BHARAT HEAVY ELECTRICALS LIMITED

TRANSMISSION BUSINESS ENGINEERING MANAGEMENT

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TITLE		NAME		RJ	MK	AG
	400kV AC CIRCUIT BREAKER	DATE		10/06/11	10/06/11	10/06/11
		GROUP		TBEM	W.O. No	80014

CUSTOMER	Power Grid Corporation of India Ltd
PROJECT	±800kV, 6000MW, HVDC MULTI-TERMINAL NER/ER – NR/WR INTERCONNECTOR-I PROJECT
NOA NO.	C-61901R-S056-8/CA-II/3660 dated 22.12.2011 for Supplies & C-61901R-S056-8/CA-IV/3662 dated 22.12.2011 for Services
Station	ALIPURDUAR 04

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Rev No.	Date	Altered	Checked	Approved	REVISION DETAILS
04	01.04.14	NS	SKS	AG/AKD	Spec modified for Alipurduar quantity only.
03	18.04.12	NS	RJ/MK	AG	Operating mechanism has been revised.
02	30.09.11	RJ	MK	AG	Customer comments received from the vide letter C/ENGG/HVDC/NER-NR/227/51 dated 27.09.2011 incorporated.
01	03.09.11	RJ	MK	AG	Customer comments received from the vide letter 07/14.07.2011 incorporated.

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SECTION-1

Scope, Specific Technical Requirement and Bill of Quantity

1.1 SCOPE

This technical specification covers the requirements of design, manufacture, testing at works, documentation, packing and loading at works, transportation to site of 420 kV SF6 Circuit Breaker along with steel structure and foundation bolts. Supplier will include supervision of installation, testing and commissioning of all offered circuit breakers along with necessary instruments.
Circuit breakers operated by spring charged mechanism, hydraulic mechanism or a combination of these are only acceptable.

The scope shall encompass and include all the activities listed above.

In case of variance in the requirements specified under Section-1 and other Sections of this specification, requirements of Section-1 shall prevail. In case of variance in the requirements specified in Section-2 & 3, Section-2 shall prevail.

400kV Circuit Breaker is required for the following Project

Project: ±800KV, 6000MW, HVDC Multi-terminal NER/ER-NR/WR Interconnector-1 Project

Customer: POWERGRID CORPORATION OF INDIA LIMITED

1.2 SPECIFIC TECHNICAL REQUIREMENTS

The circuit breakers and accessories shall conform to IEC: 62271-100, IEC: 60694 and other relevant IEC standards except to the extent explicitly modified in the Section -2 of this Specification.

Technical Parameters

1	Rated Voltage	400kV
2	Rated Maximum Voltage	420kV
3	Number of poles	3
4	Rated Frequency	50 Hz

5	Class	Outdoor
6	Rated Current	3150A
7	Rated short circuit current breaking capacity at specified site conditions and rated voltage corresponding to minimum opening time under operating conditions as specified.	50kA with percentage of DC component as per IEC-62271-100
8	Symmetrical interrupting capacity (kA, rms)	50
9	Rated short circuit making current (kA, Peak)	125
10	Short time current carrying capability for one sec (kA, rms)	50
11	Out of Phase breaking current capacity (kA, rms)	12.5
12	Rated line-charging breaking current at 90^o leading Power factor (The breaker shall be able to interrupt the rated line charging current with a test voltage immediately before opening equal to the product of 0.577 V and 1,4 as per IEC-62271-100	600 A rms
13	Rated small inductive current switching capability with over voltage less than 2.3 p.u.(A)	0.5 to 10
14	First pole to clear factor	1.3
15	Total break time (ms)	40
16	Total closing time (ms)	Not more than 150
17	Rated operating duty cycle	O-0.3s-CO-3min-CO
18	**Rated Insulation level**	
	i) Full wave impulse withstand voltage (1.2/50 µsec)	
	-between line terminal and ground	±1425kVp
	-between terminals with circuit breaker	±1425kVp

	open on one terminal and 240 KVp power frequency of opposite polarity on other terminal	
	ii) Switching impulse withstand voltage (250/2500 µsec) dry and wet	
	- between line terminal and ground	± 1050 kVp ground
	- between terminals with circuit breaker open	±900 kVp switching breaker open impulse on one terminal and 345 kVp power frequency of opposite polarity on other terminal
	iii) One minute power frequency dry and wet withstand voltage	
	-between line terminal and ground	520 kV rms
	- between terminals with CB open	610 kV rms
19	Corona extinction voltage with CB open or close	320kV rms
20	Max. Radio interference voltage for frequency between 0.5Mhz and 2MHz at 266kV rms (Phase to ground) both in open & closed	1000 micro volts
21	Min. Creepage distance:	
	- Phase to ground	10500 mm
	- Between terminals	10500 mm
22	Max. Difference in the instants of closing opening of contacts (at rated control voltage, and rated operating & quenching media pressures)	
	- within a pole	2.5 ms
	- Between poles	3.3 ms
23	Trip and closing coil voltage	220V DC
24	Rating of auxiliary contacts	10A at 220V DC

25	Breaking capacity of Auxiliary contacts	2A DC with the circuit time constant of not less than 20 ms
26	Rated terminal load	100Kg static
27	Operating Mechanism	Hydraulic/Spring-charged mechanism or a combination of both.
28	Auxiliary contacts (Besides requirement of specification , supplier shall wire up these contacts for future use of customer)	15NO+ 15NC

Further, as control system shall be built with complete redundancy, the following order/indication requirements will be double

- OPEN ORD (i.e. CB open command)
- OPEN IND (i.e. CB open indication)
- CLOSE IND (i.e. CB close indication)
- ENABLE LOCAL CONTROL (i.e. provision for local/remote switch)

Other signals alarm/indication and close order (i.e. CB close command) shall be single.
Offered circuit breakers should comply with above requirements also.

1.3 BILL OF QUANTITIES

04

1.3.1 Main Supply:

S.No.	Item Description	Unit	Quantity		
			Biswanath Chariali	Agra	Alipurduar
1.0	420kV, 3150A, 50kA for 1s, 3 Phase SF6 Circuit Breaker without PIR along with support structure, foundation bolts, interpole cables, operating mechanism, control boxes and all accessories complete in all respect	Nos.	**NIL**	**NIL**	**21**
2.0	Supervision of erection, testing and commissioning of all Circuit breakers.	Lot	**NIL**	**NIL**	**1**

1.3.2 Mandatory Spares

S.No.	Item Description	Unit	Quantity		
			Biswanath Chariali	Agra	Alipurduar
1.0	420kV, 3150A, 50kA for 1s, 1 Phase SF6 Circuit Breaker without PIR along with operating mechanism, control boxes and all accessories complete in all respect	No.	**NIL**	**NIL**	**1**
2.0	SF6 Gas (in addition to the supply of SF6 for the CBs covered under main supply)	Lot	**NIL**	**NIL**	**1** (20% of the total gas quantity used for all the breakers)

1.4 TYPE TESTS

Each type of circuit breaker along with its operating mechanism shall conform to the type tests as per IEC: 62271-100.
In addition to the type tests in IEC: 62271-100, the valid type test reports for the following additional tests should be provided:

S.No.	Item Description
1.0	Sound Level: A test of the circuit breaker to demonstrate that the noise level when opening and closing the circuit breaker does not exceed the specified levels.
2.0	Test to demonstrate the Dielectric Withstand Capability of breaker in open condition at zero gauge pressure and at lock out pressure.
3.0	Seismic withstand test (0.5g horizontal and 0.3g vertical) – Bidder has to provide necessary calculations to verify seismic withstand capacity of the offered breakers.
4.0	Verification of degree of protection.

All type tests should have been conducted not earlier than five year from 30.06.09.
If any type tests report is found to be technically unacceptable, such type test(s) shall be conducted by the vendor without additional cost and delivery schedule implication to BHEL.

1.5 QUALITY PLAN

Bidder to follow valid POWERGRID approved Manufacturing Quality Plan as per POWERGRID procedure. In case the bidder does not have POWERGRID approved MQP, it will be the bidder's responsibility to get its MQP approved directly from the customer i.e. POWERGRID.

1.6 Supervision of Erection, Testing & Commissioning

Bidder shall quote lump-sum price for the supervision of erection, testing and commissioning of all offered breakers. All testing instruments (except SF6 gas leak detector and time interval meter) shall be arranged at site by ETC contractor. However supplier's service engineer shall bring gas leak detector and time interval meter at site. All site tests on Circuit breakers shall be carried out by Circuit Breaker's service engineer. Required man power, electrician, tools etc. shall be arranged by ETC contractor. Bidder must include all charges like travelling, boarding etc. in the quoted price for supervision work; prices per man days are not acceptable.

SECTION-2

Equipment Specification

2.1 GENERAL

The circuit breakers and accessories shall conform to relevant IEC: 62271-100, IEC: 60694 and other relevant IEC standards except to the extent explicitly modified in the Specification.

The circuit breakers for 400 kV ac systems shall be Sulphur hexafluoride (SF6) type only. The circuit breaker shall be complete with operating mechanism, control cabinets, piping, inter-pole cable, cable accessories like glands, terminal blocks, marking ferrules, lugs, pressure gauges, density monitors (with graduated scale), galvanized support structure for CB and control cabinets, their foundation bolts and all other circuit breakers accessories required for carrying out all the functions the CB is required to perform.

All necessary parts to provide a complete and operable circuit breaker installation such as main equipment, terminals, control parts and other devices whether specifically called for herein or not, shall be provided.

The support structure of circuit breaker shall be hot dip galvanized and control cabinet shall be made of 3 mm thick aluminum sheet. All other ferrous parts shall be suitably painted with Polyurethane paint. The shade of the paint shall be Siemens Grey RAL 7032 and all other exposed hardware items shall be hot dip galvanized or electro galvanized.

2.2 APPLICABLE STANDARDS

The circuit breakers shall strictly conform to the following latest Indian and International standards as appropriate:

IEC 62271-100	Specification for high voltage alternating-current circuit breaker
IEC 60376: 2005-06	Specification of technical grade sulphur hexafluoride (SF6) for use in electrical equipment
IS/IEC 60947 (Part 1): 2004	Low voltage switchgear and control gear, General rules
IS/IEC 60947 (Part 2): 2003	Low voltage switchgear and control gear, Circuit Breakers
IS 325 : 1996 (Reaffirmed 2007)	Three phase induction motors
IS 2629 : 1985	Recommended practice for hot dip galvanizing on iron and

	steel.
IEC 60060 (Part-1)	High voltage test techniques, General definition and test requirement.
IEC 60060 (Part 2)	High voltage test techniques: Measuring devices
IEC 60060 (Part 3)	High voltage test techniques: Definitions and requirements for on-site testing
IEC 60694	Common specification for high voltage switchgear and control gear
IEC 60071 (Part 1)	Insulation coordination, Definition Principle and rules
IEC 60071 (Part 2)	Insulation coordination, Application Guide
CIGRE WG Report No. 13-02-1973	Switching over-voltage in EHV and UHV systems with special reference to closing and re-closing transmission lines
IS 2633 : 1986	Method for Testing Uniformity of coating on zinc coated articles.
IS 2544 : 1973	Specification for Porcelain Post Insulators for systems with nominal voltages greater than 1000 volts.
IS 5561 : 1970	Electric Power Connectors.
IS 5621 : 1980	Hollow insulators for use in electrical equipments.
IEC 62155	Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltage greater than 1000V
IS 4379 : 1981	Identification of contents & industrial gas cylinders
IS 7285 : 1988	Seamless steel cylinders for permanent and high pressure liquefiable gases
IEC 62271-101	High-voltage switchgear and control gear: Synthetic testing
IEC 62271-100	High voltage Switchgear and control gear, HV-AC Circuit Breaker

2.3 DUTY REQUIREMENTS

The circuit breaker shall be rated for the switching, interrupting and current carrying duty imposed upon them in their intended application

The total interrupting time shall be 2 cycles or less from energization of trip circuit of the circuit breaker to the extinction of the arc. The total closing time shall be less than 150 msec from energization of closing circuit of the circuit breaker to closing of the breaker contacts.
The operating duty cycle shall be O - 0.3 sec - CO - 3 min - CO, with no de-rating for the first re-closure between operations over the voltage range from nominal to rated maximum voltage and from zero to the maximum rated interrupting current without the necessity of intermediate maintenance. The circuit breakers shall be capable of withstanding the transient recovery voltage as per IEC-62271.

The circuit breaker shall be designed for M2C2 class as per IEC 62271 under all duty conditions.

The circuit breaker shall meet the duty requirements for any type of fault or fault location and for line switching when used on a 400 kV effectively grounded system and perform make and break operations as per the stipulated duty cycles satisfactorily.

The circuit breaker shall be capable of performing their required duty as per application including

- Interrupting steady and transient magnetizing current of transformers of specified ratings or as the case may be.
- Interrupting line charging current as per IEC
- Clearing short line faults (Kilometric faults) with source impedance behind the bus equivalent to symmetrical fault current specified.
- Clearing bus faults on Employer's 400 kV ac yard
- Clearing faults as second-in-line breaker in the event of failure of main breaker
- Breaking small inductive currents of 0.5A to 10 A without switching over voltage exceeding 2.3 p.u.
- Breaking 25% of the rated fault current at twice rated voltage under phase opposition condition.

The breakers shall satisfactorily withstand the high stresses imposed on them during fault clearing, load rejection and re-energization with trapped charges. The breakers shall also withstand the voltages specified.

The breakers shall be capable of withstanding high currents of high frequency which may occur for faults near the breakers located close to ac filters.

The total break time as specified shall not be exceeded under any of the following duties:

- Test duties 1,2 ,3,4 ,5 (TRV as per IEC:62271-100)
- Short line fault L75, L90 (TRV as per IEC:62271-100)

The Bidder may please note that the total break time of the breaker shall not be exceeded under any duty conditions specified.

2.4 CONSTRUCTIONAL FEATURES

The features and constructional details of the circuit breaker shall be in accordance with requirements stated hereunder:

1. The gap between the open contacts shall be such that it can withstand at least the rated phase to ground voltage for 8 hours at zero gauge pressure of SF6 gas due to leakage. The breaker should be able to withstand all dielectric stresses imposed on it in open condition at lockout pressure continuously (i.e. 2 p.u. across the breaker continuously).

2. If multi break interrupters are used, these shall be so designed and augmented that a uniform voltage distribution is developed across them. Calculations/test reports in support of the same shall be furnished by the Contractor. The thermal and voltage withstand capabilities of the grading elements shall be adequate for the service conditions and duty specified.

3. The SF6 circuit breaker shall meet the following additional requirements:

   a) The circuit breakers shall be of single pressure puffer type. The design and construction of the circuit breaker shall be such that neither SF6 gas shall leak to atmosphere and nor moisture shall enter in the breaker. There shall not be any condensation of SF6 gas on the internal insulating surface of the circuit breakers.

   b) All gasket surfaces shall be smooth, straight and reinforced, if necessary, to minimize distortion and to make a tight seal. The operation rod connecting the operating mechanism to the arc chamber shall have adequate seals. The SF6 gas leakage should not exceed 1% per year. In case the leakage under specified conditions is more than 1% after one year of commissioning of the circuit breaker, the manufacturer shall have to supply free of cost, the total make up gas requirement for subsequent ten(10) years based on actual leakage observed during first year of operation after commissioning.

c) In the interrupter assembly there shall be an absorbing product box to minimize the effects of SF6 decomposition products and moisture. The material used in the construction of the circuit breakers shall be fully compatible with SF6 gas as well as its decomposition products.

d) Each pole shall form an enclosure filled with SF6 gas independent of two other poles and the SF6 density of each pole shall be monitored. The SF6 gas density monitor shall be provided on each of the individual poles.

e) The gas density in the SF6 circuit breaker shall never be less than the minimum required insulating density of SF6. Gas density monitoring equipment with two level alarms shall be provided.

f) The dial type SF6 gas density monitor shall be adequately temperature compensated to model the density changes due to variations in ambient temperature within the body of the circuit breaker as a whole. The density monitor shall meet the following requirements:

- It shall be possible to dismantle the density monitor for checking/replacement without draining the SF6 gas by using suitable interlocked non-return valve coupling.

- It shall damp the pressure pulsation while filling the gas so that the flickering of the pressure switch contacts does not take place. Filling of SF6 gas shall not be performed in closed position of breaker.

g) Suitable means for pressure relief shall be provided in the gas chamber of circuit breaker to avoid the damages or distortion during the occurrence of abnormal pressure increase or shock waves generated by internal electric fault arcs. The position of vents, diaphragms and pressure relief devices shall be so arranged to minimize danger to the operators in the event of gas or vapour escaping under pressure.

h) Each circuit breaker shall be capable of withstanding a vacuum of 8 mil bars without distortion or failure of any parts.

i) Sufficient SF6 gas including that required for gas analysis during filling shall be provided to fill all the circuit breakers installed. In addition 20% of total gas requirement shall be supplied at respective station, in separate cylinders as spare requirement for Employer's later use.

4. Provision shall be made for attaching an operational analyzer after installation at site to record contact travel, and making measurement of operating timing, synchronization of contacts in one pole and dynamic contact resistance measurement.

2.5 SULPHUR HEXAFLUORIDE GAS (SF6 GAS)

The SF6 gas shall comply with IEC-60376, 376A and 376B and shall be suitable in all respects for use in the switchgear under the operating conditions.

The high pressure cylinders in which the SF6 gas shall be shipped and stored at site shall comply with requirements of the following standards and regulations:

- IS: 4379 - identification of the contents of industrial gas cylinders
- IS: 7311 - seamless hi-carbon steel cylinders for permanent and high pressure liquefiable gases

The cylinder shall also meet Indian boiler regulations.

SF6 gas shall be tested for purity, dew point, break down voltage, air, hydrolysable fluorides and water content as per IEC-60376, 376A and 376B and test certificates shall be furnished to Employer indicating all the tests as per IEC-60376 for each lot of SF6 gas. Gas bottles shall be tested for leakage after receipt at site.

2.6 INSULATORS

The porcelain of the insulators shall conform to the requirements stipulated in the applicable Indian/International standards.

The mechanical characteristics of insulators shall match with the requirements of the offered equipment.

All insulators shall conform to IEC-62155. The interrupter insulators are subjected to pressure test as routine test and bending load test as a sample test. The support insulators are subject to bending load test as routine test and pressure test as a sample test.

Jointed porcelain shall not be accepted.

2.7 OPERATING MECHANISM

GENERAL REQUIREMENTS

a) Circuit breaker shall be operated by spring charged mechanism, hydraulic mechanism or a combination of these. The mechanism shall be housed in a weather proof and dust proof control cabinet.

b) The operating mechanism shall be strong, rigid, not subject to rebound and shall be readily accessible for maintenance by a man standing on ground.

c) The operating mechanism shall be suitable for high speed re-closing and other duties specified. During re-closing operation the breaker operating mechanism and control shall have capability to close fully and re-open if required. The mechanism shall be anti-pumping and trip free (as per IEC definition) under every method of closing.

d) The mechanism shall be such that the failure of any auxiliary spring shall not prevent tripping and shall not cause trip or closing operation of the power operating devices.

e) A mechanical indicator shall be provided to show open and close position of the breaker. It shall be located in a position where it shall be visible to a man standing on the ground level with the mechanism housing closed. An operation counter shall also be provided in the central control cabinet.

f) Working parts of the mechanism shall be of corrosion resisting material. Bearings which require grease shall be equipped with pressure type grease fittings. Bearing pins, bolts, nuts and other parts shall be adequately pinned or locked to prevent loosening or changing adjustment with repeated operation of the breaker.

2.8 CONTROL

a) The close and trip circuits shall be designed to permit use of momentary contact switches and push buttons.

b) Each breaker pole shall be provided with two (2) independent tripping circuits and coils each being connected to different set of protective relays.

c) The breaker shall normally be operated by remote electrical control. Electrical tripping shall be performed by shunt trip coils. However, provisions shall be made for local electrical control. For this purpose a local/remote selector switches and close and trip push buttons shall be provided in the breaker central control cabinet.

d) The trip coils shall be suitable for trip circuit supervision during both open and close position of breaker. The trip circuit supervision relay would be provided.

e) Closing coil & associated circuits shall operate correctly at all values of voltages between 85% & 110% of rated voltage Shunt trip coil shall operate correctly under all operating conditions of the circuit breaker up to the rated breaking capacity of the circuit breaker and at all values of supply voltage between 70% and 110% of rated voltage.

f) Density meter contacts and pressure switch contacts shall be suitable for direct use as permissive in closing and tripping circuits. Separate contacts have to be used for tripping and closing circuits. If contacts are not suitably rated and multiplying relays/contactors are used for density monitor and pressure switch contact multiplication then fail safe logic/schemes shall be employed. DC supplies for all auxiliary circuits shall be monitored and provision shall be made for remote annunciation and operation lockout in case of failures. Density monitors are to be mounted such that the contacts do not change on vibration during operation of circuit breaker.

g) The auxiliary switch of the breaker shall be positively driven by the breaker operating rod.

SPRING OPERATED MECHANISM

a) Spring operated mechanism shall be complete with motor, opening spring and closing spring with limit switch for automatic charging and other necessary accessories to make the mechanism a complete operating unit.

b) As long as power is available to the motor, a continuous sequence of the closing and opening operations shall be possible. The motor shall have adequate thermal rating for this duty.

c) After failure of power supply to the motor OCO operation shall be possible with the energy contained in the operating mechanism.

d) Breaker operation shall be independent of the motor which shall be used solely for compressing the closing spring. Facility for manual charging of the closing spring shall also be provided. The motor rating shall be such that it requires not more than 30 seconds for full charging of the closing spring.

e) Closing action of the circuit breaker shall compress the opening spring ready for tripping.

f) When closing springs are discharged after closing the breaker they shall be automatically charged for the next operation and an indication of this shall be provided in the local control cabinet.

g) Provisions shall be made to prevent a closing operation of the breaker when the spring is in partial charged condition. Mechanical interlocks shall be provided in the operating mechanism to prevent discharging of closing springs when the breaker is already in the closed position.

h) The spring operating mechanism shall have adequate energy stored in the operating spring to close and latch the circuit breaker against the rated making current and also to provide the required energy for the tripping mechanism in case the tripping energy is derived from the operating mechanism.

HYDRAULICALLY OPERATED MECHANISM

a) Hydraulically operated mechanism shall comprise of operating unit with power cylinder, control valves, high and low pressure reservoir, motor etc. A hand pump set (one no. per station) shall be provided for emergency operation.

b) The hydraulic oil used shall be fully compatible for the specified temperature range.

c) The oil pressure switch controlling the oil pump and pressure in the high pressure reservoir shall have adequate number of spare contacts to be used for continuous monitoring of low pressure, high pressure etc. and remote alarm indication.

d) The mechanism shall be suitable for at least two close open operations after failure of AC supply to the motor starting at a pressure equal to the lowest pressure of auto re-close duty plus pressure drop for one close open operation.

e) The mechanism shall be capable of operating the circuit breaker correctly and performing the duty cycle specified under all condition with the pressure of hydraulically operated fluid in the operating mechanism at the lowest permissible pressure before makeup. The opening time at the lowest pressure for a particular operation shall not exceed the guaranteed operating time within any value of trip coil supply voltage as specified.

f) Trip lockout shall be provided to prevent operations of the circuit breaker below the minimum specified hydraulic pressure. Alarm contacts for loss of Nitrogen shall also be provided.

g) All hydraulic joints shall have no oil leakage under the site conditions and joints shall be tested at factory against oil leakage at a minimum of 1.5 time maximum working pressure.

2.9 SUPPORT STRUCTURE

All steel structures and anchor/foundation bolts shall be fully galvanized after fabrication. Purity of zinc to be used shall be 99.95% as per IS: 209.The weight of the zinc coating shall be at least 0.610 kg/m^2. One additional nut shall be provided below the base plate which may be used for the purpose of leveling.

Bolting

- Every bolt shall be provided with a washer under the nut so that no part of the threaded portion of the bolt is within the thickness of the parts bolted together.

- All steel items, bolts, nuts and washers except spring washers shall be hot dip galvanized. Spring washers shall be electro galvanized.

- 2% extra nuts and bolts shall be supplied for erection.

Stability of Structure

The Supplier shall be responsible for the stability of the structure at all stages of its erection at site and shall take all necessary measures by the additions of temporary bracings and guying to ensure adequate resistance to wind and also to loads due to erection equipment and their operations.

The structure design shall be such that during operation of circuit breaker vibrations are reduced to a minimum.

If required, the Contractor shall provide suitable platform with steps on both sides of the circuit breaker for easy accessibility for monitoring the density/pressure of gas.

2.10 TERMINAL PADS

The circuit breaker terminal pads shall be made up of high quality electrolytic copper or aluminum.

2.11 FITTINGS AND ACCESSORIES

Following is a partial list of some of the major fittings and accessories to be furnished by Contractor in the central control cabinet. Number and exact fixing location of these parts shall be indicated in the drawing.

a) Cable glands, lugs, ferrules, etc.
b) Local/Remote changeover Switch
c) Open/Close buttons and Operation counter
d) Pressure gauges
e) Control switches to cut off control power supply
f) MCBs/MCCBs as required
g) Anti-pumping relay
h) DC auxiliary power supervision relay.
i) Pole discrepancy relay
j) Rating and diagram plate in accordance with IEC
k) The number of terminals provided shall be adequate to wire out all contacts and control circuits after leaving 24 terminals as spare for future use.

2.12 TESTS

Type Tests

Each type of circuit breaker along with its operating mechanism shall conform to the type tests as per IEC: 62271-100.
In addition to the type tests in IEC: 62271-100, the valid type test reports for the following additional tests should be provided:

a) Sound Level: A test of the circuit breaker to demonstrate that the noise level when opening and closing the circuit breaker does not exceed the specified levels.

b) Test to demonstrate the Dielectric Withstand Capability of breaker in open condition at zero gauge pressure and at lock out pressure.

c) Seismic withstand verification by calculation

d) Verification of degree of protection

All type tests should have been conducted not earlier than five year from the date of bid opening i.e. 30.06.09.

If any type tests report is found to be technically unacceptable, such type test(s) shall be conducted by the vendor without additional cost and delivery schedule implication to BHEL.

Routine Tests

Routine tests as per IEC: 62271-100 shall be performed on all circuit breakers. In addition to the mechanical and electrical tests specified by IEC, the following tests shall also be performed.

i) Speed curves for each breaker shall be obtained with the help of a suitable operation analyzer to determine the breaker contact movement during opening, closing, auto- re-closing and trip free operation under normal as well as limiting operating conditions (control voltage, etc.). The tests shall show the speed of contacts directly at various stages of operation, travel of contacts, opening time, closing time, shortest time between separation and meeting of contacts at break make operation etc. This test shall also be performed at site for which the necessary operation analyzer along with necessary transducers, cables, console, etc. shall be furnished as mandatory maintenance equipment.
ii) Measurement of Dynamic contact resistance for arcing and main contacts. Signature of Dynamic contact resistance measurements shall be taken as reference for comparing the same during operation and maintenance in order to ascertain the healthiness of contacts.

iii) Ultrasonic test shall be performed on insulators.

Site Tests

All routine tests except dielectric shall be repeated on the completely assembled breaker at site. All site tests mentioned in the Powergrid approved field quality plan shall also be carried out by the supplier's engineer at site.

SECTION-3

Project Details and General Technical Requirements

Please refer document TB-343-316-000: “General Technical Requirements – Section 3”

SECTION 4

GUARANTEED AND TECHNICAL PARTICULARS FOR 400kV CIRCUIT BREAKER

Bidder shall furnish the technical parameters for each type/voltage class of offered circuit breaker separately in the below mentioned format.

1. GENERAL

a) Name of the Manufacturer ……

b) Country of Manufacturer ……

c) Type of Circuit Breaker ……..

d) Manufacturer's type designation ……

e) Standard Applicable ……

f) Rated Voltage (kV rms) ……

g) Rated Current ……

i. Under normal condition (A) ……

ii. Under site condition (A) ……

h) Rated frequency (Hz) ……

i) Number of poles ……

j) Whether 3 pole or single pole unit ……

k) Whether All The 3 poles ganged electrically or mechanically ……

l) Whether dead tank or live tank design ……

m) Type of installation ……

n) No. of break per pole ……

……

o) Latching Current

2. GUARANTEED RATINGS

a) Rated short circuit breaking current ……

i. Symmetrical component at highest system voltage (kA) ……

ii. DC Component (%) ……

iii. Asymmetrical breaking current at highest system voltage (kA) ……

b) Rated Making Capacity ……

i. At higher rated voltage (kAp) ……

ii. At lower rated voltage (kAp) ……

……

c) (i) Maximum Total break time under any duty condition for any current upto rated breaking current with limiting conditions of voltage and pressure (ms)

ii. Rated break time ……

d) Closing time (ms) ……

e) Minimum opening time under any condition with limiting voltage and pressure (ms) ……

f) Maximum opening time under any condition with limiting voltage and pressure (ms) ……

g) Maximum close open time under any condition with limiting voltages and pressures (ms) ……

h) First pole to clear factor ……

i) Short time current rating (kA) for 1s ……

j) Rated operating duty ……

k) Maximum braking capacity under kilometric faults and rated TRV characteristic (kAp) ……

l) Maximum breaking capacity under phase opposition (kAp) ……

m) Maximum line charging breaking current with temporary over voltage upto 1.4 p.u. (A) ……

n) Maximum over voltage (p.u.) on switching transformer on no load and corresponding charging current ……

o) Maximum period between closing of first contact & last contact in a pole (ms) ……

p) Maximum pole discrepancy (ms) ……

q) Maximum arc duration and corresponding current under lockout pressure ……

r) Pre-insertion resistor

i. Value/ pole (ohms) / with tolerance ……

ii. Minimum and maximum duration of insertion per pole (ms) ……

iii. Thermal rating for the C-1m-O-CO-2m-C-1m-O-CO for terminal fault considering maximum resistance and ……

iv. Thermal rating for the same duty as (iii) above for reclosing against trapped charges ……

s) Small fault current breaking capacity (kAp) ……

t) Maximum temperature rise for main contacts over design ambient temperature of 50ºC ……

u) Rated voltage & pick up range for trip coil (V) ……

v) Rated voltage & pick up range for closing coil (V) ……

w) Rated pressure and limits of pressure of operating mechanism ……

x) Rated pressure and limits of pressure of extinguishing medium ……

y) Minimum dead time for

i. Three phase reclosing (ms) ……

ii. Single phase reclosing (ms) ……

3. DIELECTRIC WITHSTAND OF COMPLETE BREAKER

a) One minute dry & wet power frequency withstand voltage

i. Between live terminal and ground (kVrms) ……

ii. Between terminals with breaker contacts open (kV rms) ……

b) 1.2/50- micro second impulse withstand test

voltage

i. Between live terminals and ground(kVp) ……

ii. Between terminals with breaker contacts open (kVp) ……

c) 250/2500 micro second switching surge withstand test voltage

i. Between live terminals and ground (kVp) ……

ii. Between terminals with breaker contacts open (kVp) ……

d) Corona extinction voltage (kV rms) ……

e) Maximum radio interference voltage (micro V) at 1.1 Ur/_/3 ……

f) Total creepage distance

i. To ground (mm) ……

ii. Between terminals (mm) ……

4. OPERATING MECHANISM

a) Type of operating mechanism for

i. Closing ……

ii. Opening ……

b) Manufacturer's type designation ……

c) Normal power consumption (W) at rated voltage of ……

i. Trip coil ……

ii. Closing coil ……

4.1 Hydraulic operating mechanism

a) Rated pressure of oil in operating cylinder (kg/cm2) ……

b) Limits for pressure (kg/cm2) ……

c) Quantity of oil (litre) ……

d) Details of arrangements to prevent change of position of breaker of position of breaker in the event of hydraulic ……

e) Details of monitoring arrangement for hydraulic pressure ……

f) No. of close-open operations possible after loss of AC supply to drive motor ……

g) Details of hand pump set provided for emergency operation ……

h) Pressure drop starting from lowest pressure at which motor starts for

   i. C-operation ……

   ii. O-operation ……

   iii. CO-operation ……

   iv. O-CO-operation ……

   v. 2-CO-operation ……

i) Time required to make up pressure upto loss of nitrogen pressure after

   i. C-operation ……

   ii. O-Operation ……

   iii. CO-operation ……

   iv. O-CO-operation ……

   v. 2-CO-operation ……

4.3 Spring charged mechanism

a) Number of close open operations possible after failure of AC supply to motor ……

b) Time required for motor to charge the closing spring (min) ……

c) Whether indication of spring charged condition provided in central control cabinet ……

5. TYPE OF BREAKERS

5.1 SF6 Circuit Breakers

a) Quantity of SF6 per pole (m3) at rated pressure ……

b) Guaranteed max. leakage rate per year ……

c) Rated pressure of SF6 in operating chamber ……

d) Limit of pressure at which breaker operates correctly (kg/ cm2) ……

e) Standard to which SF6 gas complies ……

f) Whether 20% spare SF6 gas stores in unused gas cylinder, included in proposal ……

g) Compacity & filling ration of containers in which SF6 gas would be shipped (m3) ……

h) Whether breakers are dispatched filled with SF6 or required to be filled at site ……

i) Type and make of SF6 pipe coupling used ……

j) Type and make of mandatory maintenance equipment

   i. SF6 gas filling and evacuation trolley (portable) ……

   ii. SF6 gas drying, filling, evacuating equipment and its capacity ……

   iii. Operating analyzer type and make ……

   iv. SF6 gas leak detector ……

k) Parameters of SF6 gas for initial filling & satisfactory operation

   i. Density ……

   ii. Dielectric strength/ kVmm ……

   iii. Acidity (ppm) ……

   iv. Water content (ppm) ……

   v. Oil content (ppm) ……

vi. Condensation temperature ºC) ……

vii. Resistivity (Ohm-cm) ……

l) Whether details of SF6 gas viz test methods, handling etc. enclosed ……

m) Type and material of gasket used to ensure gas tight joints for

i. Metal to metal joints ……

ii. Metal to porcelain joints ……

n) Method of housing SF6 gas compressors and equipment

i. At circuit breaker ……

ii. In control cubicle ……

o) Type and make of

i. Densimeter ……

ii. Pressure gauge ……

p) Densimeter Settings

i. Lockout ……

ii. Alarm ……

q) Minimum time interval between each make/ break operation (ms) ……

5.2 GENERAL

a) Whether OGA drawing enclosed ……

b) Weight of complete 3 phase breaker for foundation design (kg) ……

c) Weight of heaviest part of breaker (kg) ……

d) Impact loading for foundation design ……

e) Seismic level for which breaker is designed ……

f) Minimum safety clearance from earthed objects ……

g) Noise level in (dB) at base of the breaker ……

h) Minimum clearance in air

i. Between live parts (mm) ……

ii. Live parts to earth (mm) ……

iii. Live parts to ground level (mm) ……

6. CONSTRUCTIONAL DETAILS

a) Whether arcing contacts provided ……

b) Type and material of main contacts and arcing contacts ……

c) Contact pressure on main contacts (kg/cm2) ……

d) Contact separation in arcing position (mm) ……

e) Contact separation in open position (mm)

i. Main contacts ……

ii. PIR contacts ……

f) Whether pressure relief device for each of the gas chamber of SF6 CB provided ……

g) Rate of contact travel

i. Opening (m/sec) ……

ii. Closing (m/sec) ……

h) Whether the making & breaking contacts are hermetically sealed ……

i) Type and capacity of device used to obtain uniform voltage distribution between breaks ……

j) Overvoltage withstand capability of grading components (kV/mms)

i. Continuous ……

ii. 10 minutes ……

iii. 1 minute ……

iv. 5 seconds ……

k) Number of auxiliary contacts per pole provided for Owner's use ……

l) Rated voltage of auxiliary contacts (V) ……

m) Current rating of auxiliary contacts

i. Continuous (A) .....

ii. DC breaking with 20 ms time constant (A) .....

n) Whether auxiliary contacts silver plated .....

o) Whether support structure included in supply .....

p) Height of support structure .....

q) Material of support structure .....

r) Standard to which the design of support structure conforms .....

s) Whether foundation bolts for breakers and cabinets included in scope of supply .....

7. DETAILED LITERATURE

i. Type test reports as per IEC-56 .....

ii. Factory test report & / or filed test report in case of reactor switching duty .....

iii. Details of operating mechanism .....

iv. Drawing of breaker of support structure .....

v. Calculations for compressed .....

vi. Details of SF6 gas filling .....

vii. Details of SF6 gas leak detector .....

viii. Precautions in use of SF6 gas .....

ix. Leaflets & literature bringing out salient features of equipment offered .....

x. Schematic diagrams of switching mechanism for closing resistor showing the duration of insertion alongwith calculation for thermal rating of closing resistors .....

xi. Whether drawings/data data furnished as per cl.12 of chapter switchgear (CB) .....

xii. Method of checking of voltage distribution devices at site enclosed .....

xiii. Details alongwith a complete catalogue of operation analyzer enclosed .....

xiv. Data on capabilities of circuit breaker in terms of time and number of operations at duties ranging from 100% fault currents to load currents of the lowest possible value without requiring any maintenance or checks .....

xv. Effect of non simultaneity between contact within a pole or between poles and also show how it is covered in the guaranteed rated break time. .....

xvi. Details and type of filters used in interrupter assembly and also the operating experience with such filters .....

xvii. Curves supported by test data indicating the opening time under close open operation with combined variation of trip coil voltage & pneumatic/ hydraulic pressure .....

xviii. All duty requirements specified alongwith adequate test reports .....

CONTROL CABINETS

1. Manufacturer's Name .....

2. Indoor/ Outdoor application .....

3. Design ambient air temperature (deg. C) .....

4. Standards applicable .....

5. Thickness of sheet steel (mm) and whether cold rolled or hot rolled .....

6. Degree of protection provided .....

7. Bill of material for all the equipment mounted on control cabinet giving the following details .....

a) Make and type .....

b) Applicable Standard .....

c) Voltage rating .....

d) Current rating .....

e) Duty class, if applicable	……
f) Manufacturers catalogue No.	……
g) Total heat load of cabinet (for purpose of ventilation requirement)	……
8. Colour of finish paint IS:5	……
a) Outside	……
b) Inside	……
9. Control Wiring	
(a) Size of conductor	……
i. For CT circuits	……
ii. For other circuits	……
b) Conductor Solid/ Standard	……
c) Number of Strands/ conductor	……
10. Terminal Blocks	
(a) Make & type	……
b) Current rating	……
i) Power terminals (A)	
ii) Other terminals (A)	
11. Space Heater Rating at 240 V AC	
12. Control cabinet drawing showing the following	
a) Outline dimensions, floor openings, floor/wall/ pedestal fixing arrangements, weights etc.	
b) Front view, inside view showing the mounting arrangement of various equipment	
13. Schematic/ Wiring diagram of control cabinet enclosed	
14. Interconnection drawing showing cable, connections to the control cabinet enclosed	
15. Type test report to verify design of protection enclosed	
16. Details of terminal rows:	

i) Whether aranged
vertical or horizontal

ii) Clearance from adjacent components

iii) Distance between rows

iv) Whether transparent protection cover provided

TERMINAL CLAMPS AND CONNECTORS

1. Manufacturer's Name

2. Applicable Standards

3. Type

4. Material of connector

a) Clamp body

b) Botls & Nuts

c) Spring washers

5. Rated Current

6.a) Rated terminal load (kg)

b) Factor of safety

7. Minimum thickness of any part (mm)

8. Weight of clamp complete with hardware (kg)

9. Type test reports as per IS enclosed

10. OGA drawing enclosed

BUSHING/SUPPORT INSULATOR

1.Manufacturer's Name

2.Type

3.Applicable Standards

i) Height

ii. Diameter (Top)

iii. Diameter (Bottom)

4.Total Creepage distance (mm)

5.Rated voltage (kV)

6.Power frequency withstand voltage for 1 Min. (kVrms) dry and wet

7. 1.2/50 micro sec. Impulse withstand voltage (kVp)

8. 250/2500 micro sec. Switching impulse withstand voltage (kVp) dry and wet

9.Corona Extinction voltage (kV)

10.Weight (kg)

11. Max. Allowable span (mm)

12. Cantilever Strength (kg)

13. OGA drawing enclosed

BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION BUSINESS ENGINEERING MANAGEMENT

DOCUMENT No.	TB-343-316-000	Rev. No.	02		Prepared	Checked	Approved
TYPE OF DOC.	TECHNICAL SPECIFICATION			SIGN			
TITLE	GENERAL TECHNICAL REQUIREMENTS-SECTION 3			NAME	NK	MK/AG	RK
				DATE	06.04.11	07.04.11	07.04.11
				GROUP	TBEM	W.O. No	80014

CUSTOMER	**Powergrid Corporation of India Ltd.**
PROJECT	**±800KV, 6000MW, HVDC MULTI-TERMINAL NER/ER – NR/WR INTERCONNECTOR-I PROJECT**
LOA NO.	**C-61901R-S056-8/NOA-II/3660 dated 21.3.2011 for Supplies & C-61901R-S056-8/NOA-IV/3662 dated 21.3.2011 for Services**

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GENERAL TECHNICAL REQUIREMENTS-SECTION 3

3 General

The Works covered by the Specification shall be designed, manufactured, built, tested and commissioned in accordance with the Acts, Rules, Laws and Regulations of India. The Equipment(s) shall also conform to the general requirements detailed in the following standards, which shall form an integral part of the Specification, in addition to meeting the specific requirements called for elsewhere in the Specification.

The Supplier shall note that the standards mentioned herein are not mutually exclusive or complete in themselves, but are intended to complement each other, with minimum repetition, to define the requirements of the Specification. In the event of a conflict between requirements of any two clauses of the Specification/ documents or requirements of different codes/ standards specified, the more stringent requirement as per the interpretation of the owner shall apply, unless confirmed otherwise by the owner in writing based on a written request from the Supplier.

In case of conflicting requirements between this document (General Technical Requirements - Section 3) and equipment specification (Section 1 & Section 2), equipment specification shall prevail.

When specific requirements stipulated in the Specification exceed or change those required by the applicable standards, the stipulations of the Specification shall take precedence.

Unless specifically agreed to by the Purchaser prior to Award of Contract, the Work shall be in accordance with the standards indicated and the requirements of the Specification. The Supplier shall be held responsible for any deviation.

In case of conflict between the various standards, the decision of owner shall be binding & final.

3.1 Definitions

The following words and expressions shall have the meanings hereby assigned to them throughout this document

"Biswanath Chariali " means Biswanath Chariali Converter Station

"Alipurduar " means Alipurduar Converter Station

"Agra" means Agra Converter Station

"Employer/Owner" means Power Grid Corporation of India Ltd.

"Purchaser" means Bharat Heavy Electricals Limited

"Supplier/Manufacturer" means the person or persons, firm or company assigned to execute the works as defined by the scope of supply, described here.

"Specification" refers to this document.

3.2 Instructions to Suppliers

The supplier should be approved by Power Grid. If not, it is the responsibility of the vendor to be assessed and approved by Power Grid, before placement of order by BHEL. Any cost involved in vendor assessment/approval must be borne by the vendor himself.

The supplier shall submit the technical requirements, data and information as per the technical data sheets provided in the appropriate clause of bid document.

Equipment furnished shall be complete in every respect with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/or needed for erection, completion and safe operation of the equipment as required by applicable codes though they may not have been specifically detailed in the Specifications unless included in the list of exclusions. Materials and components not specifically stated in the specification but which are necessary for commissioning and satisfactory operation of the switchyard/substation unless specifically excluded shall be deemed to be included in the scope of the specification and shall be supplied without any extra cost. All similar standard components/parts of similar standard equipment provided, shall be inter-changeable with one another.

The Supplier shall offer equipment whose similar equipment for similar applications have been in service for at least two years from the date of first stage bid opening (30-06-2009) and should have been type tested as per relevant standards.

The suppliers who have supplied 400 kV equipment rated for 40 kA earlier to POWERGRID, may supply 50 kA rated equipment subject to fulfilling specified requirements:

The supplier shall supply type tested (including special tests as per tech. specification) equipment and materials. The Employer shall accept the equipment type test reports under the following conditions:

(i) Type test in accordance with the relevant specified standards

(ii) Type tests performed within five (5) years from the date of first stage bid opening (30-06-2009)

(iii) The type tested equipment shall be of the same design, insulation class and rating as per the equipment offered under this contract

In the event that equipment furnished includes important modifications of, or significant departure from, the designs of equipment on which type test report has been furnished or if there is evidence that the equipment does not comply with the requirements of the Specifications, the Supplier shall conduct the type test without any cost implication to the Purchaser. In the price bid, the type test charges shall be included and no separate type test charges shall be indicated by the supplier.

Acceptance of the type test reports shall be at the discretion of the Employer. All type tests

performed after the date of award of the Contract shall be witnessed by the Employer unless authority to proceed with the tests in his absence is received from the Employer in writing.

3.3 Standards

All equipment and materials, unless otherwise specifically required in the Specification, shall conform to latest revisions of the standards listed in the Specification, in force at the time of signing of the contract for this project.

Generally the standards listed in the specification are applicable in accordance with the specific requirements of the technical section covering particular alternating current equipment or materials.

3.4 Site information

Table 3.4 - 1 Table for site information

	Particular	*Biswanath Chariali*	*Alipurduar*	*Agra*
a)	Employer/Owner	*Power Grid Corporation of India Ltd (POWERGRID)*		
b)	Project Title	*±800 kV, 6000 MW HVDC Multi terminal System Package*		
c)	Location	*70 km from Tezpur in Sonitpur district of Assam, Kolkatta port is the nearest port to the site*	*175 Kms. from Siliguri city in the state of West Bengal. Kolkatta port is the nearest port to the site*	*12.6 Km Agra-Shamsabad road PO – Shyamo, Agra*
d)	Nearest Rail Head	*Guwahati*	*Alipurduar junction*	*Agra*
e)	Postal Address	*To follow*	*To follow*	*To follow*
f)	Design ambient temp.	*40°C*	*40°C*	*50°C*
g)	SEISMIC COEFFICIENT	*Zone V Importance factor for the stations is 1.5 as per table no. 6 of IS-1893.*	*Zone IV Importance factor for the stations is 1.5 as per table no. 6 of IS-1893.*	*Zone III Importance factor for the stations is 1.5 as per table no. 6 of IS-1893.*
h)	Site Wind Pressure	*Zone V with basic wind speed of 50 m/s at 10 m height above mean ground level. The risk level coefficient/factor shall be taken as 1.07.*	*Zone IV with basic wind speed of 47 m/s at10 m height above mean ground level. The risk level coefficient/factor shall be taken as 1.07.*	*Zone III with basic wind speed of 44 m/s at 10 m height above mean ground level. The risk level coefficient/factor shall be taken as 1.07.*
i)	Isokeraunic Level	*150 days per year*	*150 days per year*	*50 days per year*
j)	Relative Humidity	*Max. 100%*		
k)	Rain fall Intensity	*In 24 hours: 250mm 80mm/hr (for drainage system Design*	*In 24 hours: 250mm 80mm/hr (for drainage system Design*	*In 24 hours: 200mm, 30mm/hr (for drainage system Design)*

3.5 Site temperatures for design purposes

The Supplier shall assume the temperatures given below for the design of the works at the converter stations.

Table 3.5 - 2 Table for Site temperatures

Description	*Temperature in deg C*		
Site	*Biswanath Chariali*	*Alipurduar*	*Agra*
Maximum dry bulb one hour average	*40*	*40*	*50*
Maximum dry bulb 24 hour average	*40*	*40*	*40*
Annual mean dry bulb temperature	*30*	*30*	*30*
Minimum dry bulb one hour average	*0*	*0*	*0*
Maximum wet bulb one hour average	*33*	*33*	*33*
Dry bulb temperature for low ambient condition	*33*	*33*	*33*
Wet bulb temperature for low ambient condition	*23*	*23*	*23*

3.6 Documentation

All technical description, specifications, literature, correspondence, prints, drawings, instruction manuals, test reports(both factory and site), progress photographs, booklets, schedules and all supplementary data or documents furnished in compliance with the requirements of the Contract, shall become the property of the Purchaser/owner and the costs shall be considered as included in the Contract price.

The Supplier shall be responsible for any time delay, misinterpretation, error and conflict during design, manufacturing, testing and erection of the Works resulting from non-compliance with the requirements of this Specification.

The Purchaser/owner shall have the right to make copies of any documents, data, reports, information etc. supplied by the Supplier in connection with the Works. The Purchaser/ owner shall not impart the information of these documents to any other manufacturer or competitor but he shall be free to use these for preparation of technical papers, reports etc.

The Supplier shall submit consolidated list of all symbols used in any drawing, data and information under three separate headings namely Civil, Mechanical & Electrical. If symbols other than IS or IEC are used, the Supplier shall submit consolidated list of these symbols and their significance under a separate section.

The Supplier is not required to supply detailed drawings whose purpose is manufacture only butin case such information is specifically asked for by the Purchaser/owner during evaluation of Bid, finalization of Contract, design review by Purchaser/owner his appointed Consultant or during execution of the Contract, the Supplier shall comply with the same.

All drawings, documents manual etc. as specified in this section shall have to be provided separately for each station.

All documentation shall be in English language.

Requirements for submission of documents, information and data by the supplier

General

The Supplier shall submit to the Owner/Purchaser all documents in accordance with an approved schedule of submissions and shall submit any further information (in the form of drawings, documents, manuals, literature, reports etc.) when asked by the Owner/Purchaser while commenting/approving any drawings/documents etc. All applicable documents shall be provided for each converter/repeater station separately.

The documents which are subject to the approval of the Owner/Purchaser shall be identified by the Supplier with the stamp "FOR APPROVAL". All other documents shall be submitted to the Owner/Purchaser for information and shall be identified by the Supplier with the stamp "FOR INFORMATION".

The sequence of submission of the documents shall be subject to the approval of the Employer. The sequence of submissions of all documents shall be such that the necessary information is available to enable the Employer to approve or comment the document.

The Supplier shall supply 5 hard copies of all drawings and documents. The final documentation for the project shall be supplied in nine sets of hard copies (three to each site) and nine sets of CDs to the Purchaser.

The entire plant documentation shall include all construction drawings, equipment specifications, design/study reports, O&M documents, factory test reports, etc. All the final/as built drawings shall be submitted in CAD format along with the complete final documentation.

In case a "SUBSEQUENT" revision of any document is made due to any reason whatsoever, a revision of the same, highlighting the changes shall be resubmitted for the Employer's specific approval/ information.

Documents for approval

Approved documents shall be considered as the working documents. However the Specification and connected documents shall prevail over these documents in case a decision is required on interpretation.

Documents for information

The Supplier shall not delay the Works pending the receipt by the supplier of the comments on documents submitted to the Owner/Purchaser for information. However, the Owner/Purchaser shall have the right to comment on all the documents submitted by the Supplier, when, in the opinion of the Owner/Purchaser the document does not comply with the Contract or otherwise. The Supplier shall satisfactorily demonstrate that the information contained in the aforesaid document does meet the requirements of the Contract or revise the document in order that the information shall comply with the requirements of the Contract.

Drawings and data

General

The Supplier shall submit to the Owner/Purchaser all assembly and detail drawings of equipment,

station design, civil work, building, controls, protection, etc., as well as the corresponding computation where necessary in order to establish to the satisfaction of the Owner/Purchaser the Supplier's compliance with the requirements of the Contract.

Drawings, as set forth below shall be submitted to the Owner/Purchaser and shall be completewith all information necessary for complete interpretation of the drawings by the Owner/ Purchaser. All drawings shall show the materials, dimensions, finish, fits, clearances, tolerances, bolting and such other information as is necessary to demonstrate to the Owner/ Purchaser that all items covered by the drawings are in compliance with the requirements of the Contract.

Drawings may consist of several sheets as required in order to provide for the degree of detail required by the Employer, so that he may clearly understand such drawings.

Not later than 90 (ninety) days after completion of successful trial operation of the HVDC station, the Supplier shall supply copies of the last revision of all drawings produced for this project, stamped as "AS BUILT".

The Supplier shall provide separate sets of drawings for each control cubicle. Typical drawings for similar cubicles shall not be accepted. If there are several cubicles per system, then one common bill of material and one system schematic diagram may be provided. Such system schematic diagram shall show the control scheme for the particular system in its entirety and shall be laid out on the minimum number of drawings sheets consistent with clarity and legibility.

The Owner/Purchaser shall not accept typical drawings for control, protection and three-phase schematics, power circuits and single line diagrams. The Supplier shall supply complete set of such drawings for each system, even when drawings are duplicates.

Inspections plans and documentation

The Supplier shall submit in required number copies for the Owner's/Purchaser's approval an inspection plan (quality plan) describing the inspection system indicating the inspections to be carried out and their sequence in the manufacturing stages.

The inspection plan shall be such that it can be related to the manufacturing program. The plan shall also include a description of the inspection methods employed with reference to the Supplier's written inspection procedures.

Separate inspection plans describing the inspection systems for equipment supplied by each sub-Supplier, in the same form as that of the Supplier, shall be submitted for the approval of the Owner/Purchaser.

In addition to the inspection plans referred to above, the Supplier shall submit complete and satisfactory evidence of possessing a working scheme assuring the control of all critical activities pertinent to the assurance of quality, and objective evidence (by means of quality manuals and appropriate forms, etc.) of this capability to employ and maintain quality control to meet the required quality level of the manufacture and construction of the Works.

Supplier's Quality Control Program in the context of this Clause means the implementation of a quality assurance program by means of which full conformance of material and workmanship to best

quality standards can be achieved effectively and economically by the Supplier's control and surveillance of all essential inspection operations, and periodic verification of the results of the manufacture of equipment and the assembly, erection and installation of equipment at the sites.

Required number of copies of all test reports, including those supplied by Sub-Suppliers, and shall be submitted to the Owner/Purchaser for approval. The Supplier shall include in the report all additional data required by the Owner/Purchaser to permit a clear understanding of the reports.

All test reports shall be certified and shall contain the signature of the Inspector as having witnessed the test, unless such witnessing has been specifically waived by the Owner/ Purchaser. A certified test report shall be issued for each test.

Instruction manuals and operating manuals

The Supplier shall provide Instruction & Maintenance Manuals for each part of the Plant and Equipment included in the Works and Operating Manuals for each Station.

The Instruction Manuals and Operating Manuals shall be arranged in an organized library adequately cross referenced to facilitate issuing clauses of the manuals as required by the work i.e. erection instructions shall be required before operating & maintenance instructions.

All Manuals provided by the Supplier shall be fully detailed and specifically prepared for the Works and equipment provided. General manuals not specifically required for the work shall not be acceptable.

The instruction manuals shall at least contain:

a) A general description of all components
b) Storage instructions
c) Erection instructions
d) Pre-commissioning Instruction :
e) Material and part list.
f) Design clearances and settings
g) Complete sets of drawings as finally issued
h) Operating Instructions:
i) Routine and Preventive Maintenance instructions with material requirement for each site
j) Preventive Maintenance Schedule.
k) Replacement instruction for all equipment

The operation manuals shall at least contain:

a) Operator oriented functional descriptions of the equipment.
b) Operator oriented description of the protection and control systems
c) Description of the equipment auxiliary systems
d) Fault finding and diagnostic tools
e) User software interface tools for modification/augmentation etc.

Notes:

The supplier may please note that all resubmissions must incorporate all comments given in the ear-

lier submission by the Owner/Purchaser or adequate justification for not incorporating the same must be submitted failing which the submission of documents is likely to be returned.

If after the commissioning and initial operation of the substation, the instruction manuals require any modifications/ additions/changes, the same shall be incorporated and the updated final instruction manuals shall be submitted by the Supplier to the Owner/Purchaser.

The Supplier shall furnish to the Owner/Purchaser, catalogues of spare parts also.

3.7 Quality assurance requirements

Quality assurance programme

To ensure that the equipment and services under the scope of Contract, whether manufactured or performed at the Supplier's Works or at his Sub-supplier's premises or at the Purchaser's site or at any other place of Work, are in accordance with the specifications, the Supplier shall adopt a suitable quality assurance programme to control such activities at all points, as necessary. Such programme shall be outlined by the Supplier and shall be submitted by the supplier after the award of contract and finally accepted by the owner after discussions prior to commencement of manufacturing.

A quality assurance programme of the supplier shall generally cover the following:

(a) Supplier's organisation structure for the management and implementation of the proposed quality assurance programme;
(b) Design and Documentation control system;
(c) Qualification data of Supplier's key personnel;
(d) The procedure for purchases of materials, parts components and selection of sub-Supplier's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchased etc.
(e) System for shop manufacturing and site erection controls including process controls and fabrication and assembly control;
(f) Control of non-conforming items and system for corrective actions;
(g) Inspection and test procedure both for manufacture and field activities;
(h) Control of calibration and testing of measuring and testing equipment.
(i) System for quality audits;
(j) System for indication and appraisal of inspection status
(k) System for authorising release of manufactured product to the Purchaser
(l) System for maintenance of records;
(m) Furnishing of quality plans (QP)/inspection and test plan (ITP) for manufacturing and field activities detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of equipment/component.

General requirements - Quality assurance

1. All services, materials, components and equipment covered under this specification shall be engineered, designed, procured, manufactured, erected, commissioned and tested at all the stages, as per a comprehensive Quality Assurance Programme. It is the Supplier's responsibility to draw up and implement agreed programme for system as a whole as well as for individual equipment.

The detailed Quality Plans for manufacturing and field activities shall be drawn up by the Supplier and shall be submitted to the Employer for approval.

The Supplier shall furnish with his bid a list of approved suppliers for the information of the Employer.

2. Engineering and design quality Plan shall detail out the studies, overall detail design documentation and communicating, defining interfaces and controlling changes. To achieve quality, reliability and schedule objectives that project shall be designed so that it meets performance requirements. Manufacturing Quality Plan shall detail out for all the components and equipment, various tests/inspection, to be carried out as per the requirements of this Specification and standards mentioned therein and quality practices and procedures followed by Supplier's Quality Control Organisation, the relevant reference documents and standards, acceptance norms, inspection documents etc., during all stages of materials procurement, manufacture, assembly, and final testing/performance testing.

3. Field Quality Plan shall detail out for all the equipment, the quality practices and procedures etc. to be followed by the Supplier's site Quality Control Organisation, during various stages of site activities from receipt of materials/equipment at site onwards.

4. The Supplier shall also furnish copies of the reference documents/plant standards/ acceptance norms/tests and inspection procedure etc., as referred in Quality Plans along with respective Quality Plan. These Quality Plans and reference documents/standards etc. shall be subject to Employer's approval without which manufacture shall not proceed. In these approved QPs, the Employer shall identify customer inspection points (CIP), test/checks which shall be carried out in presence of the Employer's Engineer or his authorised representative and beyond which the work shall not proceed without consent of Employer or his authorised representative in writing. All deviations to specification, approved quality plans and applicable standards must be documented and referred to the Employer for approval and disposition.

5. No material shall be dispatched from the manufacturer's works before the same is accepted subsequent to pre-dispatch final inspection including verification of records of all previous tests/inspections by Employer's Engineer and / or his authorised representative, and duly authorised for dispatch issuance of Material Inspection Clearance Certificate (MICC). Before making request for issuance of MICC, the Supplier shall ensure that approval of type tests, data sheets, drawing etc. had already been obtained from Employer. All materials used or supplied shall be accompanied by valid materials certificates and tests and inspection reports. These certificates and reports shall indicate the sheet numbers or other such acceptable identification numbers of the material. The material certified shall also have the identification details stamped on it.

6. All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME section - IX/BS-4870 or other International equivalent standard acceptable to the Employer.

7. All the (sub)-Vendors proposed by the Supplier for procurement of bought out item list of which shall be drawn up by the Supplier and finalised with the Employer shall be subject to the Employer's approval. Quality Plans of the successful vendors shall be discussed, finalised and approved by the Employer and shall form part of the purchase order between the Supplier and the Vendor.

8. The Employer reserves the right to carry out quality audit and qualify surveillance of the systems and procedures of the Supplier's of their sub-Supplier's (sub-vendor's) quality management and control activities. The Supplier shall provide all necessary assistance to enable the Employer carry out such audit and surveillance.

9. As a part of quality assurance of engineering and design, the technical review meetings (TRMs) shall be conducted between the Employer and/or his consultants/representative and the Supplier and/or his subSupplier(s). The duration and cycle of such TRMs shall be as frequent and regular as required to meet the time schedules. The meetings shall be held at either at the Employer's office and/or at the office/manufacturing place of the Supplier/sub-Supplier or at any other place as agreed mutually.

10. The Supplier shall agree upon a schedule of submissions of documents concerning the Quality Assurance Program within two months of the effective date of the Contract. This schedule shall indicate the list of mutually agreed items/equipment for which quality Plans shall be submitted by the Supplier and the last dates for the submissions. It shall be ensured by the Supplier that the submissions are so programmed that all relevant approvals are obtained from the Employer for these documents in a timely manner before the material induction and commencement of the manufacture for any equipment.

11. The documents that shall be submitted by the Supplier to the Employer for review and approval as per the agreed schedule include:

    a) QA Manuals
    b) Quality Plans (Inspection & Test Plans) for all equipment/materials manufactured in the Supplier's works and/or in the sub-Supplier's works
    c) Purchase Specifications for equipment procured from sub- Suppliers.
    d) Supplier's assessment reports of his sub-Suppliers
    e) Field Quality Plans for all activities at site
    f) Reference documents referred to in Quality Plan.
    g) Erection, commissioning, operation and maintenance manuals

12. QA Document Package

The Supplier shall submit the following Quality Assurance Documents to the Employer. These documents shall be as per the approved Quality Plans for the concerned equipment. The documents shall include, but not limited to, the following:

    a) Routine test reports & Acceptance test reports
    b) Type test reports
    c) Quality records etc. corresponding to items identified Quality Plan
    d) Inspection reports for Customer inspection points
    e) Reports on repair/modification carried out to make the item/equipment acceptable.
    f) Non-destructive examination result reports including radiography interpretation reports, wherever applicable.

The above documents are required to be submitted in required number of copies within three weeks after dispatch of equipment.

Inspection and testing

1. In order to verify that all the manufacturing of equipment by the Supplier as well as materials & equipment being procured and provided by the Supplier are in complete conformance with the requirement of theContract, the Employer and/or his duly authorized representative shall have access to the Supplier's premises or works at all reasonable times to inspect and examine the material, equipment and workman ship during its manufacture or installation. In addition to carrying out inspection the Employer and/or his authorized representative/Consultant all carry out quality audit on the Supplier's Quality Assurance System and conduct quality surveillance to check conformance to quality procedure/practice in general. The Supplier shall provide necessary facilities to carry out all the above activities at their works and the works of the sub- Suppliers.

2. The Supplier shall provide a detailed inspection schedule for those inspection stages identified as CIP and shall furnish updated schedules once every two months.

3. The Supplier shall give the Employer/Inspector six(6) weeks written notice, by telex or by letter, of the tentative date any material/equipment shall be ready for witness points, corresponding to Customer inspection points (CIP), when the Employer/Inspector is based in India. Final confirmation shall be given at least 15 days in advance. The Employer/Inspector, unless witnessing of the tests is waived, shall attend such tests, failing which the Supplier may proceed with the test which shall be deemed to have been made in the Inspector's presence. The Supplier shall forthwith forward to the Employer copies of duly certified test reports. Test reports of all tests corresponding to CIP performed in the supply shall be reviewed and approved, subject to satisfactory conduction and successful passing of the test, by the Employer or his authorised representative (even if the witnessing of the test was waived).

4. The Employer or his authorized representative shall, within fifteen (15) days from receipt of such reports, give notice in writing to the Supplier of any objection to any aspect of the test reports or any or all equipment and workmanship which in his opinion is not in conformance with the Contract. The Employer or his authorized representative shall advise his reasons for objections on completion and review of the activity. The Supplier shall give due consideration to such objection(s) and shall either make the modifications that may be necessary to overcome the said objection(s) or shall confirm in writing giving reasons therein that no modifications are necessary to comply with the Contract. However, the Supplier may proceed with the works/dispatch even before the receipt of written objection(s), if any, at his own cost & risk.

5. Whenever the Employer's inspection engineer undertakes the inspection, at a particular stage identified as Customer inspection point (CIP) in the Quality Plan, the acceptance of test reports/test results and the MICC where applicable shall be given immediately after the test if the results, including those for previous points identified as per clause 9.6 are found to be in conformity with the Contract. In case of any deviations, the Employer/Inspector at his discretion may refer the matter to the Employer's main office, together with the manufacturer's comments, who in turn shall communicate his final decision regarding the acceptance or otherwise to the Supplier within fifteen (15) days of the receipt of such test reports/results. In case the presence of the Employer/Inspector is waived, the acceptance of test results and issuance by the Employer of Material Inspection Clearance certificate wherever applicable, shall be given within fifteen (15) days after receipt of test reports/results for the CIP as well as for previous CIP's identified in the approved Quality Plan, provided such test reports/test results are found to be in order. The Em-

ployer/Inspector shall at his discretion and based on the outcome of any inspection and the requirements of the contract, have the right to 'accept', 'accept as noted' or 'reject' any equipment/material. The reasons/comments in case of each ruling shall be communicated to the Supplier in writing.

6. In all cases where the contract provides for tests, whether at the premises of works of the Supplier or of any sub-Supplier, the Supplier, except where otherwise specified, shall provide free of charge such items as labour, materials, electricity, fuel, water, apparatus and instruments as required to fulfil the requirements of the approved Quality Plan.

7. The inspection by Employer/Inspector or waver of the presence of the Employer/Inspector, issue of CIP clearance certificate and issue of Material Inspection clearance certificate (MICC) thereon shall in no way limit the liabilities and responsibilities of the Supplier in respect of the agreed quality plans forming part of the contract. The Employer shall not be found to accept the material/equipment if on further testing it is found to be not in compliance with the requirements of the contract. The Supplier shall include in all orders to his sub-Suppliers, the requirements for any equipment, being supplied by the sub- Supplier for incorporation in his equipment to be subjected to inspection and testing by the Employer or is authorised representative. Copies of such orders or purchase specifications, blanked for prices, shall be forwarded to the Employer.

8. The costs of all tests specified in the Contract together with the same for all tests facilities, test samples and such like shall be to the Supplier's account.

9. The Employer/Inspector shall have complete authority to reject, on behalf of the Employer, any material, equipment or parts thereof considered unsatisfactory and not in accordance with the Contract. Accept, accept as noted or reject materials, equipment or any components thereof shall not relieve the Supplier of any of his obligations under the Supplier, nor impose any liability whatsoever on the Employer.

10. The Employer shall have the right to have Inspectors on the Sites, on a regular basis or from time to time as required at his sole discretion to monitor the quality and the progress of the work. Generally the site inspection shall be as per the approved Field Quality Plans (FQPs) and the Installation & Operation Manual(s). All quality related documents and test results shall be a part of plant documentation.

3.8 Materials and workmanship

Where the specification does not contain references to workmanship, it is understood that the equipment shall be new, of the best quality and in accordance with the purpose for which they are intended.

In case where the equipment, materials or components are indicated in the specification as "similar" to any special standard, the owner shall decide upon the question of similarity. When required by the specification or when required by the Purchaser & owner the Supplier shall submit for approval, all the information concerning the materials or components to be used in manufacture. Machinery, equipment, materials and components supplied, installed or used without such approval shall run the risk of subsequent rejection, it being understood that the cost as well as the time delay associated with the rejection shall be borne by the Supplier.

The design of the Works shall be such that installation, future expansions, replacements and general maintenance may be undertaken with a minimum of time and expenses. Each component shall be designed to be consistent with its duty and suitable factors of safety shall be used throughout the design.

All joints and fastenings shall be devised, constructed and documented so that the component parts shall be accurately positioned to fulfil their required function. In general, screw threads shall be standard metric threads. The use of other thread forms will only be permitted when prior approval has been obtained from the owner.

Whenever possible, all similar parts of the works shall be made to gauge and shall also be made interchangeable with similar parts. All spare parts shall also be made interchangeable and shall be made of the same materials and workmanship as the corresponding parts of the equipment supplied under the specification. All the equipment of the same type and rating shall be physically and electrically interchangeable.

All materials and equipment shall be installed in strict accordance with the manufacturer's recommendation(s). All factory assembled rotating machinery shall be checked for alignment and adjustments made as necessary. The spare equipment(s) shall be installed at designated locations and tested for healthiness.

The Supplier shall apply oil and grease of the proper specification as is necessary for the installation of the equipment. Lubricants used for installation purposes shall be drained out and the system flushed through where necessary in readiness for applying the lubricant required for operation. The Supplier shall apply all operational lubricants to the equipment installed by him. All insulating oil, lubricating material, grease and other consumables used in the Works/ Equipment shall be purchased in India unless the Supplier has any special requirement for the specific application for a type of oil or grease not available in India. If such is the case he shall declare in the proposal where such oil or grease or other consumables is available. In any case he shall identify equivalent Indian makes and inform the Purchaser & owner of the name of at least two Indian suppliers before handing over of the Works to the Purchaser. All consumables required upto operational acceptance shall be the part of supply scope of the Supplier.

The supplier shall perform all tests and inspection necessary to ensure that the material and workmanship conform to the approved design drawings and that such tests are adequate to demonstrate that the equipment shall comply with the requirements of the Specification & relevant standards.The supplier shall test the component parts at his plant or his Sub- supplier's plant, prior to packaging and shipping, to determine that the performance requirements have been met. All testing shall be in accordance with the Standards related to the piece of work.

3.9 Colour schemes

The Supplier shall propose a colour scheme for the equipment for the approval of the Employer. The decision of the Employer shall be final. However, the finishing colour shall be RAL 7035 for indoor panels and RAL 7032 for outdoor panels. The scheme shall include:

- Finishing colour of Indoor equipment
- Finishing colour of Outdoor equipment
- Finishing colour of various auxiliary system equipment including piping
- Finishing colour of various building items.

- Finishing colour of all cubicles.

All steel structures, plates etc shall be painted with non-corrosive paint on a suitable primer. The galvanised structures in the switchyard shall not be painted. However galvanised structures in other areas may require painting for aesthetic reasons.

3.10 Clamps & connectors

i) All power clamps and connectors shall conform to IS: 5561, and/or IEC standard and shall be made of materials listed below:

a)	For connecting ACSR conductors	Aluminium alloy casting, conforming to designation A6 of IS: 617 and shall be tested for all tests as per IS:617
b)	For connecting equipment terminals made of copper with ACSR conductors	Bimetallic connectors made from aluminium alloy casting, conforming to designation A6 of IS 617 with 2 mm thick Bimetallic liner and shall be tested as per IS: 617.
c)	For connecting G.I. Shield wire	Galvanised mild steel
d).1	Bolts, nuts & Plain washers.	Electro galvanized for sizes below M12, for others hot dip galvanised
d).2	Spring washers for items 'a' to 'c'	Electro-galvanised mild steel suitable for at least service condition-3 as per IS: 1573

ii) Equipment shall be supplied with the necessary terminals and connectors, as required by the ultimate design for the particular installation. The conductor terminations of equipment shall be either expansion, sliding or rigid type. The requirements regarding external corona and RIV as specified for any equipment shall include its terminal fittings and the equipment shall be factory tested with the connectors in position. In case the connector is not available then equivalent connector may be used. If corona rings are required to meet these requirements they shall be considered as part of that equipment and included in the scope of Work.

iii) Where copper to aluminium connections are required, bi-metallic clamps shall be used, which have been properly designed to ensure that any deterioration of the connection is kept to a minimum and restricted to parts which are not current t shall be furnished to the Employer.

iv) Low voltage connectors, grounding connectors and accessories for grounding all equipment as specified are also included in the scope of Work.

v) No current carrying part of any clamp shall be less than 10 mm thick. All ferrous parts shall be hot dip galvanised. Copper alloy liner of minimum 2mm thickness shall be cast integral with aluminium body for Bi-metallic clamps. When copper alloy is not cast integral with aluminium body, a bimetallic washer or strip shall be used to meet the functional requirement.

vi) All casting shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.

vii) Flexible connectors, braids or laminated straps made for the terminal clamps for bus posts shall be suitable for both expansion or through (fixed/sliding) type connection of IPS Aluminium tube as required. In both the cases the clamp height (top of the mounting pad to centre line of the tube) should be same.

viii) Clamp shall be designed to carry the same current as the conductor and the temperature rise shall be equal or less than that of the conductor at the specified ambient temperature. The rated current for which the clamp/connector is designed with respect to the specified reference ambient temperature, shall also be indelibly marked on each component of the clamp/connector, except on the hardware.

ix) All current carrying parts shall be designed and manufactured to have minimum contact resistance.

x) TESTS

The following is the list of type tests.
a) Temperature rise test (maximum temperature rise allowed is 35deg C over 50 deg C ambient)
b) Short time current test
c) Dry corona and RIV test as per annexure-A
d) Resistance test and tensile test

3.11 Name Plates and Markings

All equipment mounted on front and rear side as well as equipment mounted inside the panels shall be provided with individual nameplates with equipment designation engraved. Also on the top of each panel on front as well as rear side, large and bold nameplates shall be provided for circuit/ feeder designation.

All front mounted equipment shall also be provided at the rear with individual name plates engraved with tag numbers corresponding to the one shown in the panel internal wiring to facilitate easy tracing of the wiring.

All relays and other devices shall be clearly marked with manufacturer's name, manufacturer's type, serial number and electrical rating data.

Name Plates shall be made of non-rusting metal or 3-ply lamicoid. Name plates shall be black with white engraving lettering.

All the panels shall be provided with nameplate mounted inside the panel. Stainless steel nameplates shall be installed on all apparatus and on all major equipment components. For indoor cubicles, nameplates made of aluminium shall also be acceptable. Name plates shall be white with black engraved lettering and shall carry all the applicable information specified in the applicable items of the Standards, together with any other relevant information which may be required. For groups of smaller items for which this is not possible e.g. switch bays etc. a common nameplate with the title and special instructions on it shall be provided. No scratching, corrections or changes shall be allowed on nameplates. Main equipments like converter transformer, CBs, Reac-

tor, Filter gates etc shall have nameplates in Hindi also.

All equipment mounted on front and rear sides as well as equipment mounted inside the panels shall be provided with individual name plates with equipment designation engraved. Also on the top of each panel on front as well as rear sides large name plates with bold size lettering shall be provided for circuit / feeder / cubicle / box designation.

All front mounted equipment shall also be provided at the rear with individual name plates engraved with tag numbers corresponding to the one shown in the panel internal wiring to facilitate tracing of the wiring. The nameplates shall be mounted directly by the side of the respective equipment and shall not be hidden by the equipment wiring.

The nameplate inscription and size of nameplates and letters shall be submitted to the Employer for approval.

The nameplates of the apparatus shall include, at least, the information listed below, together with any other relevant information specified in the applicable standards:

a) A concise descriptive title of the equipment

b) Rating and circuit diagram reference numbers

c) Manufacturer's name, trade-mark, model type, serial number d) Instruction book number
e) Year of manufacture

f) Total weight (for capacitor racks indicate weight, for capacitors indicate quantity of liquid)

g) Special instructions, if any, about storage, transportation, handling etc.

Each measuring instrument and meter shall be prominently marked with the quantity measured e.g. kV, A, MW etc. All relays and other devices shall be clearly marked with manufacturer's name, manufacturer's type, serial number and electrical rating data.

Danger plates and plates for phase colours shall be provided as per requirement. The Supplier shall devise a system to designate equipment and sub-systems. The nameplates/ labels displaying these designations shall be installed at appropriate locations. Wherever motion/ flow of fluids are involved, plates/ marks showing direction of motion/ flow shall also be provided.

Each main and auxiliary item of substation is to have permanently attached to it in a conspicuous position a rating plate of non-corrosive material upon which is to be engraved manufacturer's name, year of manufacture, equipment name, type or serial number together with details of the loading conditions under which the item of substation in question has been designed to operate, and such diagram plates as may be required by the Purchaser. The rating plate of each equipment shall be according to IEC requirement.

All such nameplates, instruction plates, rating plates of transformers, reactors, CB, CT, CVT, SA, Isolators, C & R panels and PLCC equipments shall be bilingual with Hindi inscription first followed by English. Alternatively two separate plates one with Hindi and the other with English inscriptions may be provided.

3.12 Provisions for Exposure to Hot and Humid Climate

Outdoor equipment supplied under the specification shall be suitable for service and storage under tropical conditions of high temperature, high humidity, heavy rainfall and environment favourable to the growth of fungi and mildew. The indoor equipments located in non-air conditioned areas shall also be of same type.

3.12.1 Space Heaters

The heaters shall be suitable for continuous operation at 240 V ac supply voltage & shall be connected to the supply through a fuse.

One or more heaters shall be provided, with thermostats or hygrostat, to prevent condensation in any compartment. The heaters shall be suitable to maintain the compartment temperature at approximately10 deg. C, above the outside air temperature to prevent condensation.

Control cubicles installed in air-conditioned area need not be provided with space heaters. These cubicles shall, however, have space heaters in case of storage of cubicles for long duration.

3.12.2 Fungi Static Varnish

Besides the space heaters, special moisture and fungus resistant varnish shall be applied on parts which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

3.12.3 Ventilation Opening

In order to ensure adequate ventilation, compartments shall have ventilation openings provided with fine wire mesh of brass or galvanized steel to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds.

3.12.4 Tropicalisation

The service building and bay kiosk shall be air-conditioned whereas the valve halls and indoor DC yard at Agra shall have ventilation system with positive pressure. All equipments shall, however, be suitable for installation in a tropical monsoon area having hot, humid climate and dry & dusty seasons with ambient conditions as specified. All control wiring, equipment and accessories shall be protected against fungus growth, condensation, vermin and other harmful effects due to a tropical environment.

3.13 Painting and finishing of metal surfaces

All sheet steel work shall be phosphated in accordance with the IS:6005 "Code of practice for phos-

phating iron and steel".

Oil, grease, dirt and swarf shall be thoroughly removed by emulsion cleaning.

Rust and scale shall be removed by pickling with dilute acid followed by washing with running water rinsing with a slightly alkaline hot water and drying.

After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying.

The phosphate coating shall be sealed with application of two coats of ready mixed, stoved type zinc chromate primer. The first coat may be "flash dried" while the second coat shall be stoved.

After application of the primer, two coats of finishing synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after inspection of first coat of painting. The exterior colour of paint shall be of a slightly different shade to enable inspection of the painting.

A small quantity of finished paint shall be supplied for minor touching up required at site after installation of the panels.

In case the Supplier proposes to follow his own standard surface finish and protection procedures any other established painting procedures, like electrostatic painting etc., the procedure shall be submitted along with the Bids for Purchaser's review & approval. The Supplier shall use procedures for painting approved by the Employer during detailed Engineering.

3.14 Hot Dip Galvanising

The minimum weight of the zinc coating shall be 615 gm/ sq.m and minimum thickness of coating shall be 85 microns for all items thicker than 6 mm. For items less than 6 mm, requirements of coating thickness shall be as per relevant ASTM. For surfaces, which shall be embedded in concrete, the zinc coating shall be 900-gm/sq.m .

The galvanized surfaces shall consist of a continuous and uniform thick coating of zinc, firmly adhering to the steel. The finished surface shall be clean and smooth and shall be free from defects like discoloured patches, bare spots, unevenness of coating, which is loosely attached to the steel globules, spiky deposits, blistered surfaces, flaking or peeling off, etc. The presence of any of these defects noticed on visual inspection shall render the material liable to rejection.

After galvanizing, no drilling or welding shall be performed on the galvanized parts of the equipment except the nuts may be rethreaded after galvanizing. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanization.

The galvanized steel shall be subjected to six one-minute dips in copper sulphate solution as per IS-2633.

Sharp edges with radii less than 2.5 mm shall be able to withstand four immersions of the Standard Preece test. All other coatings shall withstand six immersions.

The following galvanizing tests should be performed as per relevant Indian Standards.

- Coating thickness
- Uniformity of zinc
- Adhesion test
- Mass of zinc coating

3.15 Control cabinets, junction boxes, terminal boxes & marshalling boxes for equipment

All types of boxes, cabinets etc. shall generally conform to & be tested in accordance with IS-5039/IS-8623, IEC-60439, as applicable, and the clauses given below:

1. Enclosure for control cabinets, junction boxes, Marshalling boxes & terminal boxes shall be made of stainless steel or aluminium and shall be dust, water and vermin proof. The box shall be properly braced to prevent wobbling. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation.

2. The enclosures of the control cabinets, junction boxes, terminal boxes & marshalling boxes located outdoor shall provide a degree of protection of not less than IP 55 as per IS-13947:Part I One control cabinet, junction box, terminal box & marshalling box of each type shall be tested for the same.

3. Cabinets/boxes shall be freestanding floor-mounting type, wall mounting type, or pedestal mounting type as required. Equipments such as telephone exchange, Public address systems etc shall be kept inside cubicles.

4. Cabinets/ boxes shall be provided with double-hinged doors with padlocking arrangements. The distance between two hinges shall be adequate to ensure uniform sealing pressure against atmosphere. The quality of the gasket shall be such that it does not get damaged/cracked during the operation of the equipment.

5. All doors, removable covers and plates shall be gasketed all around with suitably profiled EPDM gaskets. The gasket shall be tested in accordance with approved Quality Plan. Ventilating louvers, if provided, shall have screen and filters. The screen shall be fine wire mesh made of brass.

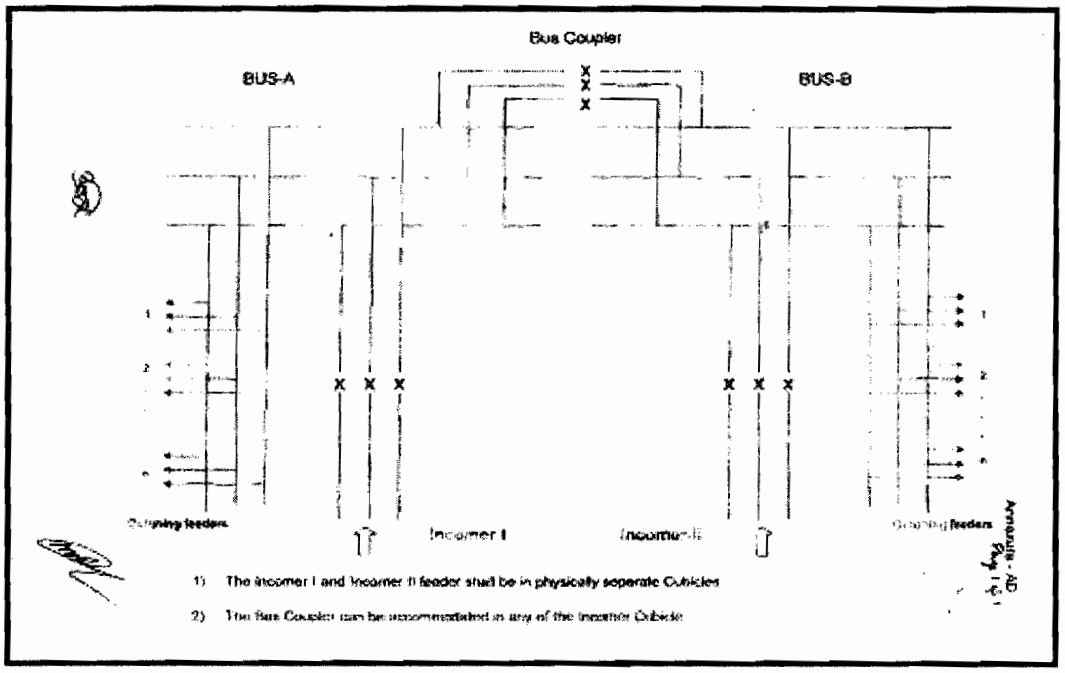
6. All boxes/cabinets shall be designed for the entry of cables from the bottom by means of weatherproof and dust-proof connections. Boxes and cabinets shall be designed with generous clearances to avoid interference between the wiring entering from below and any terminal blocks or accessories mounted within the box or cabinet. A suitable horizontal cable gland plate positioned at least 150 mm above the base of the marshalling kiosk/box shall be provided for this purpose along with the proper blanking plates. Necessary number of cable glands shall be supplied and fitted on this gland plate. The gland shall project at least 25mm above gland plate to prevent entry of moisture in cable crutch. Gland plate shall have provision for some future glands to be provided later, if required. The glands shall be dust proof, screw on & double compression type and made of brass. The gland shall have provision for securing armour of the cable separately and shall be provided with earthing tag. The glands shall conform to BS: 6121 and shall be nickel-plated.

Boxes / cabinets to be located inside a building in a non air- conditioned area may be designed for the entry of cables from the bottom or from the top.

The (415 V) secondary distribution system shall be made up of 415 V power centres serving the different classes of loads either directly or thorough motor control centres. Two separate 415 V power centres, one for each pole shall be provided. The two sections of power control centres (PCC) feeding the duplicated loads, like pumps, fans, heat exchangers, etc. as well as the duplicated supply circuits shall be physically independent, permanently energized and fed by different sections of the 415 V power centres. A tie circuit breaker, shall be provided between the two sections of above PCC feeding the duplicated loads, in order that when one section of PCC is out for maintenance or fault, the other section can supply all the loads.

The motor control centres (MCC) shall be provided in accordance with the relevant Standards. The MCC shall be located near the supplied loads. The incomers of the MCC shall be individually interlocked to prevent paralleling of two different power centre buses. The 240 V loads shall be supplied by 240 V panels located in the MCC or outside the MCC where it is required.

415 V MCCs for valve cooling, pump house, valve hall ventilation system, air-conditioning system etc. shall be arranged as per figure given below:



25% spare feeders, but not less than one of each type and rating shall be provided on 415V switchgears, power centres and motor, control centres as well as on all dc distribution boards

The AC & DC Distribution Boards shall have a fixed type, floor-mounted, free-standing, metal enclosed, with compartmentalised construction. They shall have separate Busbar chamber and cable alleys. All equipment for each feeder (i.e. main switch, HRC fuses, neutral link and cable terminals) shall be housed in a fully enclosed compartment with a separate hinged door,

such that fuse replacement, cable termination/replacement etc. are possible with complete safety, even if the Busbar and adjacent feeders are live. The connections from Busbar to the main switch shall be fully insulated/shrouded, and securely bolted. The partition between the feeder compartment and cable alley shall be non- metallic and shall be of such construction as to allow cable cores with lugs to be easily inserted in the feeder compartment for termination. Cable alley shall have no exposed live parts, and shall have no communication with Busbar chamber. The main switch shall be operated from outside, and shall be interlocked with the compartment door such that the latter can be opened only when the switch is OFF. However, it shall be possible to defeat this interlock and open and close the door with the switch ON. Busbar chamber shall be completely enclosed with metallic partitions. Bolted covers shall be provided for access to horizontal and vertical Busbar and all joints, for repair and maintenance, which shall be feasible without disturbing the feeder compartment. Cable alley door shall preferably be hinged. The main switch shall have the facility of being pad- locked in both ON and OFF positions. The switch handle shall clearly indicate the position of main switch. The Supplier shall furnish suitable plugs to cover the cable openings in the partition between feeder compartment and cable alley, for at least 50% of the total number of feeders. The distribution boards shall have a degree of protection of at least IP52 as per IS-13947:Part I.

All 415V switchgear (circuit breaker boards) shall be of single front type, with fully draw out circuit breakers, which can be drawn out without having to unscrew any connections. The circuit breakers shall be mounted on rollers and guides for smooth movement between SERVICE, TEST and ISOLATED positions and for withdrawal from the Switchboard. Testing of the breaker shall be possible in the TEST position. Unless kept in OFF position it shall not be possible to withdraw the modules from service position or rack them into service position.

All outgoing feeders in distribution boards shall be through MCBs/MCCBs.

Circuit breakers shall be three pole air break horizontal draw out type and shall have inherent fault making and breaking capacities as specified. The circuit breakers which meet specified parameter only after provision of releases or any other devices shall not be acceptable.

All circuit breakers shall be provided at least with 4 NO and 4 NC potentially free auxiliary contacts. These contacts shall be in addition to those required for internal mechanism of the breaker. Separate limit switches each having required number of contacts shall be provided in both 'SERVICE' & 'TEST' position of the breaker.

Control cabinets, junction boxes, Marshalling boxes and terminal boxes shall be made of sheet steel or aluminium enclosure.Sheet steel used shall be at least 2.0-mm thick cold rolled or 2.5 mm hot rolled. In case of aluminium enclosed box the thickness of aluminium shall be such that it provides adequate rigidity and long life as comparable with sheet steel of specified thickness.

7. Earthing

The provision for earthing shall be generally as per requirements given in Clause 3.16.2

8. Tests

a) The Marshalling Kiosks shall be subject to routine tests as per IS: 5039

b) The following routine tests shall also be conducted:

i) Check for wiring

ii) Visual and dimension check

Marshalling kiosk shall be provided with danger plate and a diagram showing the numbering/ connection/ ferruling by pasting the same on the inside of the door.

Marshalling kiosk shall also be provided with incoming MCB and one 15 Amp interlocked switched socket in addition to the MCB required.

3.16 Indoor control cubicles

The control panel, cubicles and desks shall be in accordance with the relevant IEC standards and shall be installed in air-conditioned space. Indoor electronic cubicles shall not generally require fans for cooling in order to operate successfully and correctly at the maximum ambient temperature. However, if it is absolutely necessary to install fans etc. in cubicles for cooling then these shall be driven by the same dc supply as used for control, and necessary redundancy, failure alarm etc. shall be incorporated. Louvers in the doors and side panels shall be permitted, if required.

The control and relay panels shall be suitable for numerical relays of modular type mounted in standard 19 inch racks located on the vertical front panel with rear doors for access or located on the front doors for front access type panels. Panels Cubicles shall be completely metal enclosed and shall be dust, moisture and vermin proof. The enclosure shall provide a degree of protection not less than IP 32 in accordance with IS-13947:Part I for cubicles located in air-conditioned areas. IP 31 may also be acceptable for these areas if the layout is arranged such that there is no possibility at all of any liquid entering the area. However, for ventilation reasons the cubicles may be provided with a ventilation hood at the top with a protection class of IP21.

Panels shall be free standing, floor mounting type and shall comprise structural frames enclosed completely with specially selected smooth finished, cold rolled sheet steel of thickness not less than 2.5 mm for weight bearing members of the cubicles such as base frame, front sheet and door frames, and 1.5 mm for sides, door top and bottom portions. There shall be sufficient reinforcement to provide level surfaces, resistance to vibration and rigidity during transportation and installation. The cubicles shall be provided with lifting lugs.

All doors, removable covers and plates shall be gasketed all around with neoprene gaskets. Ventilation louvers, if provided, shall have screens and filters. The screens shall be made of either brass or GI wire mesh with a graduation of 1 mm or less.

Design, material selection and workmanship shall be such as to result in a neat appearance, inside and outside with no welds rivets or bolt heads apparent from outside, with all exterior surfaces true and smooth. All cubicles located in any room shall be matched in appearance.

The Supplier along with anchor bolts and necessary hardware for mounting the cubicles shall furnish metal sills in the form of metal channels properly drilled. Panels shall have an additional rolled channel plinth at the bottom with a smooth bearing surface. The panels shall be fixed on channels with intervening layers of anti- vibration strips made of shock absorbing material, which shall be

supplied by the Supplier.

Supplier's standard practice for control panels shall be acceptable to the Employer/Purchaser subject to approval during detailed engineering and meeting all functional requirements of the specification.

3.16.1 Mounting

All equipment on and in panels shall be mounted and completely wired to the terminal blocks ready for external connections. The equipment on front of panel shall be mounted flush. No equipment shall be mounted on the doors.

Equipment shall be mounted such that removal and replacement can be accomplished individually without interruption of service to adjacent devices and are readily accessible without use of special tools. Terminal marking on the equipment shall be clearly visible.

The Supplier shall carry out cut out, mounting and wiring of the free issue items supplied by others, which are to be mounted in his panel in accordance with the corresponding equipment manufacturer's drawings. Cut outs if any, provided for future mounting of equipment shall be properly blanked off with blanking plate.

The centre lines of switches, push buttons and indicating lamps shall be not less than 750mm from the bottom of the panel. The centre lines of relays, meters and recorders shall be not less than 450mm from the bottom of the panel

The centre lines of switches, push buttons and indicating lamps shall be matched to give a neat and uniform appearance. Like wise the top lines of all meters, relays and recorders etc. shall be matched.

No equipment shall be mounted on the doors.

At existing station, panels shall be matched with other panels in the control room in respect of dimensions, colour, appearance and arrangement of equipment (centre lines of switches, push buttons and other equipment) on the front of the panel.

3.16.2 Earthing

1) All panels shall be equipped with an earth bus securely fixed. Location of earth bus shall ensure no radiation interference for earth systems under various switching conditions of isolators and breakers. The material and the sizes of the bus bar shall be at least 25 X 6 sq. mm perforated copper with threaded holes at a gap of 50mm with a provision of bolts and nuts for connection with cable armours and mounted equipment etc for effective earthing. When several panels are mounted adjoining each other, the earth bus shall be made continuous and necessary connectors and clamps for this purpose shall be included in the scope of supply of Supplier. Provision shall be made for extending the earth bus bars to future adjoining panels on either side.

2) Provision shall be made on each bus bar of the end panels for connecting Substation earthing grid. Necessary terminal clamps and connectors for this purpose shall be included in the scope

of supply of Supplier.

3) All metallic cases of relays, instruments and other panel mounted equipment including gland plate, shall be connected to the earth bus by copper wires of size not less than 2.5 sq. mm. The colour code of earthing wires shall be green.

4) Looping of earth connections, which would result in loss of earth connection to other devices when the loop is broken, shall not be permitted. Earthing may be done in such a manner that no circulating current shall flow in the panel.

5) VT and CT secondary neutral or common lead shall be earthed at one place only at the terminal blocks where they enter the panel. Such earthing shall be made through links so that earthing may be removed from one group without disturbing continuity of earthing system for other groups.

6) An electrostatic discharge point shall be provided in each panel connected to earth bus via 1 Mega Ohm resistor.

3.16.3 Instruments, meters and recorders

Only digital displays and systems shall be provided. The requirements in this section are applicable to auxiliary systems only. All instruments, meters and recorders shall be enclosed in dust proof, moisture resistant, black finished cases and shall be suitable for tropical use. They shall be calibrated to read directly the primary quantities. They shall be accurately adjusted and calibrated at the factory and shall have means of calibration, checking and adjustment at site.

3.16.4 Miscellaneous

1) The Supplier shall submit all type and routine test certificates to the Employer & Purchaser for approval before dispatching the equipment. Control and relay panels shall also be subjected to the following tests:
   i) Mechanical operation test
   ii) Verification of degree of protection as per IS-13947:Part I
   iii) High voltage test
   iv) Electrical control, Interlock and sequential operation test
   v) Verification of wiring as per approved schematic.

2) Plug Point: 240V, Single phase 50Hz, AC socket with switch suitable to accept 5 Amps and 15 Amps pin round standard Indian plug, shall be provided in the interior of each cubicle with ON-OFF switch.

3) Interior Lighting: Each panel shall be provided with a CFL lighting fixture rated for 240 Volts, single phase, 50 Hz supply for the interior illumination of the panel controlled by the respective panel door switch. Adequate lighting shall also be provided for the corridor in Duplex panels.

4) MCB's: Each panel shall be provided with necessary arrangements for receiving, distributing and isolating of DC and AC supplies for various control, signalling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with miniature circuit breakers (MCB).

5) Space Heater: Panels wherever required shall be provided with a space heater rated for 240V single phase, 50 Hz Ac supply for the internal heating of the panel to prevent condensation of moisture. The fittings shall be complete with thermostat and switch fuse /MCB unit.

3.16.5 Terminal blocks and wiring

All internal wiring to be connected to external equipment shall terminate on terminal blocks. Terminal blocks shall be 650 V grade and have 10 Amps. Continuous rating, moulded piece, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts. Markings on the terminal blocks shall correspond to wire number and terminal numbers on the wiring diagrams. All terminal blocks shall have shrouding with transparent unbreakable material.

Disconnecting type terminal blocks for current transformer and voltage transformer secondary leads shall be provided. Also current transformer secondary leads shall be provided with short circuiting and earthing facilities.

Spare terminals for Employer's use for upgrading to 6000 MW shall be provided wherever required. In addition, at least 20% spare terminals shall be provided on each panel and these spare terminals shall be uniformly distributed on all terminal blocks.

The terminal blocks shall be suitable for connecting the conductors of external cable on each side.

Terminal blocks shall be of (at least) 650V grade and have 10 amps continuous rating. These shall be moulded, complete with insulated barriers, stud type terminals, complete with washers, nuts and lock nuts. Screw clamp, overall insulated, insertion type, rail mounted terminals can be used in place of stud terminals with locking type. The terminal blocks shall be of reputed make subject to Employer's acceptance.

Terminal block design shall include a white fibre marking strip with clear plastic, /clip-on terminal covers. Markings on the terminal strips shall correspond to wire numbers on the wiring diagrams.

Terminal blocks for current transformer and voltage transformer secondary leads shall be provided with test links and isolating facilities. The current transformer secondary leads shall also be provided with short-circuiting and earthing facilities.

The conducting part in contact with the cable shall preferably be tinned or silver-plated however; nickel-plated copper shall also be acceptable. Insulating barriers shall be provided between the terminal blocks.

Manufacturer's standard practice for internal wiring of cubicles shall be acceptable to the Employer. However all external cabling requirements shall be strictly as per TS.

The Supplier shall furnish all wire, conduits and terminals for the necessary inter-phase electrical connections (where applicable) as well as between phases and common terminal boxes or control cabinets.

3.17 Degree of protection

The enclosures of the control cabinets, Junction boxes and Marshalling boxes, panels etc. to be installed as detailed here under:

The minimum requirements for panels are as follows:

Installed out door: IP- 55
Installed indoors in air-conditioned area: IP-32
Installed in covered area: IP-52
Installed indoors in non air-conditioned area where possibility of entry of water is limited: IP-41.
For LT Switchgear (AC & DC distribution Boards): IP-52.

The degree of protection shall be in accordance with IS:13947 (Part-I) / IEC-947 (Part-I) / IS 12063 / IEC 529. Type test report for degree of protection test, on each type of the box shall be submitted for approval

3.18 Welding and welders' qualifications

All welding shall be in accordance with the corresponding standards of the American Welding Society or the American Society of Mechanical Engineers. Welding shall comply with powergrid approved quality plan.

Other standards to determine the quality of welding processes and qualifications of welders may be considered, provided that sufficient information is first submitted for the approval of the Employer.

Prior to the start of fabrication, the Supplier shall submit to the Employer for approval, a description of each of the welding procedures which he proposes to adopt, together with certified copies of reports of the results from tests made in accordance with these procedures.

The Supplier shall be responsible for the quality of the work performed by his welding organization. All welding operators shall be assigned to the work, including for repair of castings, shall pass the required tests for qualification of welding procedures. The Employer reserves the right to witness the qualification tests for welding procedures and operators and the mechanical tests of the samples. If the Inspector so requires, the Supplier shall furnish to the Inspector certified copies of reports of the mechanical test results of the samples.

The Supplier shall bear all his own expenses in connection with the qualification tests. If the work of any operator at any time appears questionable, such operator shall be required to pass appropriate re-qualification tests as specified by the Inspector and at the expense of the Supplier.

Strict measures for quality control shall be exercised throughout the Equipment/Works. The Engineer may call for an adequate NDT test of the work of any operator, who, in his opinion, is not maintaining the required standard of workmanship. Should this NDT test prove defective, all work done by that operator, since his last test shall be tested at the Supplier's expense. If three or more of these tests prove defective, the operator shall be removed from the project.

A procedure for the repair of defects shall be submitted to the Employer for his approval prior to any

repairs being made.

3.19 Motors

All motors shall conform to IEC-60034-5 / IS Standard and with principal dimensions in accordance with IEC 60072-1 (1991), IEC 60072-2 (1990) and IEC 60072-3 (1994).

Motors rated 0.5 kW and above, and reversing motors, shall be rated 415 V, three phase, grounded neutral;

Motors rated below 0.5 kW shall be rated 240 V one phase;

All motors shall be designed to operate at full load dynamic conditions with a voltage range of variation of +10%, -20% and a frequency range variation of +5%,-10%. Motors shall also be designed to operate at 125% of the rated speed without mechanical damage, and to start with 80% of their rated voltage;

All motors shall be designed and rated for continuous operation at maximum ambient temperature of 50oC. The class of insulation shall be at least one class higher than used for defining the temperature rise of the motor;

Vertical motors rated 60 kW and above shall be provided with oil-lubricated
self-cooled pivoted shoe-type thrust bearing. Vertical motors below 60 kW shall be provided with re-greasable anti-friction ball or roller bearings;

All anti-friction bearings shall be guaranteed to operate successfully for a minimum of 131,000 hours;

All bearings shall be quiet operating and statically and dynamically balanced;

All belts to be used shall be "V" type and designed for the maximum power to be transmitted and for the maximum speed. The selection of the "V" belt drive for any application shall also be based on the nature of the load and the type of the driving unit. Belts installed outdoors shall be suitably protected.

3.20 Conduits, pipes and accessories

The Supplier shall supply and install all rigid conduits, mild steel pipes, flexible conduits, hume pipes etc. including all necessary sundry materials, such as tees, elbows, check-nuts, bushings, reducers, enlargers, wooden plugs, coupling caps, nipples, gland sealing fittings, pull boxes etc. The size of the conduit/pipe shall be selected to limit the fill to a maximum of 40%. All conduits/pipes shall have their ends closed by caps until cables are pulled. After cables are pulled, the ends of conduits/pipes shall be sealed in an approved manner to prevent damage to threaded portions and en- trance of moisture and foreign materials.

PVC conduits shall be of high impact, heavy gauge (at least class 2) conduit conforming to BS-4607.

The outer surface of the steel conduits shall be coated with hot-dip zinc and chromate conversion coatings. The inner surface shall have silicone epoxy ester coating for easy cable pulling. Mild steel

pipes shall be hot-dip galvanized. All rigid conduits/pipes shall be of a reputed make.

The hume pipes and accessories shall be of reinforced concrete conforming to class NP2 of IS-458. All tests on hume pipes shall be conducted as per IS-458.

Flexible conduits shall be of heat-resistant lead coated steel, water-leak, fire and rust proof.

3.21 Packaging & protection

All the equipments shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. On request of the Purchaser, the Supplier shall also submit packing details/associated drawing for any equipment/material under his scope of supply, to facilitate the Purchaser to repack any equipment/material at a later date, in case the need arises. While packing all the materials, the limitation from the point of view of availability of Railway wagon sizes in India should be taken into account. The Supplier shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, warping and other such charges claimed by the transporters, railways etc. shall be to the account of the Supplier. Purchaser takes no responsibility of the availability of the wagons.
All coated surfaces shall be protected against abrasion, impact, discolouration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and piping and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage.

3.22 Auxiliary supply

The sub-station auxiliary supply is normally met through a system having the following parameters. The auxiliary power for station supply, including the equipment drive, cooling system of any equipment, air-conditioning, lighting etc shall be designed for the specified Parameters as under. The DC supply for the instrumentation and PLCC system shall also conform to the parameters as indicated in the following :

Table 24 - 3 Table for Auxiliary Supply

Normal Voltage	*Variation in Voltage*	*Frequency in Hz*	*Phases*	*Neutral Connection*
415V	± 10%	50 ± 5%	3 or 4 Wire	Solidly Earthed
240 V	± 10%	50 ± 5%	2 Wire	Solidly Earthed
220V	190 - 242	DC	-	Isolated 2 wire system DC unearthed system
48 V	41 - 52.8	DC	-	Isolated 2 wire system positive pole directly earthed

Combined variation of voltage and frequency shall be limited to ± 10%.

3.23 Lamps and sockets

Lamps

All incandescent lamps shall use a socket base as per IS-1258, except in the case of signal lamps.

Sockets

All sockets (convenience outlets) shall be suitable to accept both 5 Amp & 15 Amp pin round Standard Indian plugs. They shall be switched sockets with shutters. Degree of protection for outdoor switch sockets shall be IP55.

Hand Lamp

A 240 Volts, single Phase, 50 Hz AC plug point shall be provided in the interior of each cubicle with ON-OFF Switch for connection of hand lamps.

Switches and Fuses

Each panel shall be provided with necessary arrangements for receiving, distributing, isolating and fusing of DC and AC supplies for various control, signalling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with switchfuse units. Selection of the main and Sub-circuit fuse ratings shall be such as to ensure selective clearance of sub-circuit faults. Potential circuits for relaying and metering shall be protected by HRC fuses. All fuses shall be of HRC cartridge type conforming to IS:9228 mounted on plug-in type fuse bases. Miniature circuit breakers with thermal protection and alarm contacts will also be accepted. All accessible live connection to fuse bases shall be adequately shrouded. Fuses shall have operation indicators for indicating blown fuse condition. Fuse carrier base shall have imprints of the fuse rating and voltage.

3.24 Availability spares

The Supplier shall supply the spare parts required to meet the specified guaranteed availability, and shall include such spare parts in the scope of supply. The detailed lists of spare parts to meet the guaranteed reliability & availability requirements shall be part of the contract documents. However if it is found during detailed engineering and/or Reliability & Availability prediction calculation that additional spares are required to meet target values, the same shall be made available by the Supplier without any additional cost to the Employer.

3.25 Commissioning spares

The Supplier shall supply additional spares which he expects to consume during installation, testing and commissioning of the systems. The quantity of these spares shall be decided based on his previous experience, such that site work shall not be hampered due to non-availability of these spares.

3.26 Tools & tackles

The Supplier shall also supply at each site one set of all special tools & tackles, testing equipment, handling equipment, etc. which are required by the Employer's maintenance staff to maintain the stations successfully.

3.27 Seismic force consideration

All structures shall be designed for seismic forces in accordance with IS-1893.

The seismic design of electrical equipment shall be performed using estimated actual earth/ ground motion,defined by a response spectrum, rather than the equivalent loads specified in typical Building Codes.

For brittle materials like glass, porcelain and glass fibre reinforced plastic the maximum calculated load should not exceed 2/3 of the guaranteed minimum rupture (breaking) strength (safety factor 1.5) as defined by the manufacturer/supplier of the material used. The minimum rupture value is defined as (X - 2*sigma), where X is the mean value and 'sigma' is the standard deviation. For load combinations in porcelain insulators and similar the following expressions shall be fulfilled:

{Ft / (Ft)b } + {Mb / (Mb)b } < 2/3 and
{ Fc / (Fc)b } + { Mb / (Mb)b }< 2/3

Where:

Ft, Fc, Mb : calculated maximum tensile force; compressive force and bending respectively

(F), (F), (M)b : corresponding guaranteed strength values

(For normal operating loads, a higher safety factor more than 1.5 shall be used, normally 2.0-2.5 depending on type of load as per recommendations of manufacturer).

Factor regarding importance of structures (I), as defined in IS-1893, shall not be taken less than 1.5.

3.28 Safety requirements

The requirements regarding provision of additional staircases and approachability as defined in the Fire Protection Manual, issued by the Regional Committees of the Tariff Advisory Committee shall be completely fulfilled. All other safety requirements shall be met as per the factories Act, TAC etc.

ANNEXURE-A
Corona and Radio Interference Voltage (RIV) Test

1. General

Unless otherwise stipulated, all equipment (except Auto Transformer & Shunt Reactor) together with its associated connectors, where applicable, shall be tested for external corona both by observing the voltage level for the extinction of visible corona under falling power frequency voltage and by measurement of radio interference voltage (RIV). The test procedure shall be reviewed for different equipment during submission of MQP/ITP.

2. Test Levels:

The test voltage levels for measurement of external RIV and for corona extinction voltage are listed under the relevant clauses of the specification.

3. Test Methods for RIV:

3.1 RIV tests shall be made according to measuring circuit as per International Special-Committee on Radio Interference (CISPR) Publication 16-1(1993) Part -1. The measuring circuit shall preferably be tuned to frequency with 10% of 0.5 Mhz but other frequencies in the range of 0.5 MHz to 2 MHz may be used, the measuring frequency being recorded. The results shall be in microvolts.

3.2 Alternatively, RIV tests shall be in accordance with NEMA standard Publication No. 107-1964, except otherwise noted herein.

3.3 In measurement of, RIV, temporary additional external corona shielding may be provided. In measurements of RIV only standard fittings of identical type supplied with the equipment and a simulation of the connections as used in the actual installation will be permitted in the vicinity within 3.5 meters of terminals.

3.4 Ambient noise shall be measured before and after each series of tests to ensure that there is no variation in ambient noise level. If variation is present, the lowest ambient noise level will form basis for the measurements. RIV levels shall be measured at increasing and decreasing voltages of 85%, 100%, 115% and 130% of the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 400 kV, 220 kV is listed in the detailed specification together with maximum permissible RIV level in microvolts.

3.5 The metering instruments shall be as per CISPR recommendation or equivalent device so long as it has been used by other testing authorities.

3.6 The RIV measurement may be made with a noise meter. A calibration procedure of the frequency to which noise meter shall be tuned shall establish the ratio of voltage at the high voltage terminal to voltage read by noise level meter.

4. Test Methods for Visible Corona

The purpose of this test is to determine the corona extinction voltage of apparatus, connectors etc. The test shall be carried out in the same manner as RIV test described above with the exception that RIV measurements are not required during test and a search technique shall be used near the onset and extinction voltage, when the test voltage is raised and lowered to determine their precise values. The test voltage shall be raised to 130% of RIV test voltage and maintained there for five minutes. In case corona inception does not take place at 130 %, test

shall be stopped, otherwise test shall be continued and the voltage will then be decreased slowly until all visible corona disappears. The procedure shall be repeated at least 4 times with corona inception and extinction voltage recorded each time. The corona extinction voltage for purposes of determining compliance with the specification shall be the lowest of the four values at which visible corona (negative or positive polarity) disappears. Photographs with laboratory in complete darkness shall be taken under test conditions, at all voltage steps i.e. 85%, 100%, 115% and 130%. Additional photographs shall be taken at corona inception and extinction voltages. At least two views shall be photographed in each case using Panchromatic film with an ASA daylight rating of 400 with an exposure of two minutes at a lens aperture of f/5.6 or equivalent. The photographic process shall be such that prints are available for inspection and comparison with conditions as determined from direct observation. Photographs shall be taken from above and below the level of connector so as to show corona on bushing, insulators and all parts of energised connectors. The photographs shall be framed such that test object essentially, fills the frame with no cut-off.

4.1 The test shall be recorded on each photograph. Additonal photograph shall be taken from each camera position with lights on to show the relative position of test object to facilitate precise corona location from the photographic evidence.

4.2 In addition to photographs of the test object preferably four photographs shall be taken of the complete test assembly showing relative positions of all the test equipment and test objects. These four photographs shall be taken from four points equally spaced around the test arrangement to show its features from all sides. Drawings of the laboratory and test set up locations shall be provided to indicate camera positions and angles. The precise location of camera shall be approved by Purchaser's inspector, after determining the best camera locations by trial energisation of test object at a voltage which results in corona.

4.3 The test to determine the visible corona extinction voltage need not be carried out simultaneously with test to determine RIV levels.

4.4 However, both test shall be carried out with the same test set up and as little time duration between tests as possible. No modification on treatment of the sample between tests will be allowed. Simultaneous RIV and visible corona extinction voltage testing may be permitted at the discretion of Purchaser's inspector if, in his opinion, it will not prejudice other test.

5. Test Records:

In addition to the information previously mentioned and the requirements specified as per CISPR or NEMA 107-1964 the following data shall be included in test report:

a) Background noise before and after test.

b) Detailed procedure of application of test voltage.

c) Measurements of RIV levels expressed in micro volts at each level.

d) Results and observations with regard to location and type of interference sources detected at each step.

e) Test voltage shall be recorded when measured RIV passes through 100 microvolts in each direction.

f) Onset and extinction of visual corona for each of the four tests required shall be recorded.