#### STANDARD PARAMETER OF 800 KV CLASS TRANSMISSION SYSTEM IN INDIA

## **PREFACE**

Earlier in the year 1990 Central Electricity Authority (CEA) brought out a report detailing parameters of the 800 kV class equipment and transmission line material based on the recommendations of Working Groups constituted following the decision of Government of India to select 800 kV (with 765 kV as the nominal voltage) as the next higher AC Transmission voltage in the country. Following this, a good number of lines were identified at this voltage. Though some of these lines have been installed maintaining 800 kV class parameters, they are being operated at 400 kV level for want of adequate power development. Accordingly associated substations continue to be at 400 kV level.

But with the initiative taken to have electricity for all by the year 2012, coinciding with the end of 11<sup>th</sup> five-year plan, now it is a near-reality to charge the above mentioned lines at 765 kV and construct few more intra-regional and interregional lines at that level with a dozen or so number of substations. Keeping this in mind and the progress that has been further made and as experienced in few countries that have this class of transmission system, it was felt necessary to revive the Standing EHV Committee of CEA with representations from leading power utilities and manufacturers in the country. As per order of Ministry of Power it was reconstituted in the year 2000. A few meetings took place for revising the salient parameters of 800 kV class of equipment and transmission material and reviewing those for 400 kV level through separate groups. The present report is an outcome of the deliberations in the meetings and inputs received from the members concerned. It is expected that the contents would serve power utilities as the basis of design and engineering of 800 kV transmission system in the country.

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#### BASIC SYSTEM PARAMETERS OF 800 KV SYSTEMS

1. Rated voltage kV: 800

2. Nominal Voltage kV: 765

3. Rated frequency Hz: 50

4. System Neutral Earthing : Effectively earthed

5. Rated current A: 2000

6. Short circuit current and duration kA: 40 for one second

7. Creepage distance

| Pollution site severity | Specific creepage distance mm/kV* |
|-------------------------|-----------------------------------|
| Low                     | 16                                |
| Medium                  | 20                                |
| Heavy                   | 25                                |
| Very Heavy              | 31                                |

<sup>\*</sup> These are the values suggested in IEC- 815, 1986, which is applicable to System Voltage of up to 525kV. As the pollution withstand characteristics is known to be non-linear for higher voltages, requiring increased creepage distance in

proportion to the non-linearity factor. Studies by ENEL, EPRI, CIGRE suggest that this factor may be as high as 20% for 800 kV System. Hence creepage distances presented in the Table are to be appropriately increased. Further, these values may not be suitable for station insulation since the influence of diameter is considerable on the pollution performance.

## 8. Insulation Levels

# a) Substation equipment

| Reactors/ | CBs/Isolators/CVTs/CTs | Transformers |
|-----------|------------------------|--------------|
|           |                        |              |

| Basic Insulation level | kV(peak) 1950    | 0         | 2400       |
|------------------------|------------------|-----------|------------|
| Basic switching level  | kV(peak) 1550    | )         | 1550       |
| Power frequency        | kV (rms) -       |           | 830        |
| RIV at 508 kV rms      | Micro -<br>volts |           | 1000(Max.) |
| b) Transmission lines  | voits            |           |            |
| Basic Insulation level | kV(peak)         | 2400      |            |
| Basic Switching level  | kV(peak)         | 1550      |            |
| Power frequency        | kV(rms)          | 830       |            |
| RIV at 508 kV (rms)    | Micro volts      | 500(Max.) |            |

## **TRANSFORMER**

## **Generator Transformers**

# 1. Ratings:

| Three phase rating MVA(Generally Single phase units are envisaged) | Voltage<br>ratio | Tapping range percent   | Percent<br>Impedance<br>Voltage           | Cooling  |
|--|------------------|---|---|--|
| 630 MVA,800<br>MVA   | 21/765           | A-off ckt<br>taps/links<br>+2<br>-6<br>(8 steps)<br>alternatively<br>B-On load taps<br>+2<br>-6<br>(16 steps) | 15.0<br>(tolerance<br>allowed<br>= + 10%) | ONAN/OFAF<br>or<br>OFAF or OFWF<br>or<br>ONAN/ODAF or<br>ODAF/ODWF |

Maximum flux density in any part of core and yoke at rated MVA, voltage and frequency.

tesla : 1.9

Withstand capability for 25% minutes : above the rated voltage

Withstand capability for 40% seconds: 5

above rated voltage

2. Connections: HV Star, Neutral effectively earthed

LV Delta

3. Connection symbol : YN, dll (in 3 phase bank)

4. Terminals:

a) LV Terminals

36 kV, 12500 amps. oil filled type bushing mounted on turrets, suitable for connections to bus bars in isolated phase bus ducts which shall have spacing of 1500 mm for each 210 MVA single-phase unit of the 630 MVA three phase bank.

1

For each of 266.6 MVA single phase unit of 800 MVA, 3 phase bank, 2 Nos. 36 kV, 12500 Amp bushings per termination shall be used (Total 4 Nos. bushings).

# b) HV Terminal line end:

800 kV oil filled 1250 amps. condenser bushing with test tap. No arcing horns shall be provided.

Neutral ends: 36 kV porcelain bushing. No arcing horns shall be provided.

## **Auto Transformers**

## 1. Ratings

| Three phase rating | Voltage        | Tapping                     | Percent<br>Voltage | Impeda | nce  | Cooling                                  |
|--------------------|----------------|-----------------------------|--------------------|--------|------|--|
| HV/IV/LV           | ratio          | range percent               | HV                 | HV     | IV   |  |
| MVA                | ratio          | range percent               | IV                 | LV     | LV   |  |
| 315/315/105        | 765/220/<br>33 | + 4.5%<br>-7.5%<br>24 steps | 12.5               | 40     | 25   | ONAN/OFAF<br>or ONAN/<br>ODAF or<br>ODAF |
|                    |                | +4.5 %                      |                    |        |      |  |
| 630/630/210        | 765/400/33     | -7.5%                       | 12.5               | 60     | 40   | -do-                                     |
|                    |                | 24 steps                    |                    |        |      |  |
| 800/800/266.6      |                | -do-                        | -do-               | -do-   | -do- | -do-                                     |
| 1000/1000/333.3    | 765/400/<br>33 | +4.5%<br>-7.5%<br>24 steps  | 14.0               | 65     | 45   | -do-                                     |
|                    | tolerance      | ±10% ±15%                   | ±15%               | ó      |      |  |

Max. flux density in any part of core and

yoke at rated MVA, voltage and frequency

tesla : 1.9

Withstand capability for 25% above the

rated voltage

minutes:

Withstand capability for 40% above the

rated voltage.

seconds: 5

2. Connection: HV/IV Star auto with neutral effectively earthed

LV-Delta

3. Connection Symbol: YNa0, dll

4. Short Circuit Level:

800 kV 40 kA (rms) for 1 second

420 kV 40 and 63 kA(rms) for 1 second

245 kV 40 kA (rms) for 1 second

5. Terminals:

a) LV Terminals 52 kV oil filled condenser bushings. The bushings shall be arranged in a line with 1000 mm spacing to allow mounting of

to phase barriers. No arcing horns shall be provided.

b) IV terminal 245/420 kV oil filled condenser bushings with test tap. No

arcing horns shall be provided.

c) HV Terminal 800 kV oil filled condenser bushing with test tap. No

Line end arcing horns shall be provided.

36 kV porcelain bushing. No arcing horns shall be provided. Neutral end

#### **Insulation Levels:**

Lightning, switching Impulse and Power frequency voltage level.

| Highest voltage<br>for equipment.<br>Um kV (rms) | Rated withstand lightning | Impulse voltage switching (kV peak) | Rated power frequency<br>short duration withstand<br>voltage kV(rms)<br>kV(peak) |
|--|---------------------------|-------------------------------------|--|
| 17.5(Neutral)                                    | 95                        | -                                   | 38   |
| 24(LV of GTs)                                    | 125                       | -                                   | 50   |
| 52 (LV of Auto Transformer)                      | 250                       | -                                   | 95   |
| 245  | 950                       | -                                   | 395  |
| 420  | 1300                      | 1050                                | -  |
| 800  | 1950                      | 1550                                | -  |

phase

In the event when transferred surges are higher than 250 (kV peak) the insulation level of tertiary winding and bushing are to be chosen accordingly.

# Partial discharge

#### **BUSHINGS:**

1) The voltage and current ratings, basic insulation level and creepage distance of the bushings shall be as follows:

| Voltage<br>Ratingk<br>V(rms) | Current<br>Rating<br>(Amp) | Creepage Dist  | tance Basic Impulse Le (peak) | vel kV Switching Impulse Level kV(peak) |
|------------------------------|----------------------------|----------------|-------------------------------|---|
| 800                          | 1250                       | 16,000         | 2100                          | 1550                                    |
| 420                          | 1250<br>2000               | 10,500         | 1425                          | 1025                                    |
| 245                          | 1250                       | 6,125          | 1025                          | -                                       |
| 52                           | 2000<br>5000               | 1,800          | 250                           | -                                       |
| 2) RIV at                    | 508 kV (rms)               | micro volts    | :                             | 1000 (Max.)                             |
| 3) Coron                     | a Extinction vo            | ltage kV(rms)  | :                             | 508 (Min.)                              |
| 4) Partial                   | discharge leve             | l pico coloumb | s :                           | 500 (Max.)                              |

### **CIRCUIT BREAKERS**

Type : SF6
 Installation : Outdoor
 No. of poles : 3

4. No. of trip circuits : 2 (independent)

5. Rated short circuit making current. kA peak : 100

6. Value of pre-insertion : 450 To limit switching surge resistor ohm over voltage to 1.9 p.u.

7. Pre- insertion time ms : 10

8. Rated operating duty cycle : 0-.3 second-CO-3 min.-CO

9. Rated break time ms : 40
10. Closing time ms : 100
11. Difference in the instants of eneming of

11. Difference in the instants of opening of contacts

- within a pole ms : 2.5 - between poles ms : 3.33

12. Difference in the instants of closing of contacts between poles ms : 10

13. Rated line charging current

|     |                            | pu (kA)     |         | 99                           | <b>g</b>               |
|-----|----------------------------|-------------|---------|------------------------------|------------------------|
|     |                            | No shunt    | reactor | With one of the two          | Both shunt reactors    |
|     |                            | in the line |         | shunt reactors failed        | in service             |
| 1   | 100                        | 0.262       |         | 0.197                        | 0.131                  |
| 2   | 150                        | 0.393       |         | 0.295                        | 0.197                  |
| 3   | 200                        | 0.542       |         | 0.393                        | 0.262                  |
| 4   | 250                        | 0.655       |         | 0.491                        | 0.328                  |
| 5   | 300                        | 0.786       |         | 0.590                        | 0.393                  |
| 6   | 350                        | 0.917       |         | 0.688                        | 0.459                  |
| 1.4 | Small inductive current    |             | :       | 0.5 A to 10 A without        |                        |
| 14. | Small inductive current    |             |         | switching over voltage       | exceeding 1.9 p.u.     |
|     |                            |             | :       | Pneumatic or hydraulic       | spring charged         |
| 15. | Type of operating mechanis | sm          | or      | combination of these         | 2.                     |
|     |                            |             |         | Anti pumping and trip fre    | ee                     |
| 16. | First pole to clear factor |             | :       | 1.3                          |                        |
| 17. | Type of auto reclosing     |             | :       | Single phase and 3-Phase     | se.                    |
|     |                            |             | :       | 10 NO and 10 NC on e         | ach pole,              |
|     |                            |             | exc     | lusively for purchaser's u   | se.Continuous          |
| 18. | No. of auxiliary contacts  |             | cur     | rent 10 A DC. Breaking ca    | apacity shall be 2     |
| 10. | No. of auxiliary contacts  |             | Am      | np. min. with circuit time c | constant not less than |
|     |                            |             | 20 1    | ms at 220 V DC. Contacts     | s should be            |
|     |                            |             | rev     | ersible type at site.        |                        |
|     |                            |             |         |                              |                        |

## **DISCONNECTS/EARTHING SWITCHES**

Typical Line Charging current at bus voltage of

1.4

Type of disconnect Vertical Break

2. No. of poles 3

3. Installation Outdoor

4. Rated peak withstand current kA 100

Rated magnetising current/ capacitive breaking & making

current.

Sl.No.

Line Length(km)

Type of operating mechanism

0.7

Electrical/Manual

### **INSTRUMENT TRANSFORMERS**

## **Current Transformers**

Rated primary currents A : 2000

A : Rated secondary current 1

Number of cores 5

4. Rated continuous thermal 120%

current.

| 5. Parameter  | Core I<br>Line/                    | Core II<br>Line/                    | Core III                | Core IV               | Core V          |
|---|------------------------------------|-------------------------------------|-------------------------|-----------------------|-----------------|
| Utilistation  | Equipment<br>Protection<br>Main- I | Equipment<br>Protection<br>Main- II | Metering                | Bus bar<br>Protection | Bus bar         |
| Transformation ratio                                  | 2000-<br>1000-<br>500/1            | 2000-<br>1000-<br>500/1             | 2000-<br>1000-<br>500/1 | 2000-<br>1000/1       | 2000-<br>1000/1 |
| Accuracy Class  | PS                                 | PS                                  | 0.2<br>ISF <10          | PS                    | PS              |
| Rated Burden  | -                                  | -                                   | 15 VA                   |                       |                 |
| Min.knee point  | 4000-                              | 4000-                               |                         | 2000-                 | 2000-           |
| voltage   | 2000-                              | 2000-                               | -                       | 1000                  | 1000            |
| $V_{k}$   | 1000 volts                         | 1000 volts                          |                         | volts                 | volts           |
| Maximum Exciting<br>Current at Rated V <sub>k/2</sub> | 10-50-100<br>mA                    | 25-50-100<br>mA                     | -                       | 25-50<br>mA           | 25-50<br>mA     |
| Maximum Secondary                                     | 15-5-2.5                           | 10-5-2.5                            |                         | 10-5                  | 10-5            |
| Winding Resistance.                                   | ohm                                | ohm                                 | _                       | ohm                   | ohm             |

## Data for TPY/TPX Core(Alternative to Core I & Core II)

i) Duty cycle : Single/Double energization CO/CO-t-CO

ii) Ratio applicable : 2000/1A

iii) Rated symmetrical short circuit current factor : 20 iv) Rated primary time constant. ms : 80

v) Duration for flow of current

Single energistation ms : 240 for CO duty

Double energisation ms : 100 & 40 for CO-t-CO duty

vi) Time interval between two successive short circuit current. ms : 1000

vii) Rated burden ohm : 7.5

# Bushing CTs Not yet finalised.

# **Capacitor Voltage Transformers**

1. Number of secondary windings : 3

2. Rated secondary voltage, burden, accuracy and utilisation

| Winding | Rated Voltage Volt | Rated burden VA | Accuracy | Purpose               |
|---------|--------------------|-----------------|----------|-----------------------|
| I       | 110 /v3            | 50              | 3P       | Main I<br>Protection  |
| II      | 110 /v3            | 50              | 3P       | Main II<br>Protection |
| III     | 110 /v3            | 50              | 0.2      | Metering.             |

4. Voltage factor

5. Rated Capacitance pF

Stray conductance of the low Voltage terminal over entire carrier frequency range micro-Siemens

7. Corona extinction voltage kV(rms)

Partial discharge level at 508 kV(rms)

Pico coulombs

# **Protection Schemes**

### **Line Protection**

1) Main I

Carrier aided distance protection suitable for use with different carrier modes.

2) Main II

> Carrier aided protection based on directional comparison using wave detection or phase comparison principles.

3) Directional Earth fault Scheme

> Two sets of directional earth fault relays, one for each main protection to cover high resistance faults.

Over-voltage Protection 4)

> The relay to have two stages and shall be able to monitor phase to neutral voltage for all the three phases.

#### **Auto Transformer Protection**

- 1) **Differential Protection** (Percentage Biased)
- High impedance differential protection 2)
- 3) Over fluxing protection.
- 4) Back-up directional over current protection.
- Overload protection. 5)
- 6) Neutral standby earth protection
- 7) Delta circulating current protection.

#### **Shunt Reactor Protection**

1.5 for 30 seconds

4400

50

508(Min.)

Less than 10

- 1) Differential protection
- 2) Restricted earthfault protection
- 3) Back-up protection

#### **Bus Bar Protection**

High speed differential protection with features for checking the security as required.

Circuit Breaker Failure Protection

In the event of circuit breaker failure, all circuit breakers connected to the Bus Section to which the fault circuit breaker is connected shall be tripped with minimum possible time delay.

### **Other Equipments**

## a) Distance to Fault Locator

Distance to Fault Locator shall be installed for identifying the location of faults and for taking preventive measures against fault prone areas.

## b) Disturbance Recording Equipment

i) Disturbance Recorder

Disturbance Recorder shall be micro-processor based and shall be used to record the graphic form of instantaneous value of voltage and current in all three phases, open delta voltage and neutral current, open or closed positions of relay contacts and breaker during the system disturbance condition.

ii) Event Logging Equipment

The Event Logger is recommended to record the status of 800 kV Switchyard equipment and relays and occurances of alarms. It shall be possible to accommodate about upto 500 points. Whenever input status change occurs, an immediate printed record would be provided by the equipment.

#### POWER LINE CARRIER COMMUNICATION

### A. Coupling Devices.

1. Method of coupling : Phase to phase/3-phase coupling

Nominal line side Impedance ohms
480 (phase to phase)
Nominal equipment side
150 (balanced)

Impedance ohms : 75(unbalanced)

4. Bandwidth kHz : 50-150

B. Line Traps

Rated inductance at system 1. 1 frequency mH

2. Blocking resistance 430 ohms kHz

50-150 3. Rated Bandwidth Radio Interference Voltage at 508 4.

kV(rms) Micro volts

Nominal discharge current 5.

of protective device connected 10

across main coil kA

C. **PLC** Terminal

1. Carrier frequency range kHz 50-500

2. Carrier frequency band kHz 4.0/2.5 or integral multiple thereof

500(Max.)

Nominal Impedance at carrier 3. 75 (unbalanced) frequency output ohms

Return loss within the nominal 4. Not less than 10

carrier frequency band.

Peak envelope power W 5. Upto 80

Speech frequency band 300-2000 or 300-2400 6. Hz

7. Speech levels

Four wire transmit

Four wire receive +8 dB -3.5 dB

Two wire transmit 0 dBTwo wire receive 7 dB

D. VF Protection Signalling

Transmission time : 20 (max.) 1. msec 2.

PLC Channel No.1 Speech + data

Protection 1 + 3. PLC Channel No.2 Express speech

4. PLC Channel No.3 Protection 2 5. : Protection 3 PLC Channel No.4

E. Coupling Capacitors

1. Installation Outdoor

Pico Farad 2. Rated capacitance 8800

Switching Impulse 3.

1550 withstand voltage kV(peak)

Voltage factor 1.5 for 30 secs. 4.

5. Equivalent series resistance

> over the entire carrier less than 40

frequency range. Ohms

6. Radio Interference 2500 (max.)

voltage at

508 kV(rms) Micro volts

7. Partial discharge

level Pico Couloumbs : Less than 10

8. Corona extinction voltage kV(rms) : 508 (Min.)

#### **SURGE ARRESTERS**

| 1. | Type Arrester                      |          | : Gapless (Metal<br>Oxide) |
|----|------------------------------------|----------|----------------------------|
| 2. | Nominal discharge current          | kA       | : 20                       |
| 3. | Rated Arrester voltage             | kV(rms)  | : 624                      |
| 4. | Continuous operating voltage       | kV(rms)  | : 485                      |
| 5. | Maximum residual voltage           | ( ( )    |                            |
|    | at lighting impulse                |          | : 1430                     |
|    | current of 20 KA                   | kV(peak) |                            |
| 6. | Maximum switching impulse          | 4 /      | 1200                       |
|    | residual voltage at 2 kA           | kV(peak) | : 1280                     |
| 7. | Maximum steep current              | 4        |                            |
|    | impulse residual voltage           |          | : 1630                     |
|    | at 20 kA                           | kV(peak) |                            |
| 8. | Dynamic over voltage               | -        |                            |
|    | withstand capability               |          |                            |
|    | for 3 peaks                        |          |                            |
|    | 0.3 sec.                           | kV(peak) | 1240                       |
|    | 0.1 sec.                           | kV(peak) | : 1045                     |
|    | 1.0 sec.                           | kV(peak) | : 920                      |
|    | 10.0 sec.                          | kV(peak) | : 865                      |
| 9. | Discharge capability               |          |                            |
|    | A- Transmission line class         |          | : 4                        |
|    | B- Minimum energy capability       | kj/kV    | : 28                       |
| NO | TE:- This energy takes into accord |          |                            |
|    | occurence of two succes            | ssive    |                            |
|    | line discharges followed           | ~        |                            |
|    | TOV profile as given at            |          |                            |
|    | Sl.No.(8).                         |          |                            |

## SWITCHYARD LAYOUT

pico-

: Double bus Double breaker. Depending on the requirement of purchaser, one and a half breaker scheme can also be adopted. However, the bays arrangements shall be so selected that the rated current of 2000 A for different equipments is not exceeded under any contingency.

250/50

coloumbs

10. Maximum radio interference/

partial discharge at 508 kV (rms) micro volts/

2. Clearance (Minimum)

Phase to earth m : 6.4
Phase to Phase m : 10.0
Section clearance m : 10.0

3. Bay details

i) Bay width m : 45

ii) Bus size (Tentative)

a) Rigid bus/equipment : 6" IPS tubular Aluminium pipe

Inter connecting bus

b) Strung bus/Crossover bus : Quad All Aluminium Tarantulla

iii) Bay Dimensions

Low level High level (Above ground) (Above ground) (Meters) (Meters) Bus level 27 12 Equipment Interconnecting level 12 12 27 Crossover bus level 39 15 90 Span length (Rigid bus)

TRANSMISSION LINE

#### Conductor:

1. Code Name : ACSR Bersimis

Number of sub-conductor /phaseSpacing between conductorsmm450

4. Bundle arrangement : Horizontal Square

5. Nominal Aluminium area sq.mm : 690

6. Stranding and Wire Diameter : 42/4.57 mm Al + 7/2.54 mm St.

7. Overall Diameter : 35.04 mm 8. Approximate mass kg/km : 2187 9. Ultimate Tensile strength kN 146.87 D.C. Resistance at 20° C 10. 0.04242 ohms/km

11. Corona extinction kV(rms)

voltage phase to ground

12. Modulus of Elasticity kg/cm<sup>2</sup> : 0.6320 x 10<sup>6</sup>

13. Coefficient of linear expansion per degree C : 21.5 x 10<sup>-6</sup>

4 Maximum allowable temperature degree C : 95

#### **Earthwire:**

1. Size : 7/3.66 mm G.S.S. wire of 95 Kgf/ sq.mm (1GPa) quality

560

2. Number of earthwire: 23. Overall Diametermm: 10.984. Quality of groundwirekgf/sq.mm: 955. Ultimate Tensile strengthkgs.: 6972

D.C. Resistance at 20° C ohms/km 2.5

7. Shield angle for towers

15° (i) Outer phase

The middle phase shall fall below the circle drawn with (ii) Middle phase

twoground wire points as diameter.

kg/cm<sup>2</sup>  $: 1.933 \times 10^6$ 8. Modulus of Elasticity 9. Coefficient of linear expansion per degree C : 11.5 x 10 <sup>-6</sup>

degree C 10. Maximum allowable temperature : 53

## Disc Insulators and Insulator Strings:

| Insulator strings   | Suspension string                 | Tension string                    | Pilot string         |
|---|-----------------------------------|-----------------------------------|----------------------|
| 1. Configuration  | V-90°                             | Quadruple 4 strings in parallel   | Single I             |
| 2. Number of discs per  |                                   | -                                 |                      |
| string(Size 280x170 mm, EMS=210 KN creepage distance= 370 mm)   | 2 x 35<br>(Each limb<br>35 discs) | 4 x 35<br>(Each limb<br>35 discs) | 1 x 35<br>(35 discs) |
| <ul> <li>3. No deformation load (67% of mechanical failing load of 210 KN)</li> <li>4. Maximum voltage across any disc</li> </ul> | 2 x 140 KN                        | 4 x 140 KN                        | 1 x 140 KN           |

across any disc

Not more than 25 kV(rms) across any disc

phase to ground

voltage of 462 kV(rms)

#### **Towers:**

1. Number of circuit Single circuit 2. Configuration Horizontal 3. 400

Normal span m

4. Wind span 1.0 x normal span (For plain terrain)

5. Weight span:

i) Suspension tower, max. 1.5 x Normal span

> 0.8 x Normal span (for plain terrain) min.

(For hilly terrain, the minimum weight span be fixed suitably).

2 x Normal span ii) Angle tower, Downward Upward 200 m Net span

6. Maximum temperature of current carrying power

conductor exposed to sun

95°C

Maximum temperature of 7. groundwire exposed to sun

53 ° C

8. Clearances: i) Minimum ground clearances as per Indian Electricity rules.
i) As per interference

12,400

mm

ii) limitations

mm

15,500

Live conductor to iii) grounded metal

|                                | Swing | Clearance |
|--------------------------------|-------|-----------|
| 'V' Suspension string (V- 90°) | Nil   | 5,000 mm  |
| 'I' Suspension string          |       |           |
| Zone I & II                    | Nil   | 5,100 mm  |
|                                | 22°   | 4,400 mm  |
|                                | 45°   | 1,300 mm  |
| Zone III & IV                  | Nil   | 5,100 mm  |
|                                | 27°   | 4,400 mm  |
|                                | 55°   | 1,300 mm  |
| Zone V & VI                    | Nil   | 5,100 mm  |
|                                | 30°   | 4,400 mm  |
|                                | 60°   | 1,300 mm  |

# Quadruple tension string

Jumper

| Zone I & II   | Nil<br>15°<br>30° | 5,100 mm<br>4,400 mm<br>1,300 mm |       |    |
|---------------|-------------------|----------------------------------|-------|----|
| Zone III & IV | Nil<br>20°<br>40° | 5,100 mm<br>4,400 mm<br>1,300 mm |       |    |
| Zone V & VI   | Nil<br>22°<br>45° | 5,100 mm<br>4,400 mm<br>1,300 mm |       |    |
| Pilot string  | 20°               | Nil<br>4,400 mm                  | 5,100 | mm |

Mid span separation iv) 12,400 mm:

For ground undulation, v) 300 mm

extra over ground

clearance

vi) Creep compensation for conductor through tensioning at the time of stringing Height of tower may be increased instead of considering reduction in temperature

over

9) Loadings:

Loadings shall be determined for the two loading combinations including wind on tower as given below:

- Combination I

As per IS: 802 -Part I-1995

- Combination II

#### SHUNT REACTORS

1. Rating (single phase) MVAR : 50, 80, 110 in three phase banks.

2. Winding connection : S

3. Neutral earthing : Earthed through Neutral Grounding Reactor.

: Linear upto 1.4 p.u.

4. Magnetisation characteristic : Slope of the characteristic in the saturated region

shall be 0.3 to 0.5.

5800

among single phase reactors of a  $\pm 2$ 

three phase bank.

Permissible unbalance current %

6. Ratio of zero sequence reactance to positive sequence reactance. : 1.0 (single phase)

7. Noise level at rated voltage dB : 81 for 50 MVAR 83 for 80 MVAR

mm

and frequency 85 for 110 MVAR

8. Clearances of terminals in air (phase to earth)

air (phase to earth)

9. Type of cooling : ONAN

10. Type of cooling medium

: Mineral oil to IS:335 (and as standardised for 800kV Power Transformers)

11. Terminals

Line Terminals : 800 kV oil filled condenser bushing with test

tap. No arcing horns shall be provided

Neutral Terminal : 145 kV oil filled condenser oil/ SF<sub>6</sub> bushing

#### 145 kV NEUTRAL GROUNDING REACTOR FOR GROUNDING SHUNT REACTOR.

1. Number of phases : 1 2. Maximum continuous current A(rms) : 15

3. Short time current Rating A(rms) To be specified by purchaser after system studies.

4. Rated Impedance ohms ) To be specified by purchaser after system studies.

5. Magnetisation characteristics : Linear upto short time current.

6. Terminals

a) Line end : 145 kV condenser bushing (as standardised for

neutral of 800 kV shunt reactor)

b) Earth end : 36 kV porcelain bushing

7. Type of cooling : ONAN

8. Type of cooling Medium : Mineral oil to IS:335 (and asstandardized for

"800 kV Power Transformers")

9. Phase to earth air clearances

a) Line end mm : 1050 b) Neutral end mm : 230

10. Insulation levels

a) Lightning impulse kV(peak)

voltage withstand of the

line terminal : 550

b) One minute power frequency kV(rms) : 38

voltage withstand of the

earth terminals.

11. Whether full or graded insulation. : Graded insulation

#### **SHUNT REACTOR**

# (Connected to tertiary of power transformer to provide back-up reactive compensation)

Rated voltage
 Number of phases
 kV
 36
 3

3. Rating (three phase) MVAR : 31.5, 50, 63, 80

4. Winding connection : Star with neutral left inside.

5. Whether full or graded insulation : Full insulation

6. Basic insulation level (for line and neutral end of winding and

bushings)

a) 1.2/50 microsecond : 250

lightning impulse

withstand voltage kV(peak)

b) One minute power frequency : 95

withstand voltage kV(rms)

7. Magnetisation characteristic : Linear upto 1.3 p.u. voltage

3. Minimum clearance in air

Phase-phase mm : 530 Phase-earth mm : 480

74 for 31.5 MVAR

9. Noise level at rated dB 75 for 50 MVAR voltage and frequency. 77 for 63 MVAR

77 for 80 MVAR

10. Terminals : 52 kV, 800/2000 A oil filled condenser bushing with

a) Line Terminals

11. Type of cooling

12. Type of cooling medium

test tap. No arcing horn shall be provided.

: ONAN with tank mounted or separately mounted radiator bank.

: Mineral oil to IS:335(and as standardised for 800 kV Power Transformers).

### INTERFERENCE LEVELS

#### **Transmission Lines**

- 1. RI should not exceed 50 dB for 80% of the time duration during the year.
- 2. TVI- The minimum signal to noise ratio should be 30.
- 3. Audio noise level for 800 kV system should be less than 55 dB(A).
- 4. Electrostatic field should be less that 10 kV/m below the outermost phase (2 m above the ground) and less than 2 kV/m at the edge of the right of way(45 m).

## PTCC:

- 1. Maximum value of induced electromagnetic voltage for fault duration of equal to or less than 200 ms.
  - volts 650
- 2. Maximum value of induced noise(noise interference) to be taken cognizance if noise is persistent).

Micro volts - 2000 (measured)