for oil surge or low oil level. The contacts shall be wired to a weather proof terminal block on the Buchholz Protector for connection by mineral insulated copper clad PVC sheathed cable (2.5 sq.mm) to terminal block in the Marshalling Kiosk described Clause 2.11.

Buchholz device shall be inserted in the pipe work between the main tank and conservator and provided with valves on both sides of the device to facilitate easy servicing. The Buchholz device shall incorporate a test cock for testing purposes. A compressed air bottle fitted with a control tank, pressure gauge, a foot operated air pump and rubber hose for compressed air tests on the Buchholz device, shall be included.

### **2.10 ON-LOAD TAP CHANGE GEAR**

#### **2.10.1 GENERAL REQUIREMENTS**

The on-load tap change gear shall be of robust construction and shall be unaffected in part or whole by the forces imposed by short circuit or other fault currents, operation, vibration and temperature changes. It shall be capable of varying the effective transformation ratio of the transformer without producing phase displacement.

The tap changing shall be effected on the high voltage winding and the oil in the chamber housing the tap change selector switch may be in communication with the oil in the main transformer tank, but the tap change circuit making and breaking switch shall be accommodated in an oil filled chamber separated from the main transformer tank.

#### **2.10.2 DUTY**

The switches shall have a continuous current rating equivalent to the continuous maximum rating of the transformer and shall give trouble free operation under site condition (Cl. 1.1). Limiting devices shall be provided to limit the operation of switches to the range of tapping specified. The mid-point reactor type of employed, shall be continuously rated for operation under site conditions.

Tenderers may offer high speed resistor type tap changer. Full details of the equipment offered shall be submitted with each offer. The equipment shall be designed to ensure that, when a tap change has commenced, it shall be

completed independently of the operation of the control relays or switches. In the event of failure of auxiliary electrical supply during a tap change or any other contingency which would result in the tap change not being completed, approved means shall be provided to safeguard the transformer and auxiliary apparatus.

### **2.10.3 SELECTION**

The equipment shall be arranged for operation giving the following selection :

- a) On-load automatic remote group operation (for three transformers)
- b) On-load manual electrical remote group operation (for three transformers)
- c) Individual on-load automatic operation of such transformer
- d) Individual on-load manual electrical remote operation of each transformer
- e) Individual local electrical operation of such transformer
- f) Individual manual hand gear operation of each transformer
- g) An one transformer individual and the other two in parallel.

### **2.10.4 INTERLOCKS & CONTROL**

The equipment to be supplied by the tenderer shall be arranged to comply with the following :

- a) The hand gear operation of mechanism shall be interlocked to prevent the electrical motor drive operating while the hand gear is in use.
- b) It shall not be possible for any two electrical points to be in operation simultaneously.
- c) Operation from any control switch shall cause one tap movement only unless the control switch is returned to the off position between successive operations.
- d) All electrical control switches and hand operating gear shall be clearly labelled to indicate the direction of tap change.
- e) The local control switches and other apparatus shall be mounted inside the Marshalling Kiosk (Cl. 2.1).
- f) A mechanical tap position indicator shall be fitted on the transformer and shall be visible from ground level.
- g) A device for registering the total number of tap change operations and a hand reset register device for counting tap change operations between maintenance periods shall be fitted.
- g) A remote indicating device shall be provided for installation in the control room. The device shall indicate the tap positions and shall be scated 1 to 13.
- h) The tap change mechanism shall be provided with additional set of “Clean Contacts” wired to a suitable terminal block in the control panel, to transmit, “Tap position” to a “ Remote Supervisory and Control Centre”.
- i) The automatic voltage regulation shall be initiated by means of a voltage relay of approved make for AC 110V 50 cycles. The relay shall close the “Raise” or “Lower” contacts when the voltage varies by 1.7 per cent. A time delay element operated off 110V AC supply shall be provided to give a variable setting range of 20 - 180 seconds and no-volt contacts shall be arranged to stop the automatic operation of the tap change mechanism.
- j) In the event of the transformers forming a group and operating in parallel getting out of step due to faulty tap change operation, a device shall be connected in the control system to make in-operative the automatic tap-change; this device shall set off an alarm to indicate the condition electrically at a remote point. The device shall be of the hand reset type.
- k) A warning lamp and buzzer shall be connected to the control system to indicate that tap changing is in progress.
- l) Tap changing will be transmitted to the “Remote Supervisory and Control Centre” for logging purposes. This applies to remote control only. Thus these signals should be transmitted only when the transformers

are set on "Remote" and on "Manual" control. Details shall be subject to the Purchaser's approval. All necessary wiring for the above should be brought to a suitable terminal block in the control panel.

- m) The tap-change driving mechanism shall be fully rated for the worst temperature conditions on site (Cl. 1.1). All motors, contact, clutches and brakes shall be designed to give trouble free operation and shall be of robust construction to prevent distortion due to variation in temperature that can occur at site during the year.

Contacts shall have silver plated contacts and where necessary shall be of the self wiping type. The current carrying shall be derated to 80% of BSS rating. All equipment and apparatus shall comply with the latest relevant IEC/British Standard Specification. Tenderers shall state the B.S.S. and site ratings in their offer. Similarly, cables shall be derated to 70% of the B.S.S. rating.

## **2.11 OIL**

The oil for the first filling of the transformer shall be to BSS 148 of approved manufacture and shall include 10% spare for wastage on site.

The oil shall be shipped in non-returnable steel drums to BSS 814 Table 1 nominal capacity 40 to 45 imperial gallons. The price of oil and drums shall be included in the price of the transformer.

## **2.12 MARSHALLING KIOSK**

Each transformer shall be provided with a Marshalling Kiosk located adjacent to the transformer. The Kiosk shall be of the outdoor type, of sheet steel construction fitted with access doors, on front and rear. Alternatively, the Kiosk may be mounted on the transformer. The Kiosk must be dust, damp, rain and vermin proof and shall be designed for temperature conditions of Oman. The front access door shall be fitted with wire reinforced glass inspection panels. Locks and handles shall be fitted to the doors.

The Kiosk shall accommodate the following :

- a) Transformer oil temperature indicator (Cl. 2.12.2)
- b) Transformer winding temperature indicator (Cl. 2.12.1)
- c) Terminal blocks and test links for (a) and (b)
- d) Local "Tap Change" selector and control switches
- e) Marshalling terminal blocks for connections between transformer auxiliaries and remote control panel.
- f) Control switches, fuses protective device associated with tap-change motor circuits, which normally cannot be accommodated in the "Tap Change Motor" compartment.
- g) The Kiosk shall be provided with heater elements suitable controlled by a switch, temperature and/or humidity relay to prevent condensation during high humidity periods.

## **2.13 INSTRUMENTS**

### **2.13.1 WINDING TEMPERATURE INDICATOR**

A dial type indicator calibrated to show the temperature of the hottest region of the windings shall be provided. This device may be of the type comprising a current transformer, heating coil, hot oil pocket, temperature measuring device and arranged to produce the desired relationship between winding temperature and hot oil temperature. The indicator shall be fitted with two sets of fixed and moving contacts one for "Trip" and one for "Alarm", adjustable to close between the range of 60 Deg. C to 120 Deg.C. The contacts shall re-open when temperature has fallen not more than 10 Deg.C of the set temperature.



A maximum temperature pointer shall be incorporated with the indicator to show highest temperature reached and arranged for hand re-setting.

### **2.13.2 OIL TEMPERATURE INDICATOR**

A dial type instrument together with capillary tube to indicate the temperature of oil in the hottest region of the main tank shall be provided. The indicator shall be fitted with two separate sets of fixed and moving contacts, one for "Alarm" and one for "Trip" adjustable to close between the range 60 Deg. to 120 Deg.C. The contacts shall re-open when the temperature has fallen not more than 10 Deg. C.

A maximum temperature pointer shall be provided to show the highest temperature reached and shall be arranged for hand re-setting.

#### **Note**

The winding temperature indicator and the oil temperature indicator shall be accommodated in the Marshalling Kiosk described in Clause 2.11.

### **2.14 TAP CHANGE CONTROL PANEL**

#### **2.14.1 GENERAL REQUIREMENTS**

The control panel shall be of sheet metal construction with hinged doors at the rear. Complete and easy access to all equipment and terminals shall be from the rear. The panel shall be of rigid construction and free from vibration and distortion and shall be unaffected by changes in temperature. Access doors shall be fitted with integral handles linked to locking bolts, incorporating keyed locks.

Interior of the panel shall have built in lighting control - lead by switches actuated by the access doors and suitable for single phase 240V A.C. 50 cycles.

#### **2.14.2 DETAILS OF EQUIPMENT**

Each tap change control panel shall include :

- a) Tap position indicator
- b) Tap change "Raise" and "Lower" spring loaded switches or push buttons
- c) Tap change control selector/switches (one switch for auto/non-auto selector and the other for master follow/independent selector
- d) "Tap change in progress" indication lamp and buzzer
- e) Out of step lamp
- f) Voltage regulation relay with time delay
- g) Ten auxiliary trip and alarm relays labelled as follows :

BUCHHOLZ TRIP - BUCHHOLZ ALARM

TAP CHANGER TRIP - TAP CHANGER OUT OF STEP

WINDING TEMPERATURE ALARM - WINDING TEMPERATURE TRIP

OIL TEMPERATURE ALARM - OIL TEMPERATURE TRIP

SPARE - LOW OIL ALARM

Operating coil voltage of the relay shall be 30V D.C. or 110V D.C. depending on the availability at site.

Each auxiliary relay complete with hand reset flag indicator and two normally open self reset contacts.

All ten elements housed in a common flush mounting drawout case.

**SCHEDULE OF TECHNICAL PARTICULARS  
FOR 10 MVA 33/11.5KV TRANSFORMERS**

<b>S.No.</b>	<b>Description</b>	<b>Particulars</b>
01	Continuous rating under Oman conditions	KVA
02	Equivalent BSS continuous rating	KVA
03	Supply voltage	KV
04	System highest voltage	KV
05	Normal voltage ratio at normal tapping	
06	BSS vector group	
07	Type of cooling	
08	Maximum temperature rise at CMR under site service conditions (50 Deg.C ambient)	
	a) Oil	Deg.C
	b) Winding	Deg.C
09	Hot spot temperature at CMR under site service conditions (50 Deg.C ambient)	“
10	Impedance voltage at 75 Deg.C and CMR between :	
	a) HV & LV windings at highest transformation ratio	%
	b) HV & LV windings at normal voltage and tapping	%
	c) HV & LV windings at lowest transformation ratio	%
11	Impulse level	
	a) 1/50 full wave	HV KV
	b) 1/50 chopped wave	LV KV KV
12	Quality of sheet steel stamping	LV KV
13	Maximum flux density in iron at normal voltage and frequency and at normal ratio	
	a) Core Telsa	
	b) Yoke Tesla	
14	Magnetising current at normal voltage as percentage of full load current	%
15	No load losses at rated voltage, ratio and frequency	KW
16	Load losses at 75 Deg. C and normal ratio	KW

S.No.	Description	Particulars
17	Total losses at 75 Deg.C and normal ratio	KW
18	Efficiency	%
	125% load at 0.8 P.F.	%
	100% load at 0.8 P.F.	%
	75% load at 0.8 P.F.	%
	50% load at 0.8 P.F.	%
19	Regulation at 75 Deg.C and normal ratio	%
	a) At unity power factor lagging	%
	b) AT 0.8 lagging power factor	%
20	Maximum current density in windings at CMR	Amps
	a) H.V. windings/sq.mm	Amps
	b) L.V. windings/sq.mm	
21	On load tap changer	
	a) Type	
	b) Range or taps	%
	c) Power frequency withstand test voltage IEC 214, 1967 between first and last contacts of the selector switch	KV
	Between any two adjacent contacts of the selector	KV
	Between open diverter switch contacts	KV
	d) Type test certificate ref. .	
	e) Size of tapping step	%
	f) Number of tapping steps	
22	Type of windings :	
	a) H.V.	
	b) L.V.	
23	Insulation of :	
	a) H.V. winding	
	b) L.V. winding	
24	Insulation of tapping connections	
25	Insulation of :	
	a) Core bolts	
	b) Side plates	
	c) Core laminations	
26	Thickness of radiator plates and/or cooling tubes	mm
	a) Sides	mm
	b) Bottom	mm
	c) Top	mm

S.No.	Description	Particulars
27	Thickness of radiator plates and/or cooling tubes	
28	Oil volumes	
	a) Total requirements including radiators	Litrs
	b) Conservator volume	Litrs
	c) Oil volume in tap changer	Litrs
29	Weights	
	a) Core and winding	Kgs
	b) Tap changer gear	Kgs
	c) Conservator tank	Kgs
	d) Complete transformer including oil	Kgs
	e) Complete transformer excluding oil	Kgs
	f) Transformer arranged for transport	Kgs
30	Overall dimensions	
	a) Width	mm
	b) Length	mm
	c) Height	mm
31	Current transformers :	
	A) 33KV side :	
	a) Differential protection	
	i) Make	
	ii) Type	
	iii) Class	
	iv) Ratio	
	v) Burden	
	b) Overcurrent and earth fault protection	
	i) Make	
	ii) Type	
	iii) Class	
	iv) Ratio	
	v) Burden	
	B) 11KV Side	
	a) Differential protection	
	i) Make	
	ii) Type	
	iii) Class	
	iv) Ratio	
	v) Burden	

S.No.	Description	Particulars
b)	Restricted earth fault protection	
i)	Make	
ii)	Type	
iii)	Class	
iv)	Ratio	
v)	Burden	
c)	Stand by earth fault protection	
i)	Make	
ii)	Type	
iii)	Class	
iv)	Ratio	
v)	Burden	

**SECTION II D**  
**PARTICULAR TECHNICAL REQUIREMENTS FOR 20 MVA 33/11.5KV**  
**TRANSFORMER WITH ON-LOAD TAP CHANGER**

<b>2.1</b>	<b>Type</b>	ONAN/ONAF
<b>2.2</b>	<b>Voltage ratio</b>	33/11.5KV
<b>2.3</b>	<b>Electrical Connections</b>	Delta/Star Vector Group Dyn 11

**2.4**

**Tappings**

The higher voltage winding shall have tappings in steps of 1.667 from + 5% to - 15% with on-load tap changer (CI 2.10).

**2.5**

**IMPEDANCE VOLTAGE**

12.5% on normal tapping and maximum continuous rating.

**2.6**

**TERMINATIONS**

**33KV SIDE**

Cable box to BS 2562 for three core 300 sq.mm copper XLPE/PVC/SWA/PVC minimum phase to phase clearance 500 mm, phase to earth 400 mm, creepage of 805 mm.

**11KV SIDE**

Cable box to BS 2562 for six single core 500 sq.mm copper XLPE/PVC/AL STRIP/PVC cables (2 cables per phase) minimum phase to phase (bushing centre to centre) 300mm, phase to earth 170mm and minimum creepage of bushing 295mm.

Neutral shall be brought out through an external bushing with creepage of 440mm.

Dry type terminations shall be provided. The cable boxes shall include compression type cable glands with earth tags, earth bonding tinned copper straps, crumping type lugs, and all necessary terminations material and shall be arranged for bottom entry of cables. Insulated cable glands shall be used for single core cables.

**2.7**

**CURRENT TRANSFORMERS**

The following current transformers shall be fitted on the transformer :

**33KV SIDE**

Three phase set of CT's for differential protection of the transformer class X ratio 400/1A.

## **11KV SIDE**

One neutral CT class X ratio 1200/1A for restricted earth fault protection.

One neutral CT class 5P10 ratio 1200/1A stand-by earth fault protection.

## **2.8 MAIN TANK**

The minimum plate thickness shall be as follows :

Top	: 20mm
Bottom	: 20mm
Sides	: 10mm
Radiators	: 1.2mm

## **2.9 BUCHHOLZ PROTECTION**

Each transformer shall be fitted with a gas and oil-actuated relay of approved make and type, having alarm contacts which close on collection of gas and tripping contacts which close for oil surge or low oil level. The contacts shall be wired to a weather proof terminal block on the Buchholz Protector for connection by mineral insulated copper class PVC sheathed cable (2.5 sq.mm) to terminal block in the Marshalling Kiosk described in Clause 2.12.

Buchholz device shall be inserted in the pipe work between the main tank and conservator and provided with valves on both sides of the device to facilitate easy servicing. The Buchholz device shall incorporate a test cock for testing purposes. A compressed air bottle fitted with a control tank, pressure gauge, a foot operated air pump and rubber hose for compressed air tests on the Buchholz device, shall be included.

## **2.10 ON-LOAD TAP CHANGE GEAR**

### **2.10.1 GENERAL REQUIREMENTS**

The on-load tap change gear shall be of robust construction and shall be unaffected in part or whole by the forces imposed by short circuit or other fault currents, operation, vibration and temperature changes. It shall be capable of varying the effective transformation ratio of the transformer without producing phase displacement.

The tap changing shall be effected on the high voltage winding and the oil in the chamber housing the tap change selector switch may be in communication with the oil in the main transformer tank, but the tap change circuit making and breaking switch shall be accommodated in an oil filled chamber separated from the main transformer tank.

### **2.10.2 DUTY**

The switches shall have a continuous current rating equivalent to the continuous maximum rating of the transformer and shall give trouble free operation under site condition (Cl. 1.1). Limiting devices shall be provided to limit the operation of switches to the range of tapping specified. The mid-point reactor type if employed, shall be continuously rated for operation under site conditions.

Tenderers may offer high speed type tap changer. Full details of the equipment offered shall be submitted with each offer. The equipment shall be designed to ensure that, when a tap change has commenced, it shall be

completed independently of the operation of the control relays or switches. In the event of failure of auxiliary electrical supply during a tap change or any other contingency which would result in the tap change not being completed, approved means shall be provided to safeguard the transformer and auxiliary apparatus.

### 2.10.3 SELECTION

The equipment shall be arranged for operation giving the following selection :

- a) On-load automatic remote group operation (for three transformers)
- b) On-load manual electrical remote group operation (for three transformers)
- c) Individual on-load automatic operation of each transformer
- d) Individual on-load manual electrical remote operation of each transformer
- e) Individual local electrical operation of each transformer
- f) Individual manual hand gear operation of each transformer
- g) Any one transformer individual and the other two in parallel.

### 2.10.4 INTERLOCKS & CONTROL

The equipment shall be arranged to comply with the following :

- a) The hand gear operation of mechanism shall be interlocked to prevent the electrical motor drive operation while the hand gear is in use.
- b) It shall not be possible for any two electrical points to be in operation simultaneously.
- c) Operation from any control switch shall cause one tap movement only unless the control switch is returned to the off position between successive operations.
- d) All electrical control switches and hand operating gear shall be clearly labelled to indicate the direction of tap change.
- e) The local control switches and other apparatus shall be mounted inside the Marshalling Kiosk (Cl. 2.1).
- f) A mechanical tap position indicator shall be fitted on the transformer and shall be visible from ground level.
- g) A device for registering the total number of tap change operations and a hand reset register device for counting tap change operations between maintenance periods shall be fitted.
- g) A remote indicating device shall be provided for installation in the control room. The device shall indicate the tap positions and shall be scaled 1 to 13.
- h) The tap change mechanism shall be provided with additional set of "Clean Contacts" wired to a suitable terminal block in the control panel, to transmit, "Tap position" to a "Remote Supervisory and Control Centre".
- i) The automatic voltage regulation shall be initiated by means of a voltage relay of approved type for AC 110V 50 cycles. The relay shall close the "Raise" of "Lower" contacts when the voltage varies by 1.7 per cent. A time delay element operated off 110V AC supply shall be provided to give a variable setting range of 20 - 180 seconds and no-volt contacts shall be arranged to stop the automatic operation of the tap change mechanism.
- j) In the event of the transformers forming a group and operating in parallel getting out of step due to faulty tap change operation, a device shall be connected in the control system to make in-operative the automatic tap-change; this device shall set off an alarm to indicate the condition electrically at a remote point. The device shall be of the hand reset type.
- k) A warning lamp and buzzer shall be connected to the control system to indicate that tap changing is in progress.
- l) Tap changing will be transmitted to the "Remote Supervisory and Control Centre" for logging purposes. This applies to remote control only. Thus these signals should be transmitted only when the transformers



are set on "Remote" and on "Manual" control. Details shall be subject to the Purchaser's approval. All necessary wiring for the above should be brought to a suitable terminal block in the control panel.

m) The tap-change driving mechanism shall be fully rated for the worst temperature conditions on site (Cl. 1.1). All motors, contact, clutches and brakes shall be designed to give trouble free operation and shall be of robust construction to prevent distortion due to variation in temperature that can occur at site during the year.

Contacts shall have silver plated contacts and where necessary shall be of the self wiping type. The current carrying shall be derated to 80% of BSS rating. All equipment and apparatus shall comply with the latest relevant IEC/British Standard Specification. Tenderers shall state the B.S.S. and site ratings in their offer. Similarly, cables shall be derated to 70% of the B.S.S. rating.

## **2.11 OIL**

The oil for the first filling of the transformer shall be to BSS 148 of approved manufacture and shall include 10% spare for wastage on site.

The oil shall be shipped in non-returnable steel drums to BSS 814 Table 1 nominal capacity 40 to 45 imperial gallons. The price of oil and drums shall be included in the price of the transformer.

## **2.12 MARSHALLING KIOSK**

Each transformer shall be provided with a Marshalling Kiosk located adjacent to the transformer. The Kiosk shall be of the outdoor type, of sheet steel construction fitted with access doors, on front and rear. Alternatively, the Kiosk may be mounted on the transformer. The Kiosk must be dust, damp, rain and vermin proof and shall be designed for temperature conditions of Oman. The front access door shall be fitted with wire reinforced glass inspection panels. Locks and handles shall be fitted to the doors.

The Kiosk shall accommodate the following :

- a) Transformer oil temperature indicator (Cl. 2.13.2)
- b) Transformer winding temperature indicator (Cl. 2.13.1)
- c) Terminal blocks and test links for (a) and (b)
- d) Local "Tap Change" selector and control switches
- e) Marshalling terminal blocks for connections between transformer auxiliaries and remote control panel.
- f) Control switches, fuse protective device associated with tap-change motor circuits, which normally cannot be accommodated in the "Tap Change Motor" compartment.
- g) The Kiosk shall be provided with heater elements suitable controlled by a switch, temperature and/or humidity relay to prevent condensation during high humidity periods.

## **2.13 INSTRUMENTS**

### **2.13.1 WINDING TEMPERATURE INDICATOR**

A dial type indicator calibrated to show the temperature of the hottest region of the windings shall be provided. This device may be of the type comprising a current transformer, heating coil, hot oil pocket, temperature measuring device and arranged to produce the desired relationship between winding temperature and hot oil temperature. The indicator shall be fitted with two sets of fixed and moving contacts one for "Trip" and one for "Alarm", adjustable to

close between the range of 60 Deg. C to 120 Deg.C. The contacts shall re-open when temperature has fallen not more than 10 Deg.C of the set temperature. For controlling external cooling fans one more set of contacts shall be included. A maximum temperature pointer shall be incorporated with the indicator to show highest temperature reached and arranged for hand re-setting.

### **2.13.2 OIL TEMPERATURE INDICATOR**

A dial type instrument together with capillary to indicate the temperature of oil the hottest region of the main tank shall be provided. The indicator shall be fitted with two separate sets of fixed and moving contacts, one for "Alarm" and one for "Trip" adjustable to close between the range 60 Deg. to 120 Deg.C. The contacts shall re-open when the temperature has fallen not more than 10 Deg. C.

A maximum temperature pointer shall be provided to show the highest temperature reached and shall be arranged for hand re-setting.

### **Note**

The winding temperature indicator and the oil temperature indicator shall be accommodated in the Marshalling Kiosk described in Clause 2.12.

### **2.14 TAP CHANGE CONTROL PANEL**

#### **2.14.1 GENERAL REQUIREMENTS**

The control panel shall be of sheet metal construction with hinged doors at the rear. Complete and easy access to all equipment and terminals shall be from the rear. The panel shall be of rigid construction and free from vibration and distortion and shall be unaffected by changes in temperature. Access doors shall be fitted with integral handles linked to locking bolts, incorporating keyed locks. Interior of the panel shall have built in lighting controlled by switches actuated by the access doors and suitable for single phase 240V A.C. 50 cycles.

#### **2.14.2 DETAILS OF EQUIPMENT**

Each tap change control panel shall include :

- a) Tap position indicator
- b) Tap change "Raise" and "Lower" spring loaded switches or push buttons
- c) Tap change control selector/switches (one switch for auto/non-auto selector and the other for master follower/independent selector
- d) "Tap change in progress" indication lamp and buzzer
- e) Out of step lamp
- f) Voltage regulation relay with time delay
- g) Ten auxiliary trip and alarm relays labelled as follows :

BUCHHOLZ TRIP - BUCHHOLZ ALARM

TAP CHANGER TRIP - TAP CHANGER OUT OF STEP

WINDING TEMPERATURE ALARM - WINDING TEMPERATURE TRIP

OIL TEMPERATURE ALARM - OIL TEMPERATURE TRIP

FAN SUPPLY FAILURE ALARM - LOW OIL LEVEL ALARM

Operating coil voltage of the relay shall be 30V D.C. or 110V D.C. depending on the availability at site.  
Each auxiliary relay complete with hand reset flag indicator and two normally open self reset contacts.  
All ten elements housed in a common flush mounting drawout case.

#### **2.15 METHOD OF COOLING**

The cooling of transformers shall be ONAN/ONAF and the transformer shall be capable of operating under ONAN conditions upto 75% or more after which the cooling equipment shall come into operation and operate as an ONAF unit. Transformers shall be capable of remaining at full load for 20 minutes after failure of blowers without the calculated winding hot temperature exceeding 150 Deg.C.

**TYPE : ONAN/ONAF**

**SCHEDULE OF TECHNICAL PARTICULARS**  
**FOR 20 MVA 33/11.5KV TRANSFORMERS**

S.No.	Description	Particulars
01	Continuous rating under Oman conditions	KVA
02	Equivalent BSS continuous rating	KVA
03	ONAN rating a forced cooled transformer	KVA
04	Supply voltage	KV
05	System highest voltage	KV
06	Normal voltage ratio at normal tapping	
07	BSS vector group	
08	Type of cooling	
09	Maximum temperature rise at CMR under site service conditions (50 Deg. C ambient)	
	a) oil	Deg.C
	b) winding	Deg.C
10.	Hot spot temperature at CMR under site service conditions (50 Deg. C ambient)	Deg.C
11.	Impedance voltage at 75 Deg.C and CMR between :	
	a) HV & LV windings at highest transformation ratio	%
	b) HV & LV windings at normal voltage and tapping	%
	c) HV & LV windings at lowest transformation ratio	%

S.No.	Description	Particulars
12	Impulse level	
	a) 1/50 full wave	KV
	a) 1/50 chopped wave	KV
		KV
13	Quality of sheet steel stamping	
14	Maximum flux density in iron at normal voltage and frequency and at normal ratio	
	a) Core Tesla	HV
	b) Yoke Tesla	HV
		LV
15	Magnetising current at normal voltage as percentage of full load current	%
16	No load losses at rated voltage, ratio and frequency	KW
17	Cooling plant losses at CMR	KW
18	Load losses at 75 Deg.C and normal ratio (excluding cooling plant losses)	
	a) CMR	KW
	b) ONAN rating	KW
19	Total losses at 75 Deg. C and normal ratio	
	a) CMR including input to cooling plant	KW
	b) ONAN rating	KW
20	Efficiency	
	125% load at 0.8 P.F.	%
	100% load at 0.8 P.F.	%
	75% load at 0.8 P.F.	%
	50% load at 0.8 P.F.	%

S.No.	Description	Particulars
21	Regulation at 75 Deg. C and normal ratio	
	a) At unity power factor lagging	%
	b) At 0.8 lagging power factor	%
22	Maximum current density in windings at CMR	
	a) H.V. windings/sq.mm	Amps
	b) L.V. windings/sq.mm	Amps
23	On load tap changer	
	a) Type	
	b) Range of taps	%
	c) Power frequency withstand	
	test voltage IEC 214, 1976	
	between first and last contacts of the selector switch	KV
	Between any tow adjacent contacts of the selector	KV
	Between open diverter switch contacts	KV
24	Type test certificate ref :	
	e) Size of tapping step	
	f) Number of tapping steps	
	Type of windings :	
	a) H.V.	
	b) L.V.	
25	Insulation of :	
	a) H.V. winding	
	b) L.V. winding	
26	Insulation of tapping connections	

S.No.	Description	Particulars
27	Insulation of : a) Core bolts b) Side plates c) Core laminations	
28	Thickness of transformer tank	
a) Sides		mm
b) Bottom		mm
c) Top		mm
29	Thickness of radiator plates and/or cooling tubes	
30	Number of air blowers per transformer	
31	Air blower motor	
a) Rating		KW
b) Single phase or three phase		
c) Starting current of each blower motor		Amps
32	Oil volumes	
a) Total requirements including radiators		Ltrs.
b) Conservator volume		Ltrs.
c) Oil volume in tapchanger		Ltrs.
33	Weights	
a) Core and winding		Kgs
b) Tap change gear		Kgs
c) Cooling equipment		Kgs
d) Conservator tank		Kgs
e) Complete transformer including oil		Kgs
f) Complete transformer excluding oil		Kgs
g) Transformer arranged for transport		Kgs

S.No.	Description	Particulars
34	Overall dimensions	mm
	a) Width	mm
	b) Length	mm
	c) Height	mm
35	Current transformers :	
	A) 33KV side	
	a) Differential protection	
	i) Make	
	ii) Type	
	iii) Class	
	iv) Ratio	
	v) Burden	VA
	b) Pilot wire protection	
	i) Make	
	ii) Type	
	iii) Class	
	iv) Ratio	
	v) Burden	VA
	B) 11KV Side	
	a) Differential protection	
	i) Make	
	ii) Type	
	iii) Class	
	iv) Ratio	
	v) Burden	VA
	b) Restricted earth fault protection	
	i) Make	
	ii) Type	
	iii) Class	
	iv) Ratio	
	v) Burden	VA
	c) Stand-by earth fault protection	
	i) Make	
	ii) Type	
	iii) Class	
	iv) Ratio	
	v) Burden	VA



**SPECIFICATION FOR 33/11.5KV 1MVA TRANSFORMERS**

**SECTION II - E**

**PARTICULAR TECHNICAL REQUIREMENTS FOR 1MVA 33/11.5KV TRANSFORMER**

1.0	Type of cooling	ONAN
2.0	Voltage ratio	33/11.5KV
3.0	Connections	Delta/Star Vector Group Dyn 11
4.0	Tappings on HV windings	+5% to - 10% in steps of 2.5% off circuit tapping switch with operating handle mounted externally on transformer tank side and having tap position indicator and facility for padlocking in definite tap position Padlock with two keys to be supplied.
5.0	Impedance voltage	5% on normal tapping and maximum continuous rating.
6.0	Termination	33KV side :  Outdoor bushings complete with bimetallic terminal clamps suitable for ACSR or AAAC conductor overall diameter 20mm creepage 40mm/kv. Phase to phase clearance (between busing centres) ; 700mm.  11KV side :  Outdoor bushings : Complete with bimetallic terminal clamps suitable for ACSR or AAAC conductor (overall diameter 20mm) creepage 40mm/kv neutral to be brought out through external bushing mounted on tank.  Phase to phase clearance : 450mm.

ADDENDUM TO OES - 6

11/33 KV TRANSFORMERS

SECTION - 1

Same as in OES - 6

SECTION II - F

PARTICULAR REQUIREMENTS FOR 20MVA 11/33KV TRANSFORMERS

2.1	Type	ONAN/ONAF
2.2	Voltage ratio	11/33KV
2.3	Electrical connection	STAR/DELTA/STAR Vector Group YN D yn0 Tertiary winding should have a short term thermal capacity at least equal to one third that of the main winding.
2.4	Tappings	+ 15% to - 15% in steps of 1.66 with on-load tap changer.
2.5	Impedance voltage	12.5% at normal tapping and continuous maximum rating.
2.6	Terminations	Same as in OES-6 Section -D Clause 2.6
2.7	Current Transformers	Current transformers shall be cast resin and slip-on type and located in the cable boxes with suitable mounting and secondary terminals.  33KV SIDE i) one set of 3 Nos. 1-phase current transformers ratio 400/1 A Class X for differential and restricted Earth Fault protection.  ii) one two core neutral current transformer as follows : 1 - core 400/1 A Class X for REF 2 - core 400/1 A Class 5P10 for standby earth fault.  11KV SIDE  One neutral current transformer with two cores as follows : 1-1200/1A Class X for REF 2-1200/1A Class 5P10 for standby earth fault.
2.8 to 2.15		Same as in OES 6 Section II-D

**ADDENDUM TO OES - 6**

**11/33 KV TRANSFORMERS**

**SECTION - 1**

**Same as in OES - 6**

**SECTION II - G**

**PARTICULAR REQUIREMENTS FOR 10MVA 11/33KV TRANSFORMERS**

Same as for 20 MVA 11/33 KV Transformers Section II-F of OES-6 except for the following :

2.5 Impedance Voltage : 7.5% on normal tapping and maximum continuous rating.

2.6 Terminations : 33KV SIDE  
Same as in Section II-F of OES-6

11KV SIDE  
Same as in Section II-C of OES-6

2.7 Current Transformers : The following current transformers shall be provided in the cable boxes They shall be of cast-resin and slip-on type with proper mounting arrangement and secondary terminals.

33KV

i) one set of 3 Nos. 1-phase 200/1A class X for Differential and Restricted earth fault protection.

ii) one two core neutral current transformer with the following ratio:

a. 200/1 A Class X for REF protection

b. 200/1 A Class 5P10 for standby earth fault protection.

11 KV

one neutral two core current transformers with the ratio as follows :

a. 600/1 A Class X - REF protection

b. 600/1 A Class 5P10 - Standby earth fault protection.

2.8 to 2.14

Same as in Section II - C of OES-6.

## ADDENDUM TO OES - 6

### BOOSTER TRANSFORMERS

#### SECTION - 1

Same as in OES - 6

#### SECTION - II H

### PARTICULAR REQUIREMENTS FOR BOOSTER TRANSFORMERS

2.1	Type	ONAN
2.2	Rating	33KV, 450 A, at +15% tap
2.4	Connection	STAR/DELTA/STAR Vector Group YNyn0
2.5	Auxiliary winding	415, 3-phase, 50Hz, 25 KVA star connected. The terminals for this supply with neutral shall be provided in the weather proof terminals box suitably located on the transformer. One 100 A 3-phase load break switch with 50A fuses shall be provided. The box shall be suitable for cable entry of 4-core 25 sq.mm. XLPE insulated PVC served steel wire armoured cable necessary cable gland shall be provided.
2.6	Tappings	+5% to - 15% wit on-load tap changer in steps of 1.66 (12 steps)
2.7	Impedance voltage	Shall not exceed 1%
2.8	Terminations	Out door bushings for incoming and out going terminals. Terminals shall be suitable for connecting ACSR conductor upto 200 sq.mm and capable of carrying current of 500A. Busing shall be of porcelain and aero-foil type. Bushing clearance shall be as follows : Phase to Phase - 700 mm Phase to Neutral - 500 mm Phase to Ground - 400 mm
2.9	Current Transformers	The following current transformers shall be provided : 6 - Nos. 500/1A ratio class X for differential protection. 2 Nos. 500/1A for measurements.
3.0	OLTC Panel	This shall be as in Clause 2.14 OES-6 Section II-D in addition differential relay shall be provided with trip indication.
3.1	Main Tank	The minimum plate thickness shall be as follows : Top : 15 mm Bottom : 15 mm Side : 8 mm Radiator : 1.2 mm
3.2	Buchholz Protection	Same as in 2.9 of OES-6 Section - IID
3.3	On-Load tap change gear	Generally as in clause 2.10, Section II - D of OES - 6
3.4	Oil	Same as in 2.11 of Section II-D OES-6
3.5	Marshalling Kiosk	Same as in 2.12 of section II - D OES-6
3.6	Instruments	Same as in 2.13 of Section II-D OES-6

**33 & 11 KV OUTDOOR CURRENT TRANSFORMERS**

**1. GENERAL**

Current transformers shall generally conform to BS 3938/IEC 185 free standing outdoor type suitable for the electrical system and climatic conditions stipulated in Oman Electrical Standard 11.

**2. RATIO**

The ratio of current transformer shall be as follows :

3/6 MVA 33/11 KV Sub station -	33KV	11KV
10/20 MVA 33/11 KV Substation	75/150/1A.	200/400/1A
	200/400/1A	600/1200/1A

**3. CLASS AND ACCURACY**

Over current and earth fault protection : Class 5P10 and metering.

Differential and Distance Protection : Class X

In the case of differential protection, kneepoint voltage shall be high and magnetisation characteristic to match with other side.

**4. BURDEN**

The burden of current transformers generally shall be 30 VA.

**5. CONSTRUCTION**

**Cast resin encapsulated type :**

It shall be post type wound primary. The core and coil assembly shall be completely enclosed in outdoor proof cast resin. It shall have ability with stand ultra violet rays and be non flammable. The housing shall have a creepage of 40mm/kv and sheds shall be aerofoil open profile type.

**Oil immersed type :**

Core and winding shall be housed in porcelain insulators filled with mineral oil to BS148/IEC296. The housing shall have a creepage distance of 40mm/kv and sheds shall have aero-foil open profile type and hermetically sealed to prevent ingress of moisture.

**PRIMARY TERMINALS :**

All primary terminals shall be suitable for connecting ACSR conductor up to 200 sq.mm and terminals shall be nickel plated copper.

## **SECONDARY TERMINALS :**

Secondary terminals shall be brought out in a weather proof terminal box which shall be part of the current transformer housing or body. The terminals shall be nickel plated. Terminals and polarity marks shall be indelibly marked on the associated terminals as per relevant standard. Facility shall be provided for short circuiting and grounding the CT secondary at the terminal box.

## **GROUNDING :**

One earthing terminal shall be provided at the base.

## **FINISH :**

All ferrous parts shall be hot dip galvanised as stipulated in OES11.

## **MOUNTING**

Suitable brackets shall be provided at the base for mounting on the steel structures.

## **MAGNETISING CHARACTERISTIC**

Magnetisation curves and secondary resistance shall be provided. In the case of CTs for differential protection knee-point voltage shall be stated. Excitation currents at 25%, 50%, 75% and 100% of knee point voltage shall be provided.

## **MARKING**

The terminal markings shall identify the following :

- 1) the primary and secondary windings
- 2) the relative polarities of windings and winding sections
- 3) the intermediate tapings if any

The terminals shall be marked clearly and indelibly on their face or in their immediate vicinity.

The marking shall consist of letters followed or preceded where necessary by number. The letters shall be in block capitals.

## **RATING AND DIAGRAM PLATE**

The Rating and Diagram plate shall be provided at the base and shall contain the following details :

- 1) Standard
- 2) Manufacturer's name or Trade mark
- 3) Serial No.
- 4) Type
- 5) Ratio
- 6) Rated output and the corresponding accuracy
- 7) Rated highest equipment voltage

- 8) Rated insulation level
- 9) Rated short time current for 3 secs.
- 10) Class of insulation

Additional marking for class X transformers

Nominal turns ratio

Rated primary current

Secondary winding resistance at 75 deg C

**TESTS**

Type tests and routine test shall be in accordance to BS 3938/IEC 18. Test certificates shall be submitted.