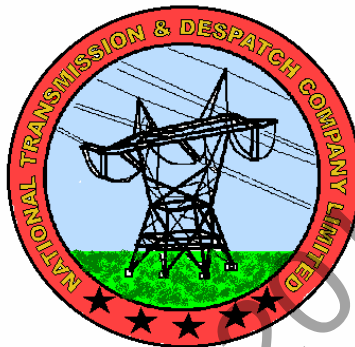


# **NATIONAL TRANSMISSION AND DESPATCH COMPANY**

## **NTDC SPECIFICATION P-90:2012**



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### **CURRENT TRANSFORMERS (145kV, 72.5kV & 36kV)**

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### **DESIGN DEPARTMENT NTDC**

**C O N T E N T S**

| <b><u>CLAUSE</u></b> | <b><u>DESCRIPTION</u></b>                                                              | <b><u>PAGE</u></b> |
|----------------------|----------------------------------------------------------------------------------------|--------------------|
| 0                    | FOREWORD                                                                               | 3                  |
| 1                    | SCOPE                                                                                  | 3                  |
| 2                    | REFERENCE STANDARD                                                                     | 3                  |
| 3                    | DEFINITIONS                                                                            | 4                  |
| 4                    | SERVICE CONDITIONS                                                                     | 9                  |
| 5                    | RATINGS AND CHARACTERISTICS                                                            | 10                 |
| 6                    | CONSTRUCTIONAL REQUIREMENTS                                                            | 13                 |
| 7                    | INSULATOR                                                                              | 15                 |
| 8                    | TERMINAL MARKINGS                                                                      | 15                 |
| 9                    | RATING PLATE MARKING                                                                   | 15                 |
| 10                   | SUPPORTING STEEL STRUCTURE                                                             | 16                 |
| 11                   | TERMINAL CONNECTOR                                                                     | 18                 |
| 12                   | TESTS                                                                                  | 19                 |
| 13                   | DRAWINGS AND DESCRIPTIVE DATA                                                          | 22                 |
| 14                   | PACKING                                                                                | 23                 |
| 15                   | ENCLOSURES:<br>a. Schedule of Technical Data for Current Transformers.<br>b. Drawings. | 23                 |

**PRINTING HISTORY**

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**NTDC SPECIFICATION P-90:2012****CURRENT TRANSFORMERS (145kV, 72.5kV & 36kV)****0.0 FOREWORD**

0.1 This specification has been prepared by Standards & Research Directorate of the Design Department NTDC. This fourth edition cancels and replaces the earlier editions published in 1975, 1979 & 1982 and its amendments.

0.2 This specification is intended for the procurement of material but does not include all the necessary provisions of the contract.

0.3 This specification is subject to revision as and when required by S&R Directorate of Design NTDC only. No other Department is authorized to make/issue amendment in the said specification.

**1.0 SCOPE**

1.1 This specification is applicable to current transformers along with steel supporting structures, grouting bolts, terminal connector for connection to external aluminium conductors as applicable for outdoor installations and operation on three phase solidly earthed system having voltages of 145kV, 72.5kV & 36kV.

1.2 The current transformers shall be designated as follows:

| Sr. No. | Description                                   | Cores | Designation |
|---------|-----------------------------------------------|-------|-------------|
| i.      | Current transformer, 145kV, 1600:800:400/1A.  | 4     | A           |
| ii.     | Current transformer, 145kV, 200:100/1A.       | 4     | B           |
| iii.    | Current transformer, 145 kV, 1200:600:300/5A. | 4     | C           |
| iv.     | Current transformer, 145 kV, 200:100/5A.      | 3     | D           |
| v.      | Current transformer, 72.5kV, 600:300:150/5A   | 3     | E           |
| vi.     | Current transformer, 36kV, 300:150:75/5A.     | 3     | F           |

1.3 Types A & B current transformers shall be used at 220/132kV Grid Stations while types C & D shall be used at 132/11.5kV Grid Stations.

**2.0 REFERENCE STANDARD**

2.1 The current transformers shall generally be designed, constructed and tested in accordance with the International Electro-technical commission publication 60044-1 "Current Transformers" amended to-date.

2.2 The definitions given in the IEC Publication 60044-1 shall apply herein.

2.3 In case the requirements laid down herein differ from those given in the IEC Publication in any particular aspect, the requirements listed herein shall prevail.

3.0 **DEFINITIONS**

The definitions of IEC 60044-1 shall apply. Some of them are recalled here for ease of reference.

3.1 **Current Transformer**

An instrument transformer in which the secondary current, in normal conditions of use, is substantially proportional to the primary current and differs in phase from it by an angle which is approximately zero for an appropriate direction of the connections.

3.2 **Primary Winding**

The winding through which flows the current to be transformed.

3.3 **Secondary Winding**

The winding which supplies the current circuits of measuring instruments, meters, relays or similar apparatus.

3.4 **Rated Primary Current**

The value of the primary current on which the performance of the transformer is based.

3.5 **Rated Secondary Current**

The value of the secondary current on which the performance of the transformer is based.

3.6 **Actual Transformation Ratio**

The ratio of the actual primary current to the actual secondary current.

3.7 **Rated Transformation Ratio**

The ratio of the rated primary current to the rated secondary current.

### 3.8 **Current Error (Ratio Error)**

The error which a transformer introduces into the measurement of a current and which arises from the fact that the actual transformation ratio is not equal to the rated transformation ratio. The current error expressed in per cent is given by the formula:

$$\text{Current error \%} = (K_n I_s - I_p) \times 100 / I_p$$

Where,

$K_n$  is the rated transformation ratio;

$I_p$  is the actual primary current;

$I_s$  is the actual secondary current when  $I_p$  is flowing, under the conditions of measurement.

### 3.9 **Phase Displacement**

The difference in phase between the primary and secondary current vectors, the direction of the vectors being so chosen that the angle is zero for a perfect transformer. The phase displacement is said to be positive when the secondary current vector leads the primary current vector. It is usually expressed in minutes or centiradians.

### 3.10 **Accuracy Class**

A designation assigned to a current transformer the errors of which remain within specified limits under prescribed conditions of use.

### 3.11 **Burden**

The impedance of the secondary circuit in ohms and power-factor. The burden is usually expressed as the apparent power in volt amperes absorbed at a specified power-factor and at the rated secondary current.

### 3.12 **Rated Burden**

The value of the burden on which the accuracy requirements of this specification are based.

### 3.13 **Rated Output**

The value of the apparent power (in volt amperes at a specified power-factor) which the transformer is intended to supply to the secondary circuit at the rated secondary current and with rated burden connected to it.

**3.14 Highest Voltage for Equipment**

The highest r.m.s. phase-to-phase voltage for which a transformer is designed in respect of its insulation.

**3.15 Highest Voltage of a System**

Highest value of operating voltage which occurs under normal operating conditions at any time and at any point in the system.

**3.16 Rated Insulation Level**

The combination of voltage values which characterizes the insulation of a transformer with regard to its capability to withstand dielectric stresses.

**3.17 Rated Resistive Burden ( $R_b$ )**

Rated value of the secondary connected resistive burden in ohms

**3.18 Rated Short-time Thermal Current ( $I_{th}$ )**

The r.m.s. value of the primary current which a transformer will withstand for one second without suffering harmful effects, the secondary winding being short-circuited.

**3.19 Rated Dynamic Current ( $I_{dyn}$ )**

The peak value of the primary current which a transformer will withstand, without being damaged electrically or mechanically by the resulting electromagnetic forces, the secondary winding being short-circuited

**3.20 Rated Continuous Thermal Current ( $I_{cth}$ )**

The value of the current which can be permitted to flow continuously in the primary winding, the secondary winding being connected to the rated burden, without the temperature rise exceeding the values specified

**3.21 Exciting Current**

The r.m.s. value of the current taken by the secondary winding of a current transformer, when a sinusoidal voltage of rated frequency is applied to the secondary terminals, the primary and any other windings being open-circuited.

### 3.22 Secondary Winding Resistance ( $R_{ct}$ )

Secondary winding d.c. resistance in ohms corrected to 75 °C or such other temperature as may be specified.

### 3.23 Composite Error

Under steady-state conditions, the r.m.s. value of the difference between:

- a) the instantaneous values of the primary current, and
- b) the instantaneous values of the actual secondary current multiplied by the rated transformation ratio, the positive signs of the primary and secondary currents corresponding to the convention for terminal markings.

The composite error  $\epsilon_c$  is generally expressed as a percentage of the r.m.s. values of the primary current according to the formula:

$$\epsilon_c = \frac{100}{I_p} \frac{1}{T} \int_0^T (K_n i_s - i_p)^2 dt$$

Where,

$K_n$  is the rated transformation ratio;

$I_p$  is the r.m.s. value of the primary current;

$i_p$  is the instantaneous value of the primary current;

$i_s$  is the instantaneous value of the secondary current;

$T$  is the duration of one cycle.

### 3.24 Multi-ratio Current Transformer

Current Transformer on which more ratios are obtained by connecting the primary winding sections in series or parallel or by means of taps on the secondary winding.

### 3.25 Measuring Current Transformer

A current transformer intended to supply indicating instruments, integrating meters and similar apparatus.

### 3.26 Rated Instrument Limit Primary Current (IPL)

The value of the minimum primary current at which the composite error of the measuring current transformer is equal to or greater than 10 %, the secondary burden being equal to the rated burden.

**3.27 Instrument Security Factor (FS)**

The ratio of rated instrument limit primary current to the rated primary current.

Note1: Attention should be paid to the fact that the actual instrument security factor is affected by the burden.

Note 2: In the event of system fault currents flowing through the primary winding of a current transformer, the safety of the apparatus supplied by the transformer is greatest when the value of the rated instrument security factor (FS) is small.

**3.28 Protective Current Transformer**

A current transformer intended to supply protective relays.

**3.29 Rated Accuracy Limit Primary Current**

The value of primary current up to which the transformer will comply with the requirements for composite error.

**3.30 Accuracy Limit Factor**

The ratio of the rated accuracy limit primary current to the rated primary current.

**3.31 Saturation Flux ( $\psi_s$ )**

That peak value of the flux which would exist in a core in the transition from the non-saturated to the fully saturated condition and deemed to be that point on the B-H characteristic for the core concerned at which a 10 % increase in B causes H to be increased by 50 %.

**3.32 Remanent Flux ( $\psi_r$ )**

That value of flux which would remain in the core 3 min after the interruption of an exciting current of sufficient magnitude to induce the saturation flux ( $\psi_s$ ) defined in 3.31.

**3.33 Rated Knee Point e.m.f. ( $E_k$ )**

That minimum sinusoidal e.m.f. (r.m.s.) at rated power frequency when applied to the secondary terminals of the transformer, all other terminals being open-circuited, which when increased by 10 % causes the r.m.s. exciting current to increase by no more than 50 %.

Note: The actual knee point e.m.f. will be  $\geq$  the rated knee point e.m.f.

### 3.34 **Excitation Characteristics**

A graphical or tabular presentation of the relationship between r.m.s. value of the exciting current and a sinusoidal r.m.s. e.m.f. applied to the secondary terminals of a current transformer, the primary and other windings being open-circuited, over a range of values sufficient to define the characteristics from low levels of excitation up to the rated knee point e.m.f.

### 3.35 **Rated Turns Ratio**

The required ratio of the number of primary turns to the number of secondary turns.

Example 1: 1/600 (one primary turn with six hundred secondary turns).

Example 2: 2/1200 (a current transformer of similar ratio to example 1 but employing two primary turns).

### 3.36 **Turns Ratio Error**

The difference between the rated and actual turn ratio, expressed as percentage.

$$\text{Turn ratio error} = \frac{(\text{actual turn ratio} - \text{rated turn ratio})}{\text{Rated turn ratio}} \times 100$$

### 3.37 **Solidly Earth Neutral System**

A system whose neutral point(s) is (are) earthed directly.

## 4.0 **SERVICE CONDITIONS**

The current transformers and all accessories shall be suitable for satisfactory operation under the following service conditions:-

### 4.1 **Climatic Conditions**

#### 4.1.1 **Ambient Temperature**

|                                |        |
|--------------------------------|--------|
| Maximum                        | 50°C.  |
| Maximum mean over any 24 hours | 45 °C. |
| Mean in any year               | 30 °C  |
| Minimum                        | -10 °C |

#### 4.1.2 **Relative Humidity**

The relative humidity may range from 0 to 100 percent. The maximum value of the ambient temperature and humidity, however, do not occur simultaneously. During the monsoons, high humidity may persist for many days at a time along with temperatures ranging from 30°C to 40°C.

#### 4.2 **Altitude**

The current transformers shall be suitable for installation upto 1000 m above sea level.

#### 4.3 **Atmospheric Conditions**

It may be assumed that the air is not normally heavily polluted by dust, smoke, aggressive gases, vapors or salt spray. However, at certain times of the year severe dust storms may be experienced.

#### 4.4 **Wind Load**

The maximum wind load shall be taken as 122 kg/sq. m. (corresponding to wind speed of 44.2 m/s).

#### 4.5 **Seismic Conditions**

The current transformers along with steel supporting structures and foundation shall be suitable to withstand the seismic stress/magnitude according to Richer-scale up to 7 (horizontal acceleration up to  $4\text{m/s}^2$  (0.4g) for safety of equipment under heavy earth quake conditions unless otherwise specified in the tender. The foundation arrangement shall be designed using the soil bearing capacity of 0.5 to  $1.0\text{ kg/cm}^2$ .

#### 4.6 **Supply System**

The current transformers shall be suitable for installation in 132 kV, 66 kV and 33 kV three phase A.C solidly earthed supply system of the following characteristics:

|                 |        |         |       |
|-----------------|--------|---------|-------|
| Rated Voltage   | 145 kV | 72.5 kV | 36 kV |
| Nominal Voltage | 132 kV | 66 kV   | 33 kV |
| Frequency       | 50 Hz  | 50 Hz   | 50 Hz |

#### 5.0 **RATINGS AND CHARACTERISTICS**

5.1 The current transformers shall comply with the following ratings, characteristics and meet all test requirements laid down herein with respect to insulation strength,

current carrying capacity, etc. The accuracy class shall be guaranteed at all specified ratios.

| Sr. No. | Designation of Current Transformers →                                                  | A                    | B           | C                    | D           | E                   | F                  |
|---------|----------------------------------------------------------------------------------------|----------------------|-------------|----------------------|-------------|---------------------|--------------------|
| a.      | Rated Voltage, $U_m$ , kV rms.                                                         | 145                  | 145         | 145                  | 145         | 72.5                | 36                 |
| b.      | Nominal Voltage, $U_n$ , kV rms.                                                       | 132                  | 132         | 132                  | 132         | 66                  | 33                 |
| c.      | Rated Frequency, Hz.                                                                   | 50                   | 50          | 50                   | 50          | 50                  | 50                 |
| d.      | Rated Primary Current, Amps.                                                           | 1600:<br>800:<br>400 | 200:<br>100 | 1200:<br>600:<br>300 | 200:<br>100 | 600:<br>300:<br>150 | 300:<br>150:<br>75 |
| e.      | Rated Secondary Current, A.                                                            | 1                    | 1           | 5                    | 5           | 5                   | 5                  |
| f.      | Rated Continuous Thermal Current, $I_{cth}$ ,                                          | 1920:<br>960:<br>480 | 240:<br>120 | 1440:<br>720:<br>360 | 240:<br>120 | 720:<br>360:<br>180 | 360:<br>180:<br>90 |
| g.      | Rated Secondary Output at Lowest Tap/Ratio, VA:                                        |                      |             |                      |             |                     |                    |
|         | - Measuring Core 1                                                                     | 15                   | 15          | 15                   | 15          | 15                  | 15                 |
|         | - Protective Core 2                                                                    | 60                   | 60          | 60                   | 60          | 60                  | 60                 |
|         | - Protective Core 3                                                                    | 30                   | 30          | 30                   | 30          | 30                  | 30                 |
|         | - Protective Core 4                                                                    | 30                   | 30          | 30                   | -           | -                   | -                  |
| h.      | Accuracy Class:                                                                        |                      |             |                      |             |                     |                    |
|         | - Measuring Core                                                                       | 0.5                  | 0.5         | 0.5                  | 0.5         | 0.5                 | 0.5                |
|         | - Protective Core                                                                      | 10P                  | 10P         | 10P                  | 10P         | 10P                 | 10P                |
| i.      | Short Time Current, kA                                                                 |                      |             |                      |             |                     |                    |
|         | - Thermal, $I_{th}$                                                                    | 40                   | 40          | 40                   | 40          | 25                  | 25                 |
|         | - Dynamic, $I_{dyn}$                                                                   | 100                  | 100         | 100                  | 100         | 63                  | 63                 |
| j.      | Rated Duration of Short Circuit, sec.                                                  | 1                    | 1           | 1                    | 1           | 1                   | 1                  |
| k.      | Accuracy Limit Factor for Protective Core                                              | 20                   | 20          | 20                   | 20          | 20                  | 20                 |
| l.      | Lightning Impulse Voltage Withstand on Primary Winding, kV peak.                       | 650                  | 650         | 650                  | 650         | 325                 | 170                |
| m.      | One minute Power Frequency Withstand Voltage, kV rms (Primary), (dry & wet)            | 275                  | 275         | 275                  | 275         | 140                 | 70                 |
| n.      | One minute Power frequency Withstand Voltage (Secondary) and between Sections, kV rms. | 3                    | 3           | 3                    | 3           | 3                   | 3                  |

| Sr. No. | Designation of Current Transformers →                      |                                                     | A     | B     | C     | D     | E     | F     |
|---------|------------------------------------------------------------|-----------------------------------------------------|-------|-------|-------|-------|-------|-------|
| o.      | Temperature rise, °C , Max.                                |                                                     |       |       |       |       |       |       |
|         | -                                                          | Winding, °C , Max.                                  | 55    | 55    | 55    | 55    | 55    | 55    |
|         | -                                                          | Top oil, °C , Max.<br>(with conservator)            | 45    | 45    | 45    | 45    | 45    | 45    |
|         | -                                                          | Top oil, °C , Max.<br>(without conservator)         | 40    | 40    | 40    | 40    | 40    | 40    |
| p.      | Partial Discharge,                                         |                                                     |       |       |       |       |       |       |
|         | -                                                          | Um, pC                                              | 10    | 10    | 10    | 10    | 10    | 10    |
|         | -                                                          | 1.2Um/√3, pC                                        | 5     | 5     | 5     | 5     | 5     | 5     |
| q.      | C & D F, (tan δ), Max.                                     |                                                     | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| r.      | Inter Turn Insulation level, kV peak.                      |                                                     | 4.5   | 4.5   | 4.5   | 4.5   | 4.5   | 4.5   |
| s.      | Max. Radio Interference Level (RIV) at 1.1Um/√3 (RIV), μV. |                                                     | 2500  | 2500  | 2500  | 2500  | -     | -     |
| t.      | Rated Mechanical Static Withstand Load, N.                 |                                                     | 2000  | 2000  | 2000  | 2000  | 1250  | -     |
| u.      | Rated Mechanical Dynamic Withstand Load, N.                |                                                     | 2800  | 2800  | 2800  | 2800  | 1750  | -     |
| v.      | Characteristics of oil                                     |                                                     |       |       |       |       |       |       |
|         | -                                                          | Viscosity at 40 °C, max.<br>mm <sup>2</sup> /s      | 12    | 12    | 12    | 12    | 12    | 12    |
|         | -                                                          | Viscosity at -30 °C, max.<br>mm <sup>2</sup> /s     | 1800  | 1800  | 1800  | 1800  | 1800  | 1800  |
|         | -                                                          | Density at 20°C, max..<br>g/ml                      | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 | 0.895 |
|         | -                                                          | Flash point, °C                                     | 135   | 135   | 135   | 135   | 135   | 135   |
|         | -                                                          | Dielectric dissipation factor, tan δ at 90 °C, Max. | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
|         | -                                                          | Pour point, max. °C                                 | -40   | -40   | -40   | -40   | -40   | -40   |
|         | -                                                          | Dielectric strength, min.<br>kV                     | 40    | 40    | 40    | 40    | 40    | 40    |
|         | -                                                          | PCB Content                                         | Nil   | Nil   | Nil   | Nil   | Nil   | Nil   |
|         | -                                                          | Acidity, max. mg KOH/g                              | 0.01  | 0.01  | 0.01  | 0.01  | 0.01  | 0.01  |

## 5.2 **Rated Continuous Thermal Current**

The current transformer shall be capable for continuous operation at 1.2 times the rated current.

## 5.3 **Temperature Rise**

The temperature-rise of the current transformer when carrying primary current equal to the rated continuous thermal current (1.2 times the rated current) with a unity power factor & burden corresponding to the rated output under service conditions shall not be more than that as specified above. The limits of temperature rise specified in the relevant IEC standard have been reduced by 10°C to account for high ambient condition required in this specification.

## 6.0 **CONSTRUCTIONAL REQUIREMENTS**

### 6.1 **General**

6.1.1 The design shall be such that installation, replacement and general maintenance may be undertaken within a minimum time and all parts are easily assembled and protected from rusting or corrosion. Provision shall be made in the design of the CTs to ensure that proper operation is not impaired by vermin, insects, small animals and birds.

6.1.2 The current transformers shall be single pole, oil filled, and self-contained outdoor type. Oil level indicator marked for 25°C shall be provided. The oil shall be uninhibited, non PCB and conforming to IEC-60296 amended to date.

6.1.3 The current transformers shall be hermetically sealed with arrangements other than nitrogen cushion. Synthetic or stainless steel bellows, or expandable cells shall be provided to accommodate oil level variation. A suitable device for indicating the position of the bellows shall be provided.

6.1.4 To obtain multiple ratios, it is permissible to provide series parallel connections of the primary winding or tapings on secondary windings. Where such arrangements are provided, it shall be possible to connect the primary windings externally to change the ratios, and the interior of the transformer should remain sealed.

### 6.2 **Painting**

6.2.1 All exposed metallic parts shall be painted except where painting will interfere with the normal operation of the equipment. Where surface is left unpainted for mounting purposes, they shall be suitably protected to prevent rusting during storage and ocean transport.

- 6.2.2 After preparation and cleaning of all surfaces to be painted, the surfaces not in contact with oil shall be painted with two coats of an epoxy primer containing red lead, zinc or aluminum. The surfaces shall be finish coated with two coats of enamel applied to provide a uniform smooth surface free from blemishes.
- 6.2.3 The interior and exterior surfaces of the current transformers shall be given manufacturers' standard finish before shipping but a dull grey colour finish shall be preferred. A very light colour or aluminum paint shall not be used.

#### 6.4 **Housing and Tank**

The housing or tank shall be of sufficient strength and rigidity to provide a tight-fitting gasket and sealed enclosure. The complete assemblies shall form sealed enclosures capable of sustaining full pressure developed within housing or tank, either above or below atmospheric, under normal operating conditions. The windings and bushings shall be hermetically sealed to prevent the entrance of moisture or leakage of the dielectric during transportation, storage and installation.

#### 6.5 **Primary Terminals**

The size of primary terminals for 'A' and 'C' type current transformers shall be 125 mm in length x 40 mm dia. For 'B', 'D', 'E' and 'F' type CTs, the terminals shall be 80 mm in length x 30 mm in dia. The fixing of terminals shall be as per any configuration mentioned in Table-9 of IEC 60044-1. The material of terminal shall be as per sample which qualifies in type tests.

#### 6.6 **Secondary Terminals**

All secondary leads shall be brought to an outlet box and terminated in non split, current shorting type, terminal block located in a weather proof case near the current transformer base. Provision shall be made for entry and connection with 4 core, 6 mm<sup>2</sup> copper control cables. CT shorting links and cable glands shall be provided. Protection class of terminal box shall be IP 55.

#### 6.7 **Earthing Terminals**

Two number earthing terminals at diagonally opposite position shall be provided. Each terminal shall be capable of carrying full short circuit current and be suitable for accommodating 95 to 120 mm<sup>2</sup> copper conductor.

#### 6.8 **Static Mechanical Terminal Load**

Current transformer shall be capable of withstanding the static loads to be applied in any direction to the primary terminals as specified above.

## 6.9 **Dynamic Mechanical Terminal Load**

Current transformer shall be capable of withstanding the dynamic loads (e.g. short circuits) of 1.4 times the static withstand load as specified above.

## 7.0 **INSULATOR**

7.1 All porcelain insulators shall be wet process, homogeneous and free from cavities and other defects and tested in accordance with IEC-60273. The color of insulators shall be chocolate glazed brown. Manufacturer's type & routine Test reports shall be submitted with the bid and at the time of pre-delivery inspection/FATs.

7.2 Porcelain insulators shall be designed to withstand internal pressure of three times the maximum operating pressure and shall have the same Insulation Level as the current transformer. These shall be airtight under pressure and shall have adequate mechanical strength to withstand the wind loads, seismic stress, static and dynamic forces from conductor.

7.3 Porcelain insulators shall have following minimum creepage distance from live to earthed parts for operation under the prevailing atmospheric conditions:

| <u>Rated Voltage (kV)</u> | <u>Minimum Creepage Distance (mm)</u> |
|---------------------------|---------------------------------------|
| 145                       | 3900                                  |
| 72.5                      | 1960                                  |
| 36                        | 970                                   |

## 8.0 **TERMINAL MARKINGS**

The terminal shall be marked clearly and indelibly in accordance with IEC publication 60044-1.

## 9.0 **RATING PLATE MARKING**

9.1 A stainless steel name plate shall be securely attached to the current transformer and shall include at least the following information marked in an indelible manner in accordance with IEC 60044-1 which shall be visible in position of nominal service and installation.

- a) Manufacturer's name.
- b) Designation and type.
- c) Serial number.
- d) Contract No./Purchase Order No. and date.
- e) Rated voltage.
- f) Rated frequency.
- g) Rated lightning impulse withstand voltage.

- h) Rated power frequency withstand voltage.
- i) Rated primary and secondary currents.
- j) Rated short time thermal and dynamic currents.
- k) Rated duration of short circuit.
- l) Class of insulation.
- m) Connection arrangements of windings.
- o) Rated continuous thermal current.
- q) Rated output, accuracy class and instrument security factor:  
(e.g. 15VA class 0.5 FS 10) for metering core.
- r) Rated Output, accuracy class and instrument security factor:  
(e.g. 30VA class 10 P 20) for protective core.
- s) Rated mechanical static and dynamic terminal loads.
- t) Quantity and weight of oil.
- u) Weight per pole in Kg.

#### 10.0 **SUPPORTING STEEL STRUCTURE**

10.1 Each current transformer shall be supplied along with steel supporting structures, its foundation/grouting bolts etc. The origin of steel supporting structures shall be same as that of current transformers. All structural material shall be hot dip galvanized.

10.2 The dimensions indicated in drawing No. PDW/TS-3204 are minimum values. The manufacturer shall submit their own design/drawings without affecting the interchangeability requirement of the foundation arrangement as indicated in detail B of the drawing. The transformer manufacturer may design the steel supporting structure according to their requirements and fulfilling the wind load, wind speed and other forces involved on the current transformer under fault conditions. The change in dimensions of foundation arrangement is not allowed.

10.3 The steel shall conform to the requirements as prescribed below:

Tensile strength:

|                             |    |
|-----------------------------|----|
| Minimum, kg/mm <sup>2</sup> | 50 |
| Maximum, kg/mm <sup>2</sup> | 80 |

|                                      |    |
|--------------------------------------|----|
| Yield points kg/mm <sup>2</sup> Min. | 35 |
|--------------------------------------|----|

Elongation in 200mm guage Length:

|                            |    |
|----------------------------|----|
| Upto 8mm Thickness, % min. | 15 |
| Over 8mm Thickness, % min. | 18 |

10.4 All nut and bolts shall be hexagonal type made from steel grade 6.8 (ISO 898) and provided with one flat and one lock washer under each nut. All connection bolts

nuts, lock nuts and washers shall be furnished in excess of at least 5% greater than actual requirements sufficient to compensate for normal field losses.

- 10.5 All grouting bolts for fixing the structures to the foundation shall be from High Tensile Steel. Washers shall not be less than 5 mm thickness and only one thickness of washer shall be used. The diameter of the washer and bolt holes shall be 1.5mm larger than the bolt diameter and the outside diameter of washer shall not be less than 1.5mm larger than the diagonal of the nut.
- 10.6 All connection bolts nuts, lock nuts and washers shall be furnished in excess of actual number required in quantity at least 5% greater than actual requirements sufficient to compensate for normal field losses.
- 10.7 All main legs/structural material shall be coupled with foundation arrangement & top plate with nuts & bolts only. No connection with welding at the base and top is allowed.
- 10.8 All members with its identification marks shall be coupled with main structural members/legs through nuts & bolts only. Welding of members with legs is not allowed.
- 10.9 Prior to galvanizing, material shall be drilled, punched, cut or otherwise fabricated as required, free from burrs, cleaned so that zinc coating shall be adherent, dense, smooth, continuous and uniform. It shall also be completely free from lumps, blisters, uncoated or porous spots, black spots, dross, flux or any other imperfection.
- 10.10 The weight and thickness of zinc coating on angles shall not be less than  $600\text{gm/m}^2$  and 0.010 mm respectively.
- 10.11 The weight and thickness of zinc coating on nuts & bolts shall not be less than  $380\text{gm/m}^2$  and 0.035 mm respectively. The brinell hardness of bolts & nuts shall be between 120 to 200 HB. The ultimate strength and other properties of the nuts & bolts not listed above shall conform to relevant International standard viz British/ASTM/IEC etc.
- 10.12 For fixing the current transformers on RCC columns or on steel support structures, the base of C.T with four holes and hole to hole center distance of 450mm shall be provided.
- 10.13 Acceptance Tests:

The following acceptance tests shall be carried out on one complete structure out of lot offered for inspection.

For Section and Plates

1. Visual examination
2. Verification of dimensions and weights
3. Assembly tests
4. Tensile tests
5. Bend Tests
6. Impact tests
7. Galvanizing tests:
  - Weight of zinc coating
  - Uniformity of zinc coating
  - Adherence of zinc coating
  - Embitterment test

For Nuts and Bolts

1. Verification of dimensions
2. Visual inspection
3. Proof load test
4. Ultimate tensile strength test
5. Hardness test
6. Galvanizing tests
  - Weight of zinc coating
  - Uniformity of zinc coating
  - Adherence of zinc coating
  - Embitterment test

Test reports shall be furnished by the manufacturer as per relevant international standard and conforming to above requirements.

**11.0 TERMINAL CONNECTOR**

11.1 Mono-metallic or Bimetallic terminal connector as per requirement of terminal head along with stainless steel nuts and bolts suitable for connection between terminal heads and Aluminum conductor having dia. of 26 to 38mm shall be provided with each pole of the current transformer. The connectors with single bolt technology i.e. without nut & washers are not acceptable. The bimetallic connectors if applicable shall have separate copper and Aluminium bodies joined by a suitable bimetal strip joint with 2mm of thickness. The connectors employing bimetallic shims shall not be accepted.

11.2 The current rating of the connector shall be same as that of the current transformer. The material and composition of the Aluminium alloy used on monometallic connectors and the Aluminium portion of the bimetallic connectors shall be properly heat treated. Aluminium alloy and keepers shall have the following characteristics:

|                                |   |                         |
|--------------------------------|---|-------------------------|
| Ultimate tensile strength, min | = | 24 kg/ mm <sup>2</sup>  |
| Yield strength, min            | = | 15.5 kg/mm <sup>2</sup> |
| Elongation, min                | = | 3% on 50 mm scale       |
| Electrical conductivity, min   | = | 38% IACS                |
| Brinell hardness, min          | = | 100 HB                  |

- 11.3 The copper alloy shall be from the Copper/Nickel base family of alloys with a minimum of 96.4% of copper in order to guarantee high conductivity properties as well as high strengths characteristics. Copper alloy shall be heat treated. Bronze or Brass alloys are not acceptable.

The copper alloy and keepers shall have the following characteristics:

|                                 |   |                        |
|---------------------------------|---|------------------------|
| Ultimate tensile strength, min  | = | 20 kg/ mm <sup>2</sup> |
| Yield strength, min             | = | 10 kg/mm <sup>2</sup>  |
| Elongation (min)                | = | 18% on 50 mm scale     |
| Electrical conductivity at 20°C | = | 32% IACS (min)         |

- 11.4 The bolts, nuts and washers shall be of stainless steel having following properties:

|                        |   |                        |
|------------------------|---|------------------------|
| Breaking strength, min | = | 65 kg/ mm <sup>2</sup> |
| Yield strength, min    | = | 40 kg/mm <sup>2</sup>  |
| Brinell hardness, min  | = | 140 HB                 |

- 11.5 The type test reports for the following tests of connector bodies, keepers shall be furnished by the manufacturer/supplier as per relevant international standard and conforming to above requirements.

- a. Material composition test
- b. Tensile strength test
- c. Elongation test
- d. Brinell hardness test
- e. Heat cycle test
- f. Conductivity test
- g. Current carrying capacity
- h. Short time withstand current

## 12.0 **TESTS**

- 12.1 Tests shall be performed in accordance with the IEC Publication 60044-1 amended to date to ascertain that, as regards design, size, material and manufacture, the current transformers complies with the specified rating, characteristics and operational requirements.

## 12.2 Type Tests

12.2.1 Duly certified and complete type test reports for type tests carried out at KEMA Lab Holland and CESI Lab Italy on the current transformers having same design, voltage ratings & ratios shall be acceptable in lieu of actual tests. The validity of the type tests reports shall be 10 years. In case of non-production of the requisite type test reports or if the type test reports are otherwise not acceptable to the Design NTDC, the following tests in accordance with IEC 60044-1 shall be performed on the current transformer having same current ratings and ratios as ordered in presence of two representatives one from Design, NTDC and other from purchaser at any STL approved Lab or any other lab approved by design NTDC at the cost and arrangement of the manufacturer including travel expenses, boarding, lodging and daily allowance for the representatives. The determination of errors test shall be performed after all other tests.

- a) Measurement of the resistance of primary and secondary windings.
- b) Lightning impulse withstand voltage test.
- c) Power frequency voltage withstand test at Primary & secondary windings and between sections (dry).
- d) Power frequency voltage withstand test at Primary windings (wet).
- e) Inter-turn over voltage test.
- f) Partial discharge measurement.
- g) Radio Interference Voltage (RIV) Test.
- h) Temperature-rise test.
- i) Short-time withstand current and peak withstand current tests.
- j) Measurement of capacitance and dielectric dissipation Factor test.
- k) Mechanical tests.
- l) Determination of errors (Limits of current error, phase displacement and instrument security factor) for measuring core.
- m) Determination of errors (Limits of current error, phase displacement and composite error) for protective core.

11.2.2 Following visual inspection/checks on the assembly subject to type tests shall be carried out and made part of the type test report.

- i) Verification of name plate data and terminal marking.
- ii) Check of constructional and performance requirements.
- iii) Visual & dimensional verification of CT assembly, steel supporting structures, terminal connectors and earth terminals.
- iv) Measurement of creepage distance.
- v) Verify all components/devices are correctly labelled.

## 12.2.2 Test Reports

The type test report for the above tests along with complete outline drawings, data, photographs, details of supporting structure, operating mechanism, record of test quantities of tested current transformer duly stamped by the independent lab shall be submitted with the bid. The type test reports shall incorporate details sufficient

to identify the design of the tested current transformer. Such information shall include, but is not restricted to the following:

- i) Drawing of CT general assembly.
- ii) The details of mountings, fixings and insulator.
- iii) Creepage length and shed profile.
- iv) Outline drawing of insulator.
- v) The resistance measured before and after the type tests

### 12.3 Routine Tests

- 12.3.1 The manufacturer shall perform routine tests on all current transformers according to respective clauses of IEC-60044-1 and test reports shall be submit at the time of pre-delivery inspection.

### 12.4 Acceptance Tests

- 12.4.1 The following acceptance tests shall be made on minimum of 10% quantity of ordered current transformers to be selected randomly from the total lot offered for pre-delivery inspection/testing in presence of two representatives one from Design, NTDC and other from Purchaser at the cost and arrangement of the manufacturer including travel expenses, boarding, lodging and daily allowance for the representatives. The arrangement, test conditions, and criteria to pass the tests shall be in accordance with relevant clauses of IEC 60044-1 amended to date. The determination of errors test shall be performed after all other tests.

- a) Measurement of the resistance of primary and secondary windings. The measured resistance should not exceed the resistance measured during type tests on current transformer.
- b) Power frequency voltage withstand test at primary & secondary windings and between sections (dry).
- c) Inter-turn over voltage test.
- d) Partial discharge measurement.
- e) Mechanical test.
- f) Measurement of capacitance and dielectric dissipation Factor test.
- g) Determination of errors (Limits of current error, phase displacement and instrument security factor) for measuring core.
- h) Determination of errors (Limits of current error, phase displacement and composite error) for protective core .

- 12.4.2 One complete current Transformer shall be fixed on the steel supporting structures for following examination:

- i) Verification of name plate data and terminal marking.
- ii) Check of constructional and performance requirements.
- iii) Visual & dimensional verification of CT assembly, steel supporting structures, terminal connectors and earth terminals.
- iv) Measurement of creepage distance.
- v) Verify all components/devices are correctly labeled.

- 12.4.3 The acceptance/inspection certificate clearly indicate the performance of above tests during pre-delivery inspection/testing and test results shall be submitted to the Purchaser. A copy of bill of quantity indicating the total quantity of each component, parts, structure, their accessories, etc, duly signed by the inspectors(s) required for consignee for verification on receipt of material in warehouse/store shall also be attached with the inspection certificate.

### 13.0 **DRAWINGS AND DESCRIPTIVE DATA**

#### 13.1 **Data to be submitted with the bid**

- 13.1.1 Supply record of offered type, current ratio & voltage rating of CTs for last five years on the following format:

| Sr. No. | Contract/Purchase Order No. & date | Quantity | Current ratio/<br>Voltage rating | Delivery period | Client Address/<br>Phone/ Fax No./<br>E-mail, etc. |
|---------|------------------------------------|----------|----------------------------------|-----------------|----------------------------------------------------|
|---------|------------------------------------|----------|----------------------------------|-----------------|----------------------------------------------------|

- 13.1.2 The schedule of technical data duly filled-in attached hereto along with supporting documents. The word indicating “as per specification/standard” will not be acceptable.
- 13.1.3 Dimensional & outline drawing of CTs showing dimensions of each individual part including, terminal head for high voltage connections, size of terminals for earthing and terminal connector.
- 13.1.4 Non submission of completely filled-in schedule of technical data and supply record on the above format or submission of incomplete information/data as mentioned above with the bid, may render the bid non-responsive.

#### 13.2 **Approval Drawings and Data to be submitted after Award of Contract/Purchase Order**

The following drawings/descriptive data shall be submitted for approval of Design Department NTDC before manufacturing the equipment:

- i. Schedule of technical data duly filled-in along with supporting documents.
- ii. Instruction Manual for installation indicating site test procedure before energizing/operation, maintenance/replacement of components procedure and storing requirements of the CTs.
- iii. Dimensional & outline drawing of CTs showing dimensions of each individual part including, terminal head for high voltage connections, size of terminals for earthing and terminal connector.
- iv. Sectional drawing of the current transformer indicating the inner details.
- v. Primary connections arrangement and secondary terminal box drawing
- vi. Drawing showing fixing arrangement of the bellows, if applicable.

- vii. Drawing showing the method of sealing and attachment in case of bellows also indicating material and endurance life.
- viii. Typical current error and phase displacement curves for the standard burdens from 0 to 1.5 times rated secondary current for metering current transformers.
- ix. Typical composite error curves from 0 to 20 times rated secondary current for protective current transformers.
- x. Typical excitation curves for current transformers up to 20 times the secondary rated current.
- xi. The maximum allowable mechanical loads for:
  - a) Any one primary terminal in any direction.
  - b) Total resulting load applicable to top assembly in any direction on primary terminals.
  - c) Torque/ resulting torque in horizontal direction on primary terminals.
- xii. Technical catalogue in respect of the bushings.
- xiii) Installation, erection, maintenance and operation instruction manuals.
- xiv. Drawings of steel supporting structure, foundation/grouting bolt drawing showing static and dynamic loading of CTs. Photographs in fully arranged and erected condition.
- xv. Type test reports of CTs, insulator, terminal connectors.
- xvi. Rating plate drawing and earth quake simulation and response calculations.

## 14.0

**PACKING**

The Current Transformers and all allied material including steel supporting structure, connector, etc. shall be supplied in individual wooden box suitable for transport by rail/road and sea as per international practice. The CTs and all allied material including steel supporting structures shall be supplied in packing suitable for transport by rail/road and sea as per international practice. Special precaution may be essential for protection of insulation during transport to prevent moisture absorption due, for instance, to rain, snow or condensation. In every package of equipment for shipment one number installation, erection, maintenance and operation instruction book enclosed in water proof material shall be provided. Bill of quantity shall indicate the quantity, size, length, weight and assembly mark of each member of structure including nuts & bolts, washers, plates, foundation bolts and all fittings complete for structure, connector etc.

## 15.0

**ENCLOSURES**

- a. Schedule of Technical Data for Current Transformer.
- b. Supporting Steel Structure Drawing No. PDW/TS/3204  
(Revision dated 01-01-2011).
- c. Mono-metallic Terminal Connector Drawing No. PDW/DF-308 (1)
- d. Bimetallic Terminal Connector Drawing No. PDW/DF-308  
(Revision dated 01-01-2011).

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**SCHEDULE OF TECHNICAL DATA**  
**FOR CURRENT TRANSFORMER (145kV, 72.5kV & 36kV)**

| Sr. No.   | DESCRIPTION                                                         |                                                                                                    |                     |                     |
|-----------|---------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|---------------------|---------------------|
| <b>A.</b> | <b>General</b>                                                      |                                                                                                    |                     |                     |
| 1.        | Manufacturer's name & address.<br>(Attach Manufacturer's catalogue) |                                                                                                    |                     |                     |
| 2.        | Type/designation of offered CTs.                                    |                                                                                                    |                     |                     |
| 3.        | Type Tests:                                                         |                                                                                                    |                     |                     |
|           | a.                                                                  | Copy of type test reports attached.                                                                | Yes/No.             |                     |
|           | b.                                                                  | Rated Voltage.                                                                                     | kV                  |                     |
|           | c.                                                                  | Rated normal primary current.                                                                      | A                   |                     |
|           | d.                                                                  | Rated secondary currents.                                                                          | A                   |                     |
|           | e.                                                                  | Rated short time withstand current at all ratios, for 1 sec, rms.                                  | kA                  |                     |
|           | f.                                                                  | Rated peak withstand current, rms                                                                  | kA                  |                     |
|           | g.                                                                  | Resistance of primary winding                                                                      |                     |                     |
|           |                                                                     | i) Series connections.                                                                             | $\mu\Omega$         |                     |
|           |                                                                     | ii) Parallel connections.                                                                          | $\mu\Omega$         |                     |
|           | h.                                                                  | Resistance of secondary winding                                                                    |                     |                     |
|           |                                                                     | Measuring Core 1.                                                                                  | m $\Omega$          |                     |
|           |                                                                     | Protective Core 2.                                                                                 | m $\Omega$          |                     |
|           |                                                                     | Protective Core 3.                                                                                 | m $\Omega$          |                     |
|           |                                                                     | Protective Core 4.                                                                                 | m $\Omega$          |                     |
|           | i.                                                                  | Temperature rise of winding.                                                                       | $^{\circ}\text{C}$  |                     |
|           | j.                                                                  | Temperature rise of top oil.                                                                       | $^{\circ}\text{C}$  |                     |
| 4.        | <b>Details of following Type Test if performed.</b>                 |                                                                                                    | <b>Date of Test</b> | <b>Name of Lab.</b> |
|           | a.                                                                  | Lightning impulse withstand voltage test.                                                          |                     |                     |
|           | b.                                                                  | Power frequency voltage withstand test at Primary & secondary windings and between sections (dry). |                     |                     |

|           |                                                        |                                                                                                    |    |  |
|-----------|--------------------------------------------------------|----------------------------------------------------------------------------------------------------|----|--|
|           | c.                                                     | Power frequency voltage withstand test at Primary & secondary windings and between sections (wet). |    |  |
|           | c.                                                     | Partial discharge Measurement.                                                                     |    |  |
|           | d.                                                     | Radio Interference Voltage (RIV) Test.                                                             |    |  |
|           | e.                                                     | Measurement of Temperature-Rise.                                                                   |    |  |
|           | f.                                                     | Measurement of resistance of Primary and secondary windings.                                       |    |  |
|           | g.                                                     | Short-time withstand current and peak withstand current tests.                                     |    |  |
|           | h.                                                     | Determination of errors before and after short circuit test.                                       |    |  |
|           |                                                        | Limits of current error for measuring core                                                         |    |  |
|           |                                                        | Phase displacement for measuring core                                                              |    |  |
|           |                                                        | Composite error for measuring core                                                                 |    |  |
|           |                                                        | Limits of current error for protective core                                                        |    |  |
|           |                                                        | Phase displacement for protective core                                                             |    |  |
|           |                                                        | Composite error for protective core                                                                |    |  |
|           | i.                                                     | Measurement of C & DF.                                                                             |    |  |
|           | j.                                                     | Mechanical Test.                                                                                   |    |  |
|           | k.                                                     | Inter Turn Voltage Test.                                                                           |    |  |
| <b>B.</b> | <b>Ratings</b>                                         |                                                                                                    |    |  |
| 1.        | Rated voltage( $U_m$ ), rms.                           |                                                                                                    | kV |  |
| 2.        | Nominal voltage, rms.                                  |                                                                                                    | kV |  |
| 3.        | Rated Frequency.                                       |                                                                                                    | Hz |  |
| 4.        | Rated normal primary current.                          |                                                                                                    | A  |  |
| 5.        | Rated Secondary current.                               |                                                                                                    | A  |  |
| 6.        | Rated continuous Thermal current, $I_{cth}$ ,          |                                                                                                    | A  |  |
| 7.        | Lightning Impulse withstand voltage (Primary winding). |                                                                                                    | kV |  |
| 8.        | Power frequency withstand Voltage (Primary winding).   |                                                                                                    | kV |  |

|     |                                                              |             |  |
|-----|--------------------------------------------------------------|-------------|--|
| 9.  | Power frequency withstand Voltage (secondary winding).       | kV          |  |
| 10. | Power frequency withstand Voltage between sections.          | kV          |  |
| 11. | Rated Frequency.                                             | Hz          |  |
| 12. | Temperature rise of winding.                                 | °C          |  |
| 13. | Temperature rise of top oil.                                 | °C          |  |
| 14. | Accuracy limit factor.                                       |             |  |
| 15. | Instrument Security Factor.                                  |             |  |
| 16. | Resistance of primary winding at 20°C ambient temperature.   |             |  |
|     | a. Series connections.                                       | $\mu\Omega$ |  |
|     | b. Parallel connections.                                     | $\mu\Omega$ |  |
| 17. | Resistance of secondary winding at 20°C ambient temperature: |             |  |
|     | a. Measuring Core 1.                                         | m $\Omega$  |  |
|     | b. Protective Core 2.                                        | m $\Omega$  |  |
|     | c. Protective Core 3.                                        | m $\Omega$  |  |
|     | d. Protective Core 4.                                        | m $\Omega$  |  |
| 18. | Rated Secondary Output at lowest tap, VA:                    |             |  |
|     | a. Measuring Core 1.                                         | VA          |  |
|     | b. Protective Core 2.                                        | VA          |  |
|     | c. Protective Core 3.                                        | VA          |  |
|     | d. Protective Core 4.                                        | VA          |  |
| 19. | Accuracy Class:                                              |             |  |
|     | a. Measuring Core.                                           | A           |  |
|     | b. Protective Core.                                          | A           |  |
| 20. | Short time current rating at all ratios, kA                  |             |  |
|     | a. Thermal, I <sub>th</sub> .                                | kA          |  |
|     | b. Dynamic, I <sub>dyn</sub> .                               | kA          |  |
| 21. | Rated duration of short circuit.                             | Sec.        |  |

|     |                                                                                          |                                                            |         |  |
|-----|------------------------------------------------------------------------------------------|------------------------------------------------------------|---------|--|
| 22. | Partial Discharge:                                                                       |                                                            |         |  |
|     | -                                                                                        | Um.                                                        | pC      |  |
|     | -                                                                                        | $1.2U_m/\sqrt{3}$ .                                        | pC      |  |
| 22. | Rated Mechanical Static Withstand load.                                                  |                                                            | N       |  |
| 23. | Rated Mechanical Dynamic Withstand load.                                                 |                                                            | N       |  |
| 24. | C & D F, (tan $\delta$ ).                                                                |                                                            |         |  |
| 25. | Max. Radio Interference Level at $1.1U_m/\sqrt{3}$ (RIV).                                |                                                            | $\mu V$ |  |
| 26. | Inter Turn Insulation level.                                                             |                                                            | kV      |  |
| C.  | <b>Construction</b><br>(Attach photograph of CT showing all parts and a detail legend ). |                                                            |         |  |
| 1.  | Complete height of the CT.                                                               |                                                            | mm      |  |
| 2.  | Clearance to ground                                                                      |                                                            | mm      |  |
| 3.  | Material of bellows, if applicable.                                                      |                                                            |         |  |
| 4.  | Material of primary winding                                                              |                                                            |         |  |
| 5.  | Material of secondary winding                                                            |                                                            |         |  |
| 6.  | Material of rating plate.                                                                |                                                            |         |  |
| 7.  | Thickness of rating plate.                                                               |                                                            | mm      |  |
| 8.  | Dimensions of rating plate (LxW)                                                         |                                                            | Mm      |  |
| 9.  | Wight per pole.                                                                          |                                                            | Kg      |  |
| 10. | Weight of oil per pole.                                                                  |                                                            | Kg      |  |
| 11. | <b>Characteristics of oil:</b>                                                           |                                                            |         |  |
|     | -                                                                                        | Viscosity at 40 °C, max. mm <sup>2</sup> /s                |         |  |
|     | -                                                                                        | Viscosity at -30 °C, max. mm <sup>2</sup> /s               |         |  |
|     | -                                                                                        | Density at 20°C, max.. g/ml                                |         |  |
|     | -                                                                                        | Flash point, °C                                            |         |  |
|     | -                                                                                        | Dielectric dissipation factor, tan $\delta$ at 90 °C, Max. |         |  |
|     | -                                                                                        | Pour point, max. °C                                        |         |  |
|     | -                                                                                        | Dielectric strength, min. kV                               |         |  |
|     | -                                                                                        | PCB Content.                                               |         |  |
|     | -                                                                                        | Acidity, max. mg KOH/g.                                    |         |  |

|           |                                                                                                     |                     |                     |
|-----------|-----------------------------------------------------------------------------------------------------|---------------------|---------------------|
| <b>D.</b> | <b>Insulator</b>                                                                                    |                     |                     |
| 1.        | Manufacturer's name & address.<br>(Attach Manufacturer's catalogue and outline/dimensional drawing) |                     |                     |
| 2.        | Type of Insulator.                                                                                  |                     |                     |
| 3.        | Type tests (Attach copy of type test reports)                                                       |                     |                     |
| 4.        | <b>Details of Type Tests if performed.</b>                                                          | <b>Date of Test</b> | <b>Name of Lab.</b> |
|           | - Mechanical test.                                                                                  |                     |                     |
|           | - Impulse withstand voltage.                                                                        |                     |                     |
|           | - Power frequency withstand voltage.                                                                |                     |                     |
|           | - Radio interference Voltage.                                                                       |                     |                     |
| 5.        | Diameter of insulator.                                                                              | Mm                  |                     |
| 6.        | Height of Insulator                                                                                 |                     |                     |
| 7.        | Creepage distance (Phase to Earth).                                                                 | Mm                  |                     |
| 8.        | Phase to phase clearance.                                                                           | Mm                  |                     |
| 9.        | Max RIV at 1 MHz.                                                                                   | μV                  |                     |
| 10.       | Impulse withstand voltage.                                                                          | kV                  |                     |
| 11.       | Power frequency withstand test voltage.                                                             |                     |                     |
|           | a. Dry 1 minute.                                                                                    | kV                  |                     |
|           | b. Wet 10 sec.                                                                                      | kV                  |                     |
| 12.       | Ultimate strength of column.                                                                        | Kg                  |                     |
| 13.       | Withstand Pressure:                                                                                 |                     |                     |
|           | a. Cantilever Strength                                                                              | N                   |                     |
|           | b. Tensile strength.                                                                                | N                   |                     |
|           | c. Torsional strength                                                                               | N                   |                     |
|           | d. Compression strength.                                                                            | N                   |                     |
|           | e. Bending.                                                                                         | N                   |                     |
| 14.       | Material and color of insulator.                                                                    |                     |                     |
| 15.       | Reference Manufacturing IEC Standard of insulator.                                                  |                     |                     |
| <b>E.</b> | <b>Steel Supporting Structure</b>                                                                   |                     |                     |
| 1.        | Manufacturer's name & address.<br>(Attach drawing/photograph of the support structure).             |                     |                     |

|           |                                                                                |                    |  |
|-----------|--------------------------------------------------------------------------------|--------------------|--|
| 2.        | Dimensions for steel support structure:                                        |                    |  |
|           | Height.                                                                        | Mm                 |  |
|           | Breadth.                                                                       | Mm                 |  |
|           | Width.                                                                         | Mm                 |  |
|           | Structure fixing foundation details.                                           |                    |  |
| 3.        | Tensile Strength of Angles/plates.                                             | Kg/mm <sup>2</sup> |  |
| 4.        | Tensile Strength of Nuts & Bolts.                                              | Kg/mm <sup>2</sup> |  |
| 5.        | Elongation.                                                                    | %                  |  |
| 6.        | Weight of Zinc Coating of angles/nuts & bolts.                                 |                    |  |
| 7.        | Thickness of zinc coating angles/nuts & bolts                                  |                    |  |
| 8.        | Hardness of nuts & bolts.                                                      | HB                 |  |
| 9.        | Designed soil bearing capacity.                                                |                    |  |
| 10.       | Seismic withstand stress/magnitude.<br>(Attach design calculations).           |                    |  |
| 11.       | Total weight of supporting steel structure with<br>foundation bolts.           | Kg                 |  |
| <b>F.</b> | <b>Terminal</b>                                                                |                    |  |
| 1.        | Manufacturer's name & address.<br>(Attach drawing/photograph of the terminal). |                    |  |
| 2.        | Material of primary terminals.                                                 |                    |  |
| 3.        | Size of primary terminals.                                                     |                    |  |
| 4.        | Current carrying capacity of primary terminals.                                | A                  |  |
| 5.        | Static withstand load of primary terminals                                     | Kg                 |  |
| 6.        | Dynamic withstand load of primary terminals                                    | Kg                 |  |
| 7.        | Whether brass cable glands are provided in the<br>secondary terminal box.      | Yes/No             |  |
| 8.        | Material of secondary terminals.                                               |                    |  |
| 9.        | Whether two earthing terminals are provided.                                   | Yes/No             |  |
| 10.       | Material of earthing terminal.                                                 |                    |  |

|           |                                                                             |                     |                     |
|-----------|-----------------------------------------------------------------------------|---------------------|---------------------|
| <b>G.</b> | <b>Terminal Connector</b>                                                   |                     |                     |
| 1.        | Manufacturer's name & address.<br>(Attach drawing/photograph with the bid). |                     |                     |
| 2.        | Type designation of connector                                               |                     |                     |
| 3.        | Type tests (Attach copy of type test reports).                              |                     |                     |
| 4.        | Details of Type Tests if performed.                                         | <b>Date of Test</b> | <b>Name of Lab.</b> |
|           | - Tensile strength & elongation.                                            |                     |                     |
|           | - Brinell hardness.                                                         |                     |                     |
|           | - Conductivity.                                                             |                     |                     |
|           | - Short circuit withstand.                                                  |                     |                     |
| 5.        | Material of connector                                                       |                     |                     |
| 6.        | Material of keeper.                                                         |                     |                     |
| 7.        | Current carrying capacity of connector.                                     | A                   |                     |
| 8.        | Tensile Strength of connector.                                              | Kg/mm <sup>2</sup>  |                     |
| 9.        | Tensile Strength of keeper.                                                 | Kg/mm <sup>2</sup>  |                     |
| 10.       | Hardness of connector.                                                      | HB                  |                     |
| 11.       | Hardness of keeper.                                                         | HB                  |                     |
| 12.       | Elongation of connector.                                                    | %                   |                     |
| 13.       | Elongation of keeper.                                                       | %                   |                     |
| 14.       | Electrical conductivity of connector.                                       | %                   |                     |
| 15.       | Electrical conductivity of keeper.                                          | %                   |                     |
| 16.       | Short Circuit Rating of connector.                                          | kA                  |                     |
| 17.       | Short Circuit Rating of keeper.                                             | kA                  |                     |
| 18.       | Material of Nuts & Bolts.                                                   |                     |                     |
| 19.       | Tensile Strength of Nuts & Bolts.                                           | Kg/mm <sup>2</sup>  |                     |
| 20.       | Brinell Hardness of Nuts & Bolts.                                           | HB                  |                     |

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ALUMINIUM ALLOY

| TYPE DESIGNATION | A       | B       |
|------------------|---------|---------|
| OMA              | 20 - 26 | 30 - 40 |
| OMH              | 28 - 32 | 30 - 40 |
| OMC              | 30 - 38 | 30 - 40 |

**NOTES.**

- 1 - ALL DIMENSIONS ARE IN MILLIMETERS.
- 2 - BODY MANUFACTURED IN ALUMINIUM ALLOY.
- 3 - THIS DRAWING IS FOR GUIDANCE ONLY.

| NATIONAL TRANSMISSION AND DISPATCH COMPANY        |                                                |                |              | DESIGN<br>DEPT. (NTDC) |                                                                      |
|---------------------------------------------------|------------------------------------------------|----------------|--------------|------------------------|----------------------------------------------------------------------|
| <b>REVISIONS</b>                                  | REVISED ON: 01-01-2011                         | TRACED         | S. M. ASHRAF | Z. Anjum               | <b>STRAIGHT<br/>MONOMETALIC CONNECTOR<br/>(BOLTED TYPE)</b>          |
| 1 - TITLE CHANGED FROM WAPDA TO NTDC.             | PERVAZ IQBAL<br>MANAGER DESIGN<br>(S&R)        | CHECKED        | GHILAN RASUL | Hamid                  |                                                                      |
| 2 - TYPE DESIGNATION CHANGED AS OMA, OMH AND OMC. | NAZAR ABBAS<br>CHIEF ENGINEER<br>DESIGN (NTDC) | DESIGNED       | A. HAMEED    | Hamid                  |                                                                      |
|                                                   |                                                | DIRECTOR       | A.M. KAZHI   | Hamid                  |                                                                      |
|                                                   |                                                | CHIEF ENGINEER | JAVID AMTAR  |                        | SCALE : N. T. S.      DATE: _____<br><b>DWG. NO. PDW/DF - 300(1)</b> |

