BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION BUSINESS GROUP
ENGINEERING MANAGEMENT

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TB-350-316-001	Name	MM	DKM	RS
Type of Document **TECHNICAL SPECIFICATION**	Sign			
Title **400/132 kV Circuit Breakers**	Date	26/04/12	27/04/12	27/04/12
	Group	**TBEM**		

Customer	**NABINAGAR POWER GENERATION CO. LTD.**
Projects	400/132/33 kV s/s at Nabinagar STPP (3x660 MW)

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Note: Offers without checklist will not be considered

Rev No.	Date	Altered	Checked		

Distribution						

SECTION 1

TECHNICAL SPECIFICATION OF 420 KV CIRCUIT BREAKER

1.1 SCOPE

This technical specification covers the requirements of design, manufacture, testing at works, packing and dispatch of 420/132 kV SF6 Circuit Breaker along with steel structure to site.

Refer Section 3 for Project Details.

The Equipment is required for the following projects

Name of Customer : **Nabinagar Power Generation Co. Pvt. Ltd. (JV between NTPC and Bihar State electricity Board)**

Name of Project : **400/132 kV Switchyard at Nabinagar STPP and extn. at 400 kV Nabinagar TPP (BRBCL)**

1.2 SPECIFIC TECHNICAL REQUIREMENTS

As per Section 2.
For requirement of controlled switching device please refer Annexure-B in section 2.

1.3 QUANTITIES

As per Annexure-I

1.4 Supervision charges for Installation and commissioning

Bidder shall quote lump-sum price for installation and commissioning of all the offered circuit breakers.

The instruments required for commissioning shall be brought by the bidder.
Following commissioning test for circuit breakers shall be **performed at site:**
a) Insulation resistance of each pole.
b) Check adjustments, if any, suggested by manufacturer.
c) Breaker closing and tripping time.
d) Slow and power closing operation and opening
e) Trip free and anti pumping operation.
f) Minimum pick up volts of coils
g) Contact resistance
h) Functional checking of compressed air plant and all accessories
i) Functional checking of control circuits, interlocks, tripping through protective relays and auto-reclose operation.
j) Insulation resistance of control circuits, motor etc.
k) Resistance of closing and tripping coils.

1.5 Spares

All spares supplied under this contract shall be strictly interchangeable with the parts for which they are intended for replacement. The spares shall be treated and packed for long term storage in the climatic conditions prevailing at the site. Small items shall be packed in sealed transparent plastic covers with desiccant bags as necessary.

Each spare part shall be clearly marked and labeled on the outside of the packing together with the description when more than one spare part is packed in single case. A general description of the contents shall be shown on outside of the case and detailed list enclosed. All cases, containers and other packages must be suitably marked and numbered for the purpose of identification.

1.6 Sub-suppliers

Equipment shall be supplied from following suppliers:

Item Description	Proposed sub-supplier	Place	Sub-supplier approval status code/category
SF6 GAS FILLING AND EVACUATING PLANT,	ENERVAC	CANADA	NOTED
	DILO	GERMANY	NOTED
GAS RECYCLING & PURIFYING PLANT,	VACCUUM PLANT INDUSTRIES	PUNE	NOTED
GAS LEAKAGE DETECTOR	AI QUALITEK	USA	NOTED
OPERATIONAL ANALYSER WITH DCRM KIT	SCOPE T & M	PUNE	NOTED
	MEGGER	UK	DR+
	HATHWAY	USA	DR+
	TECH. IMP SYSTEMS	ITALY	DR+
LT MOTOR	CGL	AHMEDNAGAR	A
	MARATHON	KOLKATA	A
	BBL	MUMBAI	A
	SIEMENS	MUMBAI	A
	ABB	FARIDABAD	A

DR+ : Detail to be submitted for NTPC review and acceptance

1.7 Qualifying requirements

400kV Circuit Breakers being offered should be from manufacturer who has manufactured and supplied minimum five (5) nos. of three phase circuit breakers suitable for Air Insulated

Substation/ Switchyard of 400 kV or above class which must have been in successful operation for a minimum period of two(2) years as on the date of bid opening.

132 kV Circuit Breakers being offered should be from manufacturer who has manufactured and supplied minimum five (5) nos. of three phase circuit breakers suitable for Air Insulated Substation/ Switchyard of 132 kV or above class which must have been in successful operation for a minimum period of two (2) years as on the date of bid opening.

1.8 Type tests

Bidder shall submit valid type test reports of the tests (given in section 2) carried out within last **ten years** from the date of bid opening i.e. **29.06.2011**. These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and test (s) should have been either conducted at an independent laboratory or should have been witnessed by a client. The owner reserves the right to waive conducting of any or all the specified type test(s) under this contract. In case type tests are waived, the type test charges shall not be payable to the bidder.

All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price

The type test reports once approved for any projects shall be treated as reference. For subsequent projects of NTPC, an endorsement sheet will be furnished by the manufacturer confirming similarity and "No design Change". Minor changes if any shall be highlighted on the endorsement sheet.

In case type test reports are more than 10 years old (from the date of bid opening i.e. 29.06.2011) OR the reports of type tests are found to be technically unacceptable, the type test shall be conducted without cost and delivery implication to BHEL/NTPC.

Annexure-I

Sl. No.	Item	Unit	Qty		
			400/132 kV Nabinagar STPP	**400 kV Nabinagar (TPP) (BRBCL)**	**Total**
I	**Main Equipment**				
1	420KV, 3150A, 50kA for 1 sec, 3 Phase Circuit Breaker without PIR, Class C2-M1 alongwith common control cabinet, support structure and other allied equipments/ items.	Nos.	8	0	8
2	420KV, 2000A, 50kA for 1 sec, 3 Phase Circuit Breaker without PIR, Class C2-M1 alongwith common control cabinet, support structure and other allied equipments/ items.	Nos.	9	3	12
3	420KV, 2000A, 50kA for 1 sec, 3 Phase Circuit Breaker without PIR, with controlled switching device, Class C2-M1 alongwith common control cabinet, support structure and other allied equipments/ items.	Nos.	2	0	2
4	132 KV, 2000A, 31.5 kA for 1 sec, 3 Phase Circuit Breaker , Class C2-M1 alongwith common control cabinet, support structure and other allied equipments/ items. (Mechanically ganged)	Nos.	4	0	4
5	132 KV, 1250A, 31.5 kA for 1 sec, 3 Phase Circuit Breaker , Class C2-M1 alongwith common control cabinet, support structure and other allied equipments/ items. (Mechanically ganged)	Nos.	7	0	7
II	Mandatory spares				
	400 kV				
6	Relays, power contractors, switch-fuses for electrical control circuit (consisting of one no. each of all types and ratings)	Set	1		1
7	Set of gaskets, rings and seals for complete Circuit Breaker	Set	1		1
8	Molecular filter for complete Circuit breaker	Set	1		1
9	Tripping and closing coil (of each type)	No.	6		6
10	Density monitoring system for 1 pole of Circuit Breaker	Set	1		1
11	Set of Spares for pneumatic/ Springs/hydraulic operated mechanism (Motor and limit switch) for one pole	Set	1		1
12	Fixed and moving arcing contact (2000 A)	Set	2		2
13	Fixed and moving arcing contact (3150 A)	Set	2		2
14	Terminal connector (of each type)	No.	0		0
15	SF6 gas filling valve(of each type)	No.	1		1
16	One Complete Pole including operating mechanism without controlled switching without closing resister and excluding support structure, common control cubicle and terminal connectors (3150 A)	No.	1		1
17	One Complete Pole including operating mechanism without controlled switching without closing resister and excluding support structure, common control cubicle and terminal connectors (2000 A)	No.	1		1

Annexure-I

Sl. No.	Item	Unit	Qty		
			400/132 kV Nabinagar STPP	400 kV Nabinagar (TPP) (BRBCL)	Total
	132 kV				
6	Relays, power contractors, switch-fuses for electrical control circuit (consisting of one no. each of all types and ratings)	Set	1		1
7	Set of gaskets, rings and seals for complete Circuit Breaker	Set	1		1
8	Molecular filter for complete Circuit breaker	Set	1		1
9	Tripping and closing coil (of each type)	Nos.	6		6
10	Density monitoring system for 1 pole of Circuit Breaker	Set	1		1
11	Set of Spares for pneumatic/ Springs/hydraulic operated mechanism (Motor and limit switch) for one pole	Set	1		1
12	Fixed and moving arcing contact (2000 A)	Set	2		2
13	Fixed and moving arcing contact (1250 A)	Set	2		2
14	Terminal connector (of each type)	No.	0		0
15	SF6 gas filling valve(of each type)	No.	1		1
16	One Complete Pole including operating mechanism without controlled switching without closing resister and excluding support structure, common control cubicle and terminal connectors (1250 A)	No.	1		1
17	One Complete Pole including operating mechanism without controlled switching without closing resister and excluding support structure, common control cubicle and terminal connectors (2000 A)	No.	1		1
III	**Maintenance equipment**				
27	SF6 Gas filling and evacuating plant (portable)	No	1		
28	SF6 Gas recycling and purifying plant (300 ltr)	No	1		
29	SF6 gas leak detector	Nos	2		
30	Operation analyzer with DCRM Kit	No	1		
IV	**Supervision**				
31	Supervision of Erection, testing and commissioning for all breakers for 400 kV (1 lot =1 CB)	lot	19	3	22
31	Supervision of Erection, testing and commissioning for all breakers for 132 kV (1 lot =1 CB)	lot	11	0	11

Note : Set means for complete replacement of one circuit breaker (three phase)

SECTION 2

EQUIPMENT SPECIFICATION

- **NTPC specification for Circuit Breaker –Chapter E1 (17 pages)**
- **Requirement of controlled switching device for circuit breaker (2 pages)**

CHAPTER - E1: CIRCUIT BREAKER

1.00.00 **GENERAL**

Circuit Breakers shall be outdoor type, comprising three identical single pole units, complete in all respects with all fittings and wiring. The circuit breakers and accessories shall conform to IEC- 62271-100 or equivalent Indian Standard.

2.00.00 **DUTY REQUIREMENTS**

2.01.00 Circuit breaker shall be C2/M1class under all duty conditions and shall be capable of performing their duties without opening resistor. The circuit breaker shall meet the duty requirement of any type of fault or fault location and shall be suitable for line charging and dropping when used on 400/132 kV effectively grounded or ungrounded systems and perform make and break operations as per the stipulated duty cycles satisfactorily.

2.02.00 The circuit breaker shall be capable for breaking the steady & transient magnetizing current corresponding to 400/132 kV transformers up to 630 MVA rating. It shall also be capable of breaking line charging currents as per IEC-62271-100 with a voltage factor of 1.4.

2.03.00 The rated transient recovery voltage for terminal fault and short line faults shall be as per IEC:62271-100.

2.04.00 The circuit breakers shall be reasonably quiet in operation. Noise level in excess of 140 dB measured at base of the breaker would be unacceptable. Bidder shall indicate the noise level of breaker at distance of 50 to 150 m from base of the breaker.

2.05.00 The Bidder may note that total break time of the breaker shall not be exceeded under any duty conditions specified such as with the combined variation of the trip coil voltage, pneumatic/hydraulic pressure and arc extinguishing medium pressure, etc. While furnishing the proof of the total break time of complete circuit breaker, the Bidder may specifically bring out the effect of non-simultaneity between same pole and poles and show how it is covered in the guaranteed total break time.

2.06.00 While furnishing particulars regarding the D.C. component of the circuit breaker, the Bidder shall note that IEC-62271-100 requires that this value should correspond to the guaranteed minimum opening time under any condition of operation.

2.07.00	The critical current which gives the longest arc duration at lock out pressure of extinguishing medium and the duration shall be indicated.
2.08.00	All the duty requirements specified above shall be provided with the support of adequate test reports to be furnished along with the bid.
3.00.00	**CONSTRUCTIONAL FEATURES**
3.01.00	All making and breaking contacts shall be sealed and free from atmospheric effect. In the event of leakage of extinguishing medium to a value, which cannot withstand the dielectric stresses specified in the open position, the contacts shall preferably self close. Main contacts shall be easily accessible for inspection and replacement. If there are no separately mounted arcing contacts, then the main contacts shall be easily accessible for inspection and replacement. Main contacts shall have ample area and contact pressure for carrying the rated current under all conditions. The interrupter sectional drawing showing the following conditions shall be furnished for information with the bid:
a)	Close position
b)	Arc initiation position
c)	Full arcing position
d)	Arc extinction position
e)	Open position.
3.02.00	All the three poles of the breaker shall be linked together either electrically/pneumatically or electro hydraulically.
3.03.00	Circuit breakers shall be provided with two (2) independent trip coils, suitable for trip circuit supervision. The trip circuit supervision relay would also be provided. Necessary terminals shall be provided in the central control cabinet of the circuit breaker.
4.00.00	**SULPHUR HEXAFLOURIDE (SF6) GAS CIRCUIT BREAKER**
4.01.00	Circuit breakers shall be single pressure type.
4.02.00	Design and construction of the circuit breaker shall be such that there is minimum possibility of gas leakage and entry of moisture. There should not be any condensation of SF6 gas on insulated surfaces of the circuit breaker.
4.03.00	In the interrupter assembly, there shall be absorbing product box to eliminate SF6 decomposition products and moisture. The details and operating experience with such filters shall be brought out in additional information schedule.

Clause No.	TECHNICAL REQUIREMENTS
4.04.00	Each pole shall form an enclosure filled with SF6 gas independent of two other poles. Common monitoring of SF6 gas can be provided for the three poles of circuit breaker having a common drive. The interconnecting pipes in this case shall be such that the SF6 gas from one pole could be removed for maintenance purposes.
4.05.00	Material used in the construction of circuit breakers shall be such as fully compatible with SF6.
4.06.00	The SF6 gas density monitor shall be adequately temperature compensated to model the density changes due to variations in ambient temperature within the body of circuit breaker as a whole. It shall be possible to dismantle the monitor without removal of gas.
4.07.00	Sufficient SF6 gas shall be supplied to fill all the circuit breakers installed plus an additional 20% of the quantity as spare.
5.00.00	**OPERATING MECHANISM**
5.00.01	Circuit breaker shall be operated by pneumatic mechanism or electrically spring charged mechanism or electro-hydraulic mechanism or a combination of these. It shall be gang operated in case of 3-phase reclosing operation as applicable.
5.00.02	The operating mechanism shall be anti-pumping and trip free (as per IEC definition) electrically and either mechanically or pneumatically under every method of closing. The mechanism of the breaker shall be such that the position of the breaker is maintained even after the leakage of operating media and/or gas.
5.00.03	The operating mechanism shall be such that the failure of any auxiliary spring will not prevent tripping and will not cause trip or closing operation of the power operated closing devices. A mechanical indicator shall be provided to show open and close positions of breaker. It shall be located in a position where it will be visible to a man standing on the ground with the mechanism housing door closed. An operation counter shall also be provided.
5.00.04	Closing coil shall operate correctly at all values of voltage between 85% and 110% of the rated voltage. Shunt trip coils shall operate correctly under all operating conditions of the circuit breaker upto the rated breaking capacity of the circuit breaker and at all values of supply voltage between 70% and 110% of rated voltage. If additional elements are introduced in the trip coil circuit their successful operation for similar applications of outdoor breaker shall be clearly brought out in the bid.
5.00.05	Working parts of the mechanism shall be of corrosion resisting material. Bearings requiring grease shall be equipped with pressure type grease fittings. Bearing pin,

	bolts, nuts and other parts shall be adequately pinned or locked to prevent loosening or changing adjustment with repeated operation of the breaker.
5.00.06	Operating mechanism shall normally be operated by remote electrical control. Electrical tripping shall be performed by shunt trip coil. Provision shall also be made for local electrical control. 'Local / remote' selector switch and close & trip push buttons shall be provided in the breaker central control cabinet. Remote located push buttons and indicating lamps shall also be provided.
5.00.07	Operating mechanism and all accessories shall be in local control cabinet. A central control cabinet for the three poles of the breaker shall be provided along with supply of necessary tubing, cables, etc.
5.00.08	Provisions shall be made on breakers for attaching an operation analyser to perform speed tests after installation at site to record contact travel against time and measure opening time.
5.00.09	The Bidder shall furnish curve supported by test data indicating the opening time under close-open operation with combined variation of trip coil and operating media along with the bid.
5.01.00	**PNEUMATICALLY OPERATED MECHANISM**
5.01.01	Bidder shall offer unit compressor with each circuit breaker. The unit compressor are to be located outdoor near the breaker(s).
5.01.02	The breaker local air receivers shall comply with the requirement specified, and shall have sufficient capacity for two 'CO' operations of the breaker at the lowest pressure for reclose duty without refilling.
5.01.03	Independently adjustable pressure switches with potential free ungrounded contacts to actuate lockout device shall be provided. This lock out device with provision for remote alarm indication shall be incorporated in the circuit breaker to prevent operation whenever the pressure of the operating medium is below that required for satisfactory operation at the specified rating. The scheme should permit operation of all block and alarm relays as soon as the pressure transient present during the rapid pressure drop has been damped and a reliable pressure measurement can be made. Such facilities shall be provided for following conditions:
a)	Trip lockout pressure - 2 nos.
b)	Close lockout pressure - 1 no.
c)	Extreme low pressure - 1 no.
d)	Auto reclose lock out pressure - 1 no.

5.01.04	The compressed air mechanism shall be capable of operating the circuit breaker under all duty conditions with the air pressure immediately before operation between 85% and 110% of the rated supply pressures. The make/break time at this supply pressure shall not exceed the specified make/ break time within any value of trip coil supply voltage as specified.
5.02.00	**SPRING OPERATED MECHANISM**
5.02.01	Spring operated mechanism shall be complete with motor, opening spring & closing spring with limit switch for automatic charging and other necessary accessories to make the mechanism a complete operating unit. Opening spring shall be supplied with limit switch for automatic charging and other necessary accessories.
5.02.02	As long as power is available to the motor, a continuous sequence of closing and opening operations shall be possible. The motor shall have adequate thermal rating for this duty. After failure of power supply to the motor, one close-open operation shall be possible with the energy contained in the operating mechanism.
5.02.03	Breaker operation shall be independent of the motor, which shall be used solely for compressing the closing spring.
5.02.04	Motor shall comply with the requirements specified in Chapter-E12. Motor ratings shall be such that it requires not more than 30 seconds for fully charging the closing spring.
5.02.05	Closing action of the circuit breaker shall compress the opening spring ready for tripping.
5.02.06	When closing springs are discharged, after closing a breaker, closing springs shall automatically be charged for the next operation and an indication of this shall be provided in the local and remote control cabinet.
5.02.07	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.
5.03.00	**HYDRAULICALLY OPERATED MECHANISM**
5.03.01	Hydraulically operated mechanism shall comprise operating unit with power cylinder, valves, and low pressure reservoir, motor, etc.

5.03.02	The hydraulic oil used shall be fully compatible for the specified temperature range.
5.03.03	The oil pressure controlling the oil pump and pressure in the high pressure reservoir shall have adequate number of spare contacts for continuous monitoring of low pressure, high pressure, etc., in control room. The necessary remote equipment shall also be provided.
5.03.04	The mechanism shall be suitable for at least two close open operations after failure of ac supply to the motor starting at pressure equal to lowest pressure of auto-reclose duty.
5.03.05	The hydraulically operated mechanism shall be capable of operating the circuit breaker correctly and performing the duty cycle specified under all conditions with the pressure of hydraulic operated fluid in the operating mechanism at the lowest permissible pressure before make up. The operating 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.
5.03.06	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 be provided and wired suitably upto the central control cabinet.
5.03.07	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 times maximum working pressure.
5.04.00	**FITTINGS AND ACCESSORIES**
5.04.01	Following is partial list of some of the major fittings and accessories to be furnished as integral part of the breakers. Number and exact location of these parts shall be indicated in the bid.
	Control unit / Central control cabinet in accordance with Chapter-E12 complete with:
a)	Double compression type cable glands, lugs, ferrules, etc.
b)	Local/remote changeover switch
c)	Operation counter
d)	Fuses, as required
e)	Anti-pumping relay/contactor
f)	Rating and diagram plate in accordance with IEC including year of manufacture, etc.
g)	Gauges for SF6 gas pressure, pneumatic/hydraulic pressure.
h)	Gas density monitor with alarm and lockout contacts

6.00.00 **FITTINGS AND ACCESSORIES**

6.01.00 **Hollow insulator columns**

The insulators shall conform to requirements stipulated in Chapter-E12. All routine tests shall be conducted on the insulators as per relevant IEC. In addition the following routine tests shall also be conducted on hollow column insulators :

a) Ultrasonic test
b) Pressure test
c) Bending load test in 4 directions at 50% specified bending load.
d) Bending load test in 4 directions at 100% specified Bending load as a sample test. The tested insulator will not be used in CB.
e) Burst pressure test as a sample test.

6.02.00 **SUPPORT STRUCTURES**

The minimum height of equipment supports shall be 2.55 meters. The height of center line of conductor shall be as given elsewhere in the specification.

6.03.00 **Terminal connectors** shall conform to requirements stipulated in Chapter E12.

6.04.00 **ADDITIONAL FITTINGS FOR PNEUMATIC CIRCUIT BREAKER**

a) Unit compressed air system.
b) Breaker local air receivers
c) Pressure gauge, spring-loaded safety valve and pressure switch with adjustable contacts
d) Pressure switch to initiate an alarm if the pressure in the auxiliary reservoir falls below a preset level for longer than it is normally necessary to refill the reservoir.
e) Stop, non-return and other control valves, piping and all accessories upto breaker mechanism housing.

6.05.00 **UNIT COMPRESSED AIR SYSTEM**

The unit compressed air system for each breaker shall be provided with compressed air piping, piping accessories, control and non-return valves, filters, coolers of adequate capacity, pressure reducing valves(if any), isolating valves, drain ports, etc.

6.05.01	**Air Compressor:**
a)	The air compressor shall be driven by automatically controlled motor. It shall be of air cooled type complete with preferably oil-less cylinder lubrication. The compressors or pumps shall be mounted within the operating mechanism housing or a separate weather-proof and dust-proof housing. The motors shall conform to requirements of Chapter-E12.
b)	The compressor size shall be such that it is capable of performing following operations satisfactorily : i) Total running time of compressor not exceeding 45 minutes per day, considering 2% leakage and 2 CO-operations. ii) Air charging time not exceeding 20 minutes after one CO operation of the breaker.
c)	The compressor shall be provided with automatic adjustable unloading device, if necessary, during starting. Each compressor shall be equipped with a time totaliser.
d)	In accordance with the requirements stipulated under Part-I, the compressors and its accessories shall conform to the type tests and shall be subject to routine tests as per applicable standards.
6.05.02	**Intercooler and After cooler :** Intercooler between compressor stage and after cooler at discharge of H.P. cylinder shall be included in Contractor's scope. They shall be of air cooled type and shall be designed as per ASME Code of IEMA Standards. The design pressure on the air side of cooler shall be 1.25 times the working pressure. A corrosion allowance of 3mm shall be included for all steel parts.
6.05.03	**Air Receivers** :
a)	The capacity of receivers shall be sufficient for two (2) CO operations of the breaker.
b)	Air receiver shall be designed in accordance with the latest edition of the ASME Code for Pressure Vessel - Section VIII of BS:5179. A corrosion allowance of 3.0 mm shall be provided for shell and dished ends. Receivers shall be hot dip galvanized.

c)	Accessories such as suitable sized safety valve to relieve full compressor discharge at a set pressure equal to 1.1 times the maximum operating pressure, dial type pressure gauge with isolating and drain valve and test connection shall be provided.
d)	Quality of Air : Compressed air used shall be dry and free of dust particles. Arrangement for conditioning the compressed air shall be provided as an integral part of air compressor system. The quality of air shall be compatible with the parts used in the system. All necessary components required to make it compatible shall be included.
6.06.00	**Controls and Control Equipment** :
a)	The compressor control shall be of automatic start stop type initiated by pressure switches on the receiver. Supplementary manual control shall also be provided.
b)	All control equipment shall be housed in a totally enclosed cabinet. Pressure gauges and other indicating devices, control switches shall be mounted on the control cabinet.
c)	Facility to annunciate failure of power supply to the compressor control shall also be provided.
6.07.00	**Compressed Air Piping, Valves and Fittings**:
a)	The flow capacity of all valves shall be at least 20% greater than the compressor capacity.
b)	The high pressure system shall be such that after one 0 - 0.3 Sec - CO operation, the breaker shall be capable of performing one CO operation within 3 minutes.
c)	All compressed air piping shall be bright annealed, seamless phosphorous Deoxidized Non-Arsenical Copper alloy or stainless steel pipe (C-106 of BS:2871).
d)	All joints and connections in the piping system shall be brazed or flared as necessary.
e)	Compressed air piping system shall be supplied in clean, sealed and packed condition. Before installation, the pipes shall be again cleaned properly to remove dust, brazing particles, etc.

6.08.00 **Spare Parts and Mandatory Maintenance Equipment :**

The Contractor shall include in his proposal mandatory spare parts and maintenance equipment as specified in scope. These shall be in accordance with requirements attached at Annexure – I of this chapter.

7.00.00 **TESTS**

7.01.00 In accordance with the requirements stipulated under part-I, the circuit breakers alongwith its operating mechanism shall be type tested for all the type tests as per annexure-II to this chapter.

7.02.00 **ROUTINE TESTS**

Routine tests as per IEC-62271-100 on the complete breaker/ pole alongwith its own operating mechanism and pole column shall be performed on all circuit breakers.

7.03.00 **SITE TESTS**

All routine tests except power frequency voltage dry withstand test on breaker shall be repeated on the completely assembled breaker at site.

8.00.00 **PARAMETERS**

8.01.00 **General**

a)	Type of circuit breaker	Outdoor SF6, single pressure , Live tank type
b)	Rated frequency	50 Hz
c)	Number of poles	Three (3)
d)	Rated operating duty cycle	O - 0.3 sec. - CO - 3min. – CO
e)	Rated line charging breaking Current (voltage factor of 1.4)	As per IEC
f)	Reclosing	Single and three phase high speed auto reclosing (as required)
g)	Total closing time	Not more than 150 ms.

h)	Maximum difference in the instants of closing/opening of contacts	As per standard
i)	Trip and closing coil voltage	220V DC
j)	Auxiliary contacts	As required plus 10 NO and 10 NC contacts per pole as spare. The contacts shall have continuous rating of 10A and breaking capacity of 2A with circuit time constant of minimum 20 millisecond at 220V DC.
k)	Noise level	Maximum 140dB at 50m distance from base of circuit breaker
l)	Rated terminal load	Adequate to withstand 100kg static load as well as wind, seismic and short circuit forces without impairing reliability or current carrying capacity.
m)	Temperature rise over Ambient	As per IEC:62271-100
n)	Type of operating mechanism	Pneumatic/spring/hydraulic/or a combination of these
o)	Minimum creepage distance	As indicated in Section – E0
p)	Rated ambient temperature	50 degree Centigrade
q)	System neutral earthing	Effectively earthed
r)	Seismic acceleration	0.3 g horizontal
s)	Support structure height	Adequate so that lowest part of support insulator of equipment is minimum 2550 mm from ground or plinth level.
8.02.00	**400kV Class Circuit Breakers**	
a)	Rated voltage	420 kVrms
b)	Rated continuous current	Minimum 3150/2000 A at rated ambient temperature current capacity
c)	Rated short circuit breaking	50kA with percentage of DC component as per IEC

	current at rated voltage	corresponding to minimum opening time under operating conditions specified.
d)	Symmetrical interrupting Capability	50 kA rms
e)	Short time current carrying Capability	50 kA rms for One (1) second
f)	Short circuit making current Capability	125 kAp
g)	Rated out-of-phase breaking	12.5 kA rms
h)	Rated line charging breaking Current (voltage factor of 1.4)	600A at 90° C leading power factor with maximum permissible switching overvoltage of 2.3 pu.
i)	Rated small inductive current Breaking capacity	Corresponding to interrupting steady and transient magnetising current of 50 to 630 MVA transformers with overvoltage less than 2.3 pu
j)	First pole to clear factor	1.3
k)	Rated break time	i) 40 ms under test duties 2, 3 & 4 at rated values ii) 45 ms under test duties 1 to 5 and short line fault test duties and combined variation of trip coil voltage, operating pressure and quenching media pressure, etc.
l)	Rated one minute power frequency withstand voltage	i) 520 kV rms between live terminals and earth. ii) 610 kV rms across isolating distance.
m)	Rated lightning impulse withstand voltage	i) ±1425 kVp between live terminals and earth. ii) ± 1425 kVp impulse on one terminal and 240 kVp power freq. voltage of opposite polarity on other terminal (across isolating distance).
n)	Rated switching impulse withstand voltage	i) ± 1050 kVp between live terminals and earth ii) ± 900 kVp impulse on one terminal and 345 kVp power freq. voltage of opposite polarity on other terminal (across isolating distance).

Clause No.	TECHNICAL REQUIREMENTS	
o)	Max. Radio interference	1000 micro volts for freq. between 0.5 MHz and 2.0 MHz at voltage 266 kV rms.
p)	Phase to phase spacing	7000 mm
q)	Corona extinction voltage	Not less than 320 kV rms
8.03.00	**145 kV CIRCUIT BREAKERS :**	
a)	Rated voltage	145 kV, rms.
b)	Rated continuous current at an ambient temperature of 50^0 C	1250 A
c)	Symmetrical interrupting Capability	31.5 kA, rms.
d)	Rated short circuit making current	80 kAp
	a) Short time current carrying Capability for one second	31.5 kA, rms.
	b) Out of phase breaking current Capacity	7.8 kA, rms.
e)	Rated line charging breaking current At 90^0 leading power factor angle (A, rms.)	As per IEC
	(The breaker shall be able to interrupt the rated line charging current with a test voltage immediately before opening equal to the product of U/$\sqrt{3}$ and 1.4 as per IEC-62271-100).	
f)	Rated small inductive current Switching capability with over-voltage less than 2.3 p.u.	0.5 to 10 A
g)	Interrupting capability of Transformer steady and transient magnetising current	upto 500 MVA
h)	First pole to clear factor	1.5
i)	Rated break time	60 ms

	Total break time	65 ms
j)	Rated Insulation levels :	
	i) Full wave impulse withstand voltage (1.2/50 micro sec.)	
	between line terminals and ground	± 650 kV peak
	between terminals with circuit breaker open	± 650 kV impulse on one terminal and other terminal earthed
	ii) One minute power frequency dry and wet withstand voltage	
	between line terminals and ground	275 kV rms
	between terminals with circuit breaker open	275 kV rms
k)	Max. radio interference voltage for Frequency between 0.5 MHz and 2 MHz at 92 kV rms (Micro volts) both in open and closed position	1000
l)	Phase to phase spacing	3000 mm (other type tested spacing is also acceptable)

Chapter-E1
ANNEXURE-I

SPECIFICATION OF MANDATORY MAINTENANCE EQUIPMENT
(Refer cl. 6.08.00 of this section)

1.0 **SF6 Gas Handling Plants:-**

a) **SF6 gas filling and evacuating equipment(Portable):**

The capacity of this plant shall be such that it shall not take appreciable time for filling or evacuating of the complete 3 pole breaker. The required vacuum for complete evacuation shall be attained with the help of this plant.

b) **SF6 gas filtering, drying, storage and recycling plant:**

-This shall include all the necessary devices for measurement of purity, moisture content, decomposition products etc. of SF6 gas mixing with air/oil/moisture during above process should be proved to be Nil during testing.

-The plant shall be complete with accessories and fittings so that SF6 gas from the breaker can be directly filled in the plant storage reservoir.

-In case purging of the equipment before filling with SF6 gas is desirable, then the required equipment for dry gases etc. shall be furnished as a part of the plant.

-For heavy items within the plant, the lifting hooks shall be provided for lifting and moving with the overhead cranes.

-The capacity of the plant shall be such as to handle and store 300 kg of SF6 gas.

1.1 i) These SF6 gas handling plants shall be complete with all the necessary pipes, couplings flexible tubes and valves for coupling to the equipment.

ii) The design and construction of the plant, valves, couplings, connections shall be such that leakage of SF6 gas shall be minimum. Similarly valves, couplings and pipe work shall be so arranged that accidental loss of gas to the atmosphere shall be minimum.

1.2 SF6 gas decomposition analyzing equipment and instruments should have capacity for performing the following functions:

a) The moisture content measurement or alternatively dew point measurement.
b) The air content measurement.

Clause No.	TECHNICAL REQUIREMENTS
c)	Sensitivity should not be affected by dust, humidity, heat & wind etc. NOTE: The equipments should have in-built calibration facility. The calibration/sensitivity check shall be demonstrated at breaker supplier's works.
1.3	SF6 Gas leak detector: The SF6 gas leak detector shall meet the following requirements:
a)	The detector shall be free from induced voltage effects.
b)	The sensing probe shall be such that it can reach all the points on the breaker where leakage is to be sensed.
c)	The accuracy of the equipment shall be at least 10 ppm.
1.4	Operational Analyser (along with DCRM Kit) : The operational analyser shall meet the following requirements:
a)	Operational analyser shall be one complete system, which once installed should record all the parameters, as laid down in subsequent clauses.
b)	It shall have facility to record the breaker contact movement during opening, closing, auto reclosing and make-break operation, the speed of contacts at various stages of operation, travel of contacts, opening time, closing time and make break time ,etc.
c)	The analyser shall have provisions for recording atleast 12 different functions of the circuit breaker. All necessary transducer(i.e three nos. for complete 3 phase speed and travel record of breaker), cables, pickups, attachments required for the breaker shall be supplied with the analyser. The cables supplied shall be sufficient enough for recordings at site on a completely assembled and erected breaker.
d)	The operational analyzer must have facility to measure Dynamic Contact Resistance of arcing contact and main contact with minimum 100 A DC current while closing / opening of circuit breaker. The necessary software (window based) for analysis of the measured data shall also be supplied along with the kit excluding computer / laptop). This software shall be demonstrated at site during commissioning. The DCR test kit shall be suitable for simultaneous measurement of DCR of both the breaks of a pole of the circuit breaker.
e)	The analyser shall be suitable for operation outdoor and shall be suitably shielded against induced charges.
f)	The output of the analyser shall be on a plain paper or any paper having infinite shelf life and the output thus obtained shall have a long life and shall not require any special storage facility. Photographic paper is not acceptable.
g)	All the necessary catalogues, write up for operation and maintenance of the analyser shall be furnished alongwith each analyser and peripheral system.

h) Demonstration at breaker manufacturer's premises for functional/operational check and compatibility with breaker.

Chapter E1
Annexure-II

List of type tests to be included by Bidder

a) Dielectric tests

b) Radio interference voltage test

c) Temperature Rise test

d) Short time withstand current and peak withstand test

e) Mechanical endurance and environment test

f) Short circuit test duties

g) Short line fault test

h) Out of phase making & breaking test

i) Line charging current breaking test

j) Corona test for 400kV CB Only

k) IP:55 test on each type of box

l) Seismic withstand test with structure for 400kV CB only

m) Thermal tests on pre-insertion resistors

n) Test for reactor switching duty for 400kV CB only.

Annexure-B

Requirement of Controlled Switching Device for 400KV Circuit Breaker

The circuit breaker with controlled switching as indicated in single line diagram shall meet the following requirement:

1. The Switching controlled Device shall be used to reduce increased over voltages, re ignition between circuit breaker contacts that may be caused by normal switching of high voltage circuit breakers and hence optimize the stresses on circuit breaker while switching the circuit. The switching controlled device will be called device henceforth.
2. The device shall be such that only switching commands (for operating purpose) are processed in the device. Open command triggered by protection on fault shall be forwarded directly to the breaker. In these cases switching instance is not controlled.
3. Circuit breaker should be able to be switched while switching controlled device is not in operation e.g. during maintenance work or power supply is not connected, a bypass shall be provided to the device. In these cases the switching commands will then be forwarded directly to the circuit breaker via this Bypass. The switching time will not be controlled with these switching operations.
4. The device shall meet the requirements of IEC-60255-4 Appendix 'E' class III regarding HF disturbance test, and fast transient test shall be as per IEC-61000 – 4 level III and insulation test as per 60255 – 5.
5. The device shall have functions for switching ON & OFF the circuit breakers.
6. The device shall get command to operate the breakers manually or through auto re-close relay at random. The controller shall be able to analyze the current and voltage waves available through the signals from secondaries of CTs & CVTs for the purpose of calculation of optimum moment of the switching the circuit breaker and issue command to circuit breaker to operate.
7. The device shall also have an adaptive control feature to consider the next operating time of the breaker in calculation of optimum time of issuing the switching command and optimize the switching behavior as necessary. In calculation of next operating time of the breaker the controller must consider all factors that may affect the operating time of the breaker.
8. The device should have display facility at the front for the settings and measured values.

9. The device shall have self monitoring facility.
10. The device shall be suitable for operation considering transient and dynamic state values of the current and voltage from the secondary of the CTs and CVTs
11. The device should be PC compatible for the setting of various parameters. During the switching operations, current and voltage waveforms and other parameters shall be recorded and saved together with calculated values. Recorded waveform shall be downloaded on to PC for evaluation purpose. It shall also enable downloading of data captured from the switching events. Window based software for this purpose shall be supplied by the contractor to be used on owner's PC.
12. It shall have self monitoring facilities. Faults which impair the functioning of the device or peripheral components, failure of trip voltage or sensors shall be displayed visually and shall give alarm.
13. The device shall be designed to operate correctly and satisfactorily with the excursion of auxiliary A/C & DC voltages and frequency as specified elsewhere in the specification.
14. The device shall have time setting resolution of 0.1 ms or better.
15. The device shall have sufficient number of output/input potential free contacts for connecting the monitoring equipment and annunciation system available in the control room. Necessary details shall be worked out during engineering the scheme.
16. Supply of all the necessary accessories required for the successful operation of controlled switching device shall be in the scope of supplier of the device.

SECTION- 3

PROJECT DETAILS & GENERAL TECHNICAL REQUIREMENTS

3.0 GENERAL

This section stipulates the General Technical Requirements under the Contract and will form an integral part of the Technical Specification.

The provisions under this section are intended to supplement general requirements for the materials, equipment and services covered under other sections of tender documents and are not exclusive. However in case of conflict between the requirements specified in this section and requirements specified under other sections, the requirements specified under respective sections shall prevail.

3.1 PROJECT INFORMATION:

	Particular	Details	
a)	Customer	**Nabinagar Power Generating Company Ltd. (NPGC)** (A joint venture of NTPC Ltd. and Bihar State Electricity Board)	
b)	Project Title	400/132 kV Switchyard including 400 kV & 33 kV Transmission Lines for Nabinagar Super Thermal Power Project (3X660 MW) at Nabinagar Bihar and extension of two line bays at 4X250MW Nabinagar TPP.	
c)	Location	**Nabinagar STPP** (i.) Place : Nabinagar (ii) District :Aurangabad (iii.) State :Bihar	**Nabinagar TPP (BRBCL)** (i.) Place : Nabinagar (ii) District :Aurangabad (iii.) State :Bihar
d)	Nearest Road Head	National Highway-2 (Approximately 25 kms from National highway)	
e)	Nearest Rail Head	Dehri-On-Sone (Approximately 30 kms from Railway Station)	
SITE CONDITIONS			
a)	Max. ambient air temp.	50°C	
b)	Min. ambient air temp.	0°C	
c)	Max. design ambient temp.	50°C	
d)	Design reference RH	100 %	
e)	Altitude	<500 MSL	
f)	Pollution Severity	High Pollution level (25mm/kV)	
g)	Seismic Zone	Zone-III	
WIND DATA			
a)	Basic Wind speed	47m/sec	
b)	The risk co-efficient (K1)	1.07	
c)	Category of terrain	Category-2	

d)	Maximum wind pressure on steel members	1500 N/m2

3.1.1 SYSTEM PARAMETERS:

Sl.No.	Parameters	**400 kV**	**132 kV**	**33 kV**
1	Highest system voltage	420 kV rms	145 kVrms	36 kVrms
2	Lightning Impulse voltage	±1425kVp	± 650kVp	± 170kVp
3	Switching impulse voltage	±1050kVp	--	--
4	Power frequency withstand for 1 min (rms)	630 kV(rms)	275 kV(rms)	70 kV(rms)
5	Max. fault level (1 sec.)	50 kA	31.5kA	25 kA
6	Minimum creepage distance	10500 mm	3625mm	900 mm

3.1.2 AUXILIARY POWER:

Sl.No.	Nominal Connection Voltage	Variations in Voltage	Frequency	Phase	Neutral
1	415V	±10%	50±5%	3	Solidly Earthed
2	240V	±10%	50±5%	4	Solidly Earthed

Combined variation of voltage and frequency shall be + 10%. Fault level of 415V system shall not be less than 20kA.

The minimum height of equipment supports shall be 2550mm. The various minimum heights of the switchyard shall be as given below from plinth level :

Voltage	Equipment /1st Level	2nd Level	3rd Level
132kV	4600mm	8500mm	12500mm
400kV (1½ breaker	8000mm	16000mm	--

3.2 INSTRUCTION TO BIDDERS:

The bidders shall submit the technical requirements, data and information as per the technical data sheets, provided in Section-4.

The bidders shall furnish catalogues, engineering data, technical information, design documents, drawings etc fully in conformity with the technical specification.

It is recognized that the bidders may have standardized on the use of certain components, materials, processes or procedures different than those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice will also be considered provided such proposals meet the specified designs, standard and

performance requirements and are acceptable to the Purchaser. Unless brought out clearly, the Bidder shall be deemed to conform to this specification scrupulously. All deviations from the specification shall be clearly brought out in the respective schedule of deviations. Any discrepancy between the specification and the catalogues or the bid, if not clearly brought out in the schedule, will not be considered as valid deviation.

Except for lighting fixtures, wherever a material or article is specified or defined by the name of a particular brand, Manufacturer or Vendor, the specific name mentioned shall be understood as establishing type, function and quality and not as limiting competition. For lighting fixtures, makes shall be as defined in Section-Lighting System.

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 Technical 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 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 under supply shall be inter-changeable with one another.

The bidder shall supply type tested (including special tests as per tech. specification) equipment and materials. The test reports shall be furnished by the bidder along with equipment/ material drawings. In the event of any discrepancy in the test reports, (i.e., if any test report is not acceptable due to any design/ manufacturing changes or due to non-compliance with the Technical Specification and/ or applicable standard), the tests shall be carried out without any additional cost implication to the BHEL. BHEL reserves the right to get any or all type/tests conducted/repeated.

3.3 STANDARDS

3.3.1 The Contractor is required to follow local statutory regulations stipulated in the latest amended Electricity Supply Act 1948 and Indian Electricity Rules 1956, and other local rules and regulations.

3.3.2 The equipment to be furnished under this specification shall conform to latest issue with all amendments of standards and/or codes specified under respective section heads. The standards mentioned in the specification are not mutually exclusive or complete in themselves, but intended to compliment each other. The Contractor shall also note that list of standards presented in this specified is not complete. Whenever necessary the list of standards shall be considered in conjunction with specific IS/IEC. When the specified requirements stipulated in the specifications exceed or differ than those required by the applicable standards, the stipulation of the specification shall take precedence.

3.3.3 Other internationally accepted standards which ensure equivalent or better performance that that specified in the standards referred under section shall also be acceptable.

3.3.4 In case governing standards for the equipment is different from IS or IEC,the salient points of difference shall be clearly brought out in additional information schedule alongwith English language version of standard of relevant extract of the same. The

equipment conforming to standards other than IS/IEC shall be subject to Employer's approval.

3.3.5 The full names of the codes and standards mentioned in abbreviations under various equipment heads are as follows:

BS British Standards
IEC/CISPR International Electro-technical Commission
IS Bureau of Indian Standards
ISO International Organisation for Standards
NEMA National Electric Manufacturers Association

3.4 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED

The 400 kV system is being designed to limit the power frequency over voltage of 1.5 p.u. and the switching surge over voltage to 2.5 p.u. In 400 kV system the initial value of temporary over voltage could be 2.0 p.u. for 1-2 cycles. All the equipment/materials covered in this specification shall perform all its function satisfactorily without undue strain, restrike etc. under such over voltage conditions. All equipment shall also perform satisfactorily under various other electrical, electromechanical and meteorological conditions of the site of installation. All equipment shall be able to withstand all external and internal mechanical, thermal and electromechanical forces due to various factors like wind load, temperature variation, ice & snow, (not applicable for this project) short circuit etc for the equipment.

The equipment shall also comply with the following:

a) All equipments shall be suitable for hot line washing.
b). To facilitate erection of equipment, all items to be assembled at site shall be "match marked"'.
c) Piping, if any, between equipment control cabinet or operating mechanism to marshalling box of the equipment, shall bear proper identification to facilitate the connection at site.
d) All equipment shall be supplied with necessary interpole cabling, and its cost shall be included in the cost of equipment.

3.5 ENGINEERING DATA

3.5.1 Drawings

All drawings submitted by the supplier including those submitted at the time of bid shall be in sufficient detail to indicate the type, size, arrangement, material description, Bill of Materials, weight of each component, break-up for packing and shipment, the external connections, fixing arrangement required. The dimensions required for installation and interconnections with other equipment and materials, clearances and spaces required for installation and interconnections between various portions of equipment and any other information specifically requested in the specifications.

Each drawing submitted by the Contractor shall be clearly marked with the name of the Purchaser, the unit designation, the specifications title, the specification number and the name of the Project. If standard catalogue pages are submitted, the applicable items shall be indicated therein. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.

Further work by the Contractor shall be in strict accordance with these drawings and no deviation shall be permitted without the written approval of the Purchaser, if so required.

The review of these data by the purchaser will cover only general conformance of the data to the specification and documents, interfaces with the equipment provided under specification, external connections and of the dimensions which might affect substation layout.. This review by the purchaser may not indicate a thorough review of the dimensions, quantities and details of the equipment, material, any devices or items indicated or the accuracy of the information submitted. This review and/or approval by the purchaser shall not be considered by the contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications and documents.

All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawings shall be at the Contractor's risk. The Contractor may make any changes in the design which are necessary to make the equipment conform to the provisions and intent of the Contract and such changes will again be subject to approval by the Purchaser. Approval of Contractor's drawing or work by the Purchaser shall not relieve the contractor of any of his responsibilities and liabilities under the Contract.

All engineering data submitted by the contractor after final process including review and approval by the purchaser shall form part of the contract document and the entire work performed under these specifications shall be performed in strict conformity, unless otherwise expressly requested by the purchaser in writing.

3.5.2 Approval Procedure

The following procedure for submission and review/approval of the drawings, data,reports, information, etc. shall be followed by Contractor:

a. All data/information furnished by Vendor in the form of drawings, documents, catalogues or in any other form for NTPC's information/interface and/or review and approval are referred by the general term "drawings".

b. The 'Master drawings list' shall be submitted for review and approval of Employer before award of contract. The Contractor shall have to prepare and submit any other drawings and reference documents in addition to the drawings contained in the list, if so required during engineering stage as felt necessary by the Employer. Number of copies of the list for the distribution shal l be as mutually agreed between Contractor and Employer.

c. All drawings (including those of subvendors') shall bear at the right hand bottom corner the 'title block' with all relevant information duly filled in. The format of title block shall approved by Engineer within thirty (30) days after the letter of award. The Contractor shall give this format to his subvendor along with his purchase order for subvendor's compliance. The size of title block basic format and its contents shall not be changed. All drawings shall be in English language. All dimensions shall be in metric units.

d. Contractor shall submit all the drawings in five (5) copies for review of Employer. Employer shall forward their comments within four (4) weeks of receipt of drawings.

e. Upon review of each drawings, depending on the correctness and completeness of the drawings, the same will be categorised and approval accorded in one of the following categories:

CATEGORY I	Approved
CATEGORY II	Approved subject to incorporation of comments/modification as noted. Resubmit revised drawing incorporating the comments
CATEGORY III	Not approved. Resubmit revised drawings for Approval after incorporating comments/modifications as noted
CATEGORY IV	For information and records

f. Contractor shall resubmit the drawings approved under Category II and III within three (3) weeks of receipt of comments on the drawings, incorporating all comments. Every revision of the drawing shall bear a revision index wherein such revisions shall be highlighted in the form of description or marked up in the drawing identifying the same with relevant revision number enclosed in a triangle (e.g 1.2.3. etc.)

g. In case Contractor does not agree with any specific comment, he shall furnish the explanation for the same to Employer consideration. In all such cases Contractor shall necessarily enclose explanations along with the revised drawing (taking care of balance comments) to avoid any delay and/or duplication in review work.

h. It is the responsibility of the Contractor to get all the drawings approved in the Category I or IV (as the case may be) and complete engineering activities within the agreed schedule. Any delay arising out of submission and modification of drawings shall not alter the contract completion schedule.

i. Contractor shall not make any changes in the portion of the drawing other than those commented. If changes are required to be made in the portions already approved, the Contractor shall resubmit the drawings identifying the changes (alongwith reasons for changes) for Employer's review and approval.

i. Approval of drawings will not in any way relieve the Contractor of his obligations of furnishing the equipment in accordance with the specification and shall not prevent subsequent rejection if such equipment is later found to be defective.

j. The drawing approval progress report shall be submitted in at least three (3) copies within one (1) week from the last date of the every month.

3.5.3 Erection Drawings.

a. Contractor shall furnish erection drawings for the guidance or commencement of erection or the first shipment, whichever is earlier. These shall generally comprise of fabrication/assembly drawings, various component/part details drawing, assembly, clearance data requirements, etc. The drawings shall contain details of components/ equipment with identification number, match marks, bill of materials, assembly procedures etc.

b. For all major equipment apart from above details, assembly sequence and instructions with check-lists shall be furnished in the form of erection manuals.

3.5.4 Instruction Manual

a. The Contractor shall submit to the Employer preliminary instruction manuals for all the equipments for review. The final instructions manuals incorporating Employer's comments and complete in all respect shall be submitted at least thirty (60) days before the first shipment of the equipment. The instruction manuals shall contain full details and drawings of all the equipments, the transportation, storage, installation, testing, operation and maintenance procedures, etc. separately for each component/equipment alongwith log record format. These instruction manuals shall be submitted in five (5) copies for approval.

b. If after commissioning and initial operation of the plant, the instruction manuals require any modifications/additions/changes, the same shall being corporated and the updated final instruction manuals shall be submitted .

c. The operating and maintenance instructions together with drawings (other than shop drawings) of the equipment, as completed, shall have sufficient details to enable the Employer to maintain, dismantle, reassemble and adjust all parts of the equipment. They shall give a step by step procedure for all operations likely to be carried out during the life of the plant/equipment, including erection, testing, commissioning, operation, maintenance dismantling and repair. Each manual shall also include a complete set of approved drawings together with performance/rating curves of the equipment and test certificates, wherever applicable. The contract shall not be considered completed for purpose of taking over until such instructions and drawings have been supplied to the Employer.

d. A separate section of the manual shall be for each size/type of equipment and shall contain a detailed description of construction and operation, together will all relevant pamphlets, drawings and list of parts with procedures for ordering spares. Maintenance instructions shall include charts showing lubrication, checking, testing and replacement procedure to be carried out daily, weekly, monthly and at longer intervals to ensure trouble free operation. Where applicable, fault location charts shall be included to facilitate finding the cause of mal-operation or breakdown. A collection of the manufacturer'' standard leaflets will not accepted to be taken as a compliance of this clause. The manual shall be specifically compiled for the concerned project.

3.5.5 Final Submission of drawings and documents:

The Contractor shall furnish the following after approval of all drawings /documents and test reports:

a. List of drawings bearing the Employer's and Contractor's drawing number.
b. Ten (10) bound sets alongwith 4 CD-ROMs of all drawing.
c. All documents/designs in five (5) copies as noted above.
d. Contractor shall also furnish nine (9) bound sets of all as-built drawings including the list of all as-built drawings bearing drawing numbers. The Contractor shall also furnish four (4) sets of film reproducibles or CD-ROMs of all as-built drawings as decided by the Employer.
e. The Contractor shall also furnish eleven (11) copies of instruction manuals (after approval) for all the equipments.

3.5.6 TEST REPORTS

Five (5) copies of all test reports shall be supplied for approval before shipment of equipment. The report shall indicate clearly the standard value specified for each test to facilitate checking of the reports. After final approval seven bound copies of all type and routine test reports shall be submitted to Employer.

3.6 MATERIAL /WORKMANSHIP

Where the specification does not contain references to workmanship, equipment, materials and components of the covered equipment, it is essential that the same must be new, of highest grade of the best quality of their kind, conforming to best engineering practice and suitable for the purpose for which they are intended and shall ensure satisfactory performance throughout the service life.

In case where the equipment, materials or components are indicated in the specification as "similar" to any special standard the purchaser shall decide upon the question of similarity. When required by the specification or when required by the purchaser the contractor 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 Contractor.

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 subject to mutual agreements. All joints and fastenings shall be devised, constructed and documented so that the component parts shall be accurately positioned and restrained to fulfill 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 Purchaser.

Whenever possible, all similar part of the works shall be made to gauge and shall also be made interchangeable with similar parts. All spare parts shall also be interchangeable and shall be made of the same materials and workmanship as the corresponding parts of the equipment supplied under the specification. Where feasible, common component units shall be employed in different pieces of equipment in order to minimize spare parts stocking requirements. All equipment of the same type and rating shall be physically and electrically interchangeable.
The equipment offered in the bid only shall be accepted for supply, with the minimum modifications as agreed/accepted.

3.7 LIMIT OF CONTRACT

All the equipment, materials and services furnished by the manufacturer shall be complete in every respect with all mountings, fitting, fixtures and standard accessories normally provided with such equipment, and needed for erection, completion and safe operation of the equipment as required by applicable codes though they may not have been specifically detailed in technical specification and unless included in the list of exclusions. The manufacturer shall supply at no extra cost to Employer any additional material/service not

covered specifically but which are found to be required for fulfillment of the scope of work under specification.

3.8 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 favorable to the growth of fungi and mildew. The indoor equipment located in non-air-conditioned areas shall also be of same type.

SPACE HEATERS

The heaters shall be suitable for continuous operation at 230 V as supply voltage. On –off switch and fuse shall be provided.

One or more adequately rated thermostatically connected heaters shall be supplied to prevent condensation in any compartment. The heaters shall be installed in the compartment and electrical connections shall be made sufficiently away from below the heaters to minimize deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation.

The heaters shall be suitably designed to prevent any contact between the heater wire and the air and shall consist of coiled resistance wire centered in a metal sheath and completely encased in a highly compacted powder of magnesium oxide or other material having equal heat conducting and electrical insulation properties or they shall consist of resistance wire wound on a ceramic and completely covered with a ceramic material to prevent any contact between the wire and the air. Alternatively, they shall consist of a resistance wire mounted into a tubular ceramic body built into an envelope of stainless steel or the resistance wire is wound on a tubular ceramic body and embedded in vitreous glaze. The surface temperature of the heaters shall be restricted to a value which will not shorten the life of the heater sheaths or that of insulated wire or other component in the compartments.

FUNGI STATIC VARNISH

Besides the space heaters, special moisture and fungus resistance 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.

Ventilation opening

In order to ensure adequate ventilation, compartments shall have ventilation openings provided with fine wire mesh of brass 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.

Degree of Protection

The enclosure of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc. to be installed shall provide degree of protection as detailed here under:

a) Installed out door: IP- 55
b) Installed indoor in air conditioned area: IP-31
c) Installed in covered area: IP-52
d) Installed indoor in non air-conditioned area where possibility of entry of water is limited: IP-41.
e) 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.

3.9 RATING PLATES, NAME PLATES AND LABELS

3.9.1 The equipment nameplate should preferably be of stainless steel. In case of aluminium, it should be at least 2mm thick.. The inscription on the nameplate shall be engraved and no punching shall be accepted except for equipment serial number and year of manufacture. These nameplates shall be black with white engraved lettering.

3.9.2 The rated current, extended current rating and rated thermal current shall be clearly indicated in the name plate in case of current transformer.

3.9.3 Rated voltage, voltage factor and intermediate voltage shall be clearly indicated on the nameplate in case of capacitor voltage transformer.

3.9.4 Name plates of cubicles and panels may be made of non-rusting metal or 3 ply lamicoid.

3.9.5 Each switch shall a clear inscription identifying its function. Switches shall also have a clear inscription of each position indication.

3.10 GALVANISING :

3.10.1 The galvanised surface shall consist of a continuous film adhering to the steel. The finished surface shall be clean and smooth, and shall be free from defects like dissolved patches, base, spot, unevenness of coating, spelter which is loosely attached to the steel globules, spiky deposits, blistered surfaces, flaking or peeling off, etc. The presence of any of these defects shall render the material liable to rejection.

3.10.2 All exposed ferrous parts shall be hot dip galvanised as per IS:2629 & IS:2633, Galvanising shall be uniform, smooth continuous and free from acidspots. Should the galvanising of the sample be found defective, the entire batch of steel shall have to be re-galvanised at Contractor's cost. The amount of zinc deposit shall be not less than 610 gms. per sq.m. of surface area and in addition, the thickness of zinc at any spot shall not be less than 85 microns. The Employer reserves the right to measure the thickness ofzinc deposit by Elkometer or any other instrument acceptable to Employer and reject any component which shows thickness of zinc at any location less than 85 microns. The testing on the galvanised materials shall be carried out as per IS:2633.

3.10.3 The amount of zinc deposit over threaded portion of the bolts, nuts and screws shall not be less than 300 gms. per sq. meter of surface area. The amount of zinc deposit on washers shall not be less than 340 gms. per sq. meter of surface area. The threads

having extra deposit of zinc shall be removed by die cutting after the completion of galvanising. The removal of extra zinc shall be carefully done so that threads shall have minimum deposits of zinc on them as specified.

3.11 PAINTING

The sheet steel to be painted shall be pretreated in tanks in accordance with IS:6005. Degreasing shall be done by alkaline cleaning. Rust and scales shall be removed by pickling with acid. After pickling, the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate coating shall be "class-C" as specified in IS:6005. The phosphated surfaces shall be rinsed and passivated prior to application of stoved lead oxide primer coating. After primer application, two coats of finishing synthetic enamel paint on panels shall be applied. Electrostatic paining shall also be acceptable. Finishing paint on outside of the panels shall be as required otherwise by the Employer. The inside of the panels shall be glossy white. Each coat of finishing shall be properly stoved. The paint thickness shall not be less than 50 microns. Finished parts shall be coated by peelable compound by spraying method to protect the finished surfaces from scratches, grease, dirt and oil spots during testing, transportation, handling and erection.

3.12 QUALITY ASSURANCE PROGRAMME

3.12.1 The Contractor shall adopt suitable quality assurance programme to ensure that the equipment and services under the scope of contract whether manufactured or performed within the Contractor's works or at his subcontractor's premises or at the Employer's site or at any other place of work are in accordance with the specifications. Such programmes shall be outlined by the Contractor and shall be finally accepted by the Employer/authorised representative after discussions before the award of the contract. The QA programme shall be generally in line with ISO-9001/IS- 14001.

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

i. His organisation structure for the management and implementation of the proposed quality assurance programme
ii. Quality System Manual
iii. Design Control System
iv. Documentation Data Control System
v. Qualification data for Bidder's key Personnel.
vi. The procedure for purchase of materials, parts, components and selection of sub-contractor's services including vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased etc.
vii. System for shop manufacturing and site erection controls including process, fabrication and assembly.
viii. Control of non-conforming items and system for corrective actions and resolution of deviations.
ix. Inspection and test procedure both for manufacture and field activities.
x. Control of calibration and testing of measuring testing equipments.
xi. System for Quality Audits.
xii. System for identification and appraisal of inspection status.
xiii. System for authorising release of manufactured product to the Employer.

xiv. System for handling storage and delivery.
xv. System for maintenance of records, and
xvi. Furnishing quality plans 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.

3.12.2 GENERAL REQUIREMENTS - QUALITY ASSURANCE

3.12.2.1 All materials, components and equipment covered under this specification shall be procured, manufactured, erected, commissioned and tested at all the stages, as per a comprehensive Quality Assurance Programme. An indicative programme of inspection/tests to be carried out by the contractor for some of the major items is given in the respective technical specification.
This is, however, not intended to form a comprehensive programme as it is the contractor's responsibility to draw up and implement such programme duly approved by the Employer. The detailed Quality Plans for manufacturing and field activities should be drawn up by the Bidder and will be submitted to Employer for approval. Schedule of finalisation of such quality plans will be finalised before award.

3.12.2.2 Manufacturing Quality Plan will 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 Contractor's/ Sub-contractor"s/ sub-supplier's Quality Control Organisation, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing. The Quality Plan shall be submitted on electronic media e.g. floppy or E-mail in addition to hard copy, for review. Once the same is finalised, hard copies shall be submitted for approval. After approval the same shall be submitted in compiled form on CD ROM.

3.12.2.3 Field Quality Plans will detail out for all the equipment, the quality practices and procedures etc. to be followed by the Contractor's site Quality Control Organisation, during various stages of site activities starting from receipt of materials/equipment at site.

3.12.2.4 The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans alongwith Quality Plans. These Quality Plans and reference documents/standards etc. will be subject to Employer's approval without which manufacturer shall not proceed.
These approved documents shall form a part of the contract. In these approved Quality Plans, Employer shall identify customer hold points (CHP), i.e. test/checks which shall be carried out in presence of the Employer's Project Manager or his authorised representative and beyond which the work will not proceed without consent of Employer/Authorised representative in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Employer alongwith technical justification for approval and dispositioning.

3.12.2.5 No material shall be despatched from the manufacturer's works before the same is accepted subsequent to predespatch final inspection including verification of records of all previous tests/inspections by Employer's Project Manager/Authorised representative and duly authorised for despatch by issuance of MDCC.

3.12.2.6 All material used for equipment manufacture including casting and forging etc. shall be of tested quality as per relevant codes/standards. Details of results of the tests conducted to determine the mechanical properties, ch emical analysis and details of heat treatment procedure recommended and actually followed shall be recorded on certificates and time temperature chart. Tests shall be carried out as per applicable material standards and/or agreed details.

3.12.2.7 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. All welding/brazing procedures shall be submitted to the Employer or its authorised representative for approval prior to carrying out the welding/brazing.

3.12.2.8 All brazers, welders and welding operators employed on any part of the contract either in Contractor's/his sub-contractor's works or at site or elsewhere shall be qualified as per ASME Section-IX or BS-4871 or other equivalent International Standards acceptable to the Employer.

3.12.2.9 Test results or qualification tests and specimen testing shall be furnished to the Employer for approval. However, where required by the Employer, tests shall be conducted in presence of Employer/authorised representative.

3.12.2.10 For all pressure parts and high pressure piping welding, the latest applicable requirements of the IBR (Indian Boiler Regulations) shall also be essentially complied with. Similarly, any other statutory requirements for the equipments/systems shall also be complied with.

3.12.2.11 All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.

3.12.2.12 No welding shall be carried out on cast iron components for repair.

3.12.2.13 Unless otherwise proven and specifically agreed with the Employer, welding of dissimilar materials and high alloy materials shall be carried out at shop only.

3.12.2.14 All non-destructive examination shall be performed in accordance with written procedures as per International Standards, The NDT operator shall be qualified as per SNT-TC-IA (of the American Society of non-destructive examination). NDT shall be recorded in a report which includes details of methods and equipment used, result/evaluation, job data and identification of personn el employed and details of co-relation of the test report with the job.

3.12.2.15 For components/equipment procured by the contractors for the purpose of the contract, after obtaining the written approval of the Employer, the contractor's

purchase specifications and inquiries shall call for quality plans to be submitted by the suppliers. The quality plans called for from the subcontractor shall set out, during the various stages of manufacture and installation, the quality practices and procedures followed by the vendor's quality control organisation, the relevant reference documents/standards used, acceptance level, inspection of documentation raised, etc..

Such quality plans of the successful vendors shall be finalised with the Employer and such approved Quality Plans shall form a part of the purchase order/contract between the Contractor and sub-contractor. Within three weeks of the release of the purchase orders/contracts for such bought out items/components, a copy of the same without price details but together with the detailed purchase specifications, quality plans and delivery conditions shall be furnished to the Employer on the monthly basis by the Contractor.

3.12.2.16 Employer reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Contractor's or their subvendor's quality management and control activities. The contractor shall provide all necessary assistance to enable the Employer carry out such audit and surveillance.

3.12.2.17 The contractor shall carry out an inspection and testing programme during manufacture in his work and that of his sub-contractor's and at site to ensure the mechanical accuracy of components, compliance with drawings, conformance to functional and performance requirements, identity and acceptability of all materials parts and equipment. Contractor shall carry out all tests/inspection required to establish that the items/equipments conform to requirements of the specification and the relevant codes/standards specified in the specification, in addition to carrying out tests as per the approved quality plan.

3.12.2.18 Quality audit/surveillance/approval of the results of the tests and inspection will not, however, prejudice the right of the Employer to reject the equipment if it does not comply with the specification when erected or does not give complete satisfaction in service and the above shall in no way limit the liabilities and responsibilities of the Contractor in ensuring complete conformance of the materials/equipment supplied to relevant specification, standard, data sheets, drawings, etc.

3.12.2.19 For all spares and replacement items, the quality requirements as agreed for the main equipment supply shall be applicable.

3.12.2.20 Repair/rectification procedures to be adopted to make the job acceptable shall be subject to the approval of the Employer/ authorised representative.

3.12.2.21 Burn in and Elevated Temperature Test Requirement for Electronics Solid State Equipment

a. All solid state electronic systems/equipment shall be tested as a complete system/equipment with all devices connected for a minimum of 168 hours (7 Days) continuously under energized conditions prior to shipment from Manufacturing works, as per the following cycle.

b. Elevated Temperature Test Cycle

During the elevated temperature test which shall be for 48 hours of the total 168 hours of testing, the ambient temperature shall be maintained at 50 deg.C. The equipment shall be interconnected with devices which will cause it to repeatedly perform all operations it is expected to perform in actual service with load on various components being equal to those which will be experienced in actual service.

During the elevated temperature test the cubicle doors shall be closed (or shall be in the position same as they are supposed to be in the field) and inside temperature in the zone of highest heat dissipating components/modules shall be monitored. The temperature rise inside the cubicle should not exceed 10 deg.C above the ambient temp. at 50 deg.C.

c. Burn in Test Cycle

The 48 hours elevated temperature test shall be followed by 120 hours of burn in test as above except that the temperature shall be reduced to the ambient temperature prevalent at that time.

During the above tests, the process I/O and other load on the system shall be simulated by simulated inputs and in the case of control systems, the process which is to be controlled shall also be simulated. Testing of individual components or modules shall not be acceptable.

In case the Contractor/ sub-contractor is having any alternate established procedure of eliminating infant mortile components, the detail procedures followed by the Contractor/ sub- contractor alongwith the statistical figures to validate the alternate procedure to be forwarded.

The Contractor/Sub-contractor shall carry out routine test on 100% item at contractor/sub-contractor's works. The quantum of check/test for routine & acceptance test by employer shall be generally as per criteria/sampling plan defined in referred standards. Wherever standards have not been mentioned quantum of check/test for routine / acceptance test shall be as agreed during detailed engineering stage.

3.12.3 QUALITY ASSURANCE DOCUMENTS

3.12.3.1 The Contractor shall be required to submit two hard copies and two sets on CDROM of the following Quality Assurance Documents as identifed in respective quality plan with tick (_) mark within three weeks after despatch of the equipment. Typical contents of Quality Assurance Document is as below:-

i) Quality Plan,
ii) Material mill test reports on components as specified by the specification and approved Quality Plans.
iii) Factory test reports/results for testing required as per applicable codes and standard referred in the specification and approved Quality Plans.
iv) Type test report(wherever applicable).
v) Non-destructive examination results /reports including radiography interpretation reports.
Sketches/drawings used for indicating the method of traceability of the radiographs to the location on the equipment.
vi) Heat Treatment Certificate/Record (Time- temperature Chart)
vii) All the accepted Non-conformance Reports (Major/Minor) / deviation,

including complete technical details / repair procedure)Verification sketches, if used and methods used to verify that the inspection and testing points in the Quality Plan were performed satisfactorily

viii) CHP / Inspection reports duly signed by the Inspector of the Employer and Contractor for the agreed Customer Hold Points.

ix) Certificate of Conformance (COC) whever applicable.

x) MDCC

3.12.3.2 Similarly, the contractor shall be required to submit two hard copies and two sets on CD ROM of Quality Assurance Documents (in line with above) pertaining to field activities as per Approved Field Quality Plans and otheragreed manuals/ procedures, prior to commissioning of individual system.

3.12.3.3 Due to the large variety of equipment items, it is always possible to adapt the content of the quality document to better match the particularities of any equipment. This shall be done in agreement with the Supplier and the Inspector.
The Quality Document file shall be progressively completed by the Supplier's sub-supplier to allow regular reviews by all parties during the manufacturing.Each quality document shall have a project specific Cover Sheet bearing name & identification number of equipment and including an index of its contents with page control on each document.

3.12.3.4 Before shipping any equipment, the Supplier shall make sure that the corresponding quality document or in the case of protracted phased deliveries, the applicable section of the quality document file is completed. The supplier will then notify the Inspector regarding the readiness of the quality document (or applicable section) for review.

i) If the result of the review carried out by the Inspector of the Quality document (or applicable section) is satisfactory.The Inspector shall stamp,the quality document (or applicable section) for release.

ii) If the quality document is unsatisfactory, the Supplier shall endeavor to correct the incompleteness, thus allowing to finalize the quality document (or applicable section) by time compatible with the requirements as per contract documents. When it is done, the quality document (or applicable section) is stamped by the Inspector.

iii) If a decision is made to ship equipment, whereas all outstanding actions cannot be readily cleared for the release of the quality document by the time as per contract documents (or finalization of the applicable section of the quality document within one month as per corresponding shipment date).The supplier shall immediately, upon shipment of the equipment, send a copy of the quality document Review Status (signed by the Supplier Representative) to the Inspector and notify of the committed date for the completion of all outstanding actions & submission.The Inspector shall stamp the quality document for applicable section when it is effectively completed.
The final quality document will be compiled and issued at the final assembly place of equipment before shipment.

3.12.4 TRANSMISSION OF QUALITY DOCUMENTS

As a general rule, two hard copies of the quality document and Two CD ROMs shall be issued to the Employer not later than 1 month after the delivery date for the corresponding equipment . One set of quality document shall be forwarded to

Corporate Quality Assurance Department and other set to respective Site .
For the particular case of phased deliveries, the complete quality document to the Employer shall be issued not later than 1 month after the date of the last delivery similarly as stated above

3.13 TYPE TESTING , INSPECTION, TESTING & INSPECTION CERTIFICATE

3.13.1 The word 'Inspector' shall mean the Project Manager and/or his authorised representative and/or an outside inspection agency acting on behalf of the Employer to inspect and examine the materials and workmanship of the works during its manufacture or erection.

3.13.2 The Project Manager or his duly authorised representative and/or an outside inspection agency acting on behalf of the Employer shall have access at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection and if part of the works is being manufactured or assembled on other premises or works, the Contractor shall obtain for the Project Manager and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works.

3.13.3 The Contractor shall give the Project Manager/Inspector fifteen (15) days written notice of any material being ready for testing. Such tests shall be to the Contractor's account except for the expenses of the Inspector's. The Project Manager/Inspector, unless the witnessing of the tests is virtually waived, will attend such tests within fifteen (15) days of the date on which the equipment is noticed as being ready for test/inspection failing which the contractor may proceed with test which shall be deemed to have been made in the inspector's presence and he shall forthwith forward to the inspector duly certified copies of test reports in two (2) copies.

3.13.4 The Project Manager or Inspector shall within fifteen (15) days from the date of inspection as defined herein give notice in writing to the Contractor, or any objection to any drawings and all or any equipment and workmanship which is in his opinion not in accordance with the contract. The Contractor shall give due consideration to such objections and shall either make modifications that may be necessary to meet the said objections or shall inform in writing to the Project Manager/Inspector giving reasons therein, that no modifications are necessary to comply with the contract.

3.13.5 When the factory tests have been completed at the Contractor's or subcontractor's works, the Project Manager /Inspector shall issue a certificate to this effect fifteen (15) days after completion of tests but if the tests are not witnessed by the Project Manager /Inspectors, the certificate shall be issued within fifteen (15) days of the receipt of the Contractor's test certificate by the Project Manager /Inspector. Project Manager /Inspector to issue such a certificate shall not prevent the Contractor from proceeding with the works.The completion of these tests, or the issue of the certificates shall not bind the Employer to accept the equipment should it, on further tests after erection be found not to comply with the contract.

3.13.6 In all cases where the contract provides for tests whether at the premises or works of the Contractor or any sub-contractor, the Contractor, except where otherwise specified shall provide free of charge such items as labour, material, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Project Manager /Inspector or his authorised representatives to carry out effectively such tests on the equipment in accordance with the Contractor and shall give facilities to the Project Manager/Inspector or to his authorised representative to accomplish testing.

3.13.7 The inspection by Project Manager / Inspector and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed Quality Assurance Programme forming a part of the contract.

3.13.8 To facilitate advance planning of inspection in addition to giving inspection notice as per Clause 3.03.00, the Contractor shall furnish quarterly inspection programme indicating schedule dates of inspection at Customer Hold Point and final inspection stages. Updated quarterly inspection plans will be made for each three consecutive months and shall be furnished before beginning of each calendar month.

3.13.9 All inspection, measuring and test equipments used by contractor shall be calibrated periodically depending on its use and criticality of the test/measurement to be done. The Contractor shall maintain all the relevant records of periodic calibration and instrument identification, and shall produce the same for inspection by NTPC. Wherever asked specifically, thecontractor shall re-calibrate the measuring/test equipments in the presence of Project Manager / Inspector.

3.14 PACKAGING & PROTECTION

3.14.1 Packing, Marking and shipping

The packing and shipping shall be carried out in accordance with the standard practice of Contractor and with the following additional requirements:

a. The equipment shall be prepared in such a manner as to protect the equipment from damage or deterioration during shipping or storage. The shipments can be exposed to heavy rains, hot sun, high humidity and sudden extreme changes of temperature. The equipment shall be packed and shipped so as to protect it from all such conditions and any other abnormal conditions, generally expected during shipping & storage.

b. The metallic containers, if any, shall be considered as the property of the Contractor and he will be allowed to remove them from site once the contents are unpacked, inspected, documented and placed in temporary storage or in final position.

c. The equipment shall be shipped in such a manner as to facilitate unloading, handling and storage enroute and at the site. The Contractor shall provide lifting lugs and special lifting devices for proper handling and erection.

d. The Contractor shall be liable for any damage or loss resulting due to careless, improper, poor or insufficient packing and handling.

e. Spare parts and spare equipment shall be packed separately in containers adequate for long term storage, plainly marked "Spare Parts Only". They shall be crated individually or in kits to be used in one single renewal or overhaul operation. Other spare part kits shall not be disturbed when using one set or kit.

f. The Contractor shall at all times protect and preserve from damage, loss, corrosion and all other forms of damage, all parts of the works.

3.14.2 Transportation

a. The Contractor shall make a careful examination of access rail/roadways to the site in order to confirm the practical maximum transport weight and dimensions as well as a careful examination of the ports of disembarkation particularly with respect to the capacity of the cranes installed and access roads.

b. All instruments and computer/microprocessor based equipment imported into India from overseas for the purpose of this contract shall be air freighted

to the nearest possible point and further by rail/road taking due precautions as per manufacturer's recommendations. Employer shall have the right to decide the items that should be air freighted and Employer's decision shall be binding on Contractor

3.14.3 Insurance

a. The Contractor shall insure all shipments and works at his own expense for not less than the full replacement cost plus any additional cost for accelerated manufacturing of the replacement parts.

b. Loss or the damage to equipment during shipping or transportation to the site(s) or otherwise shall not constitute groups for claims for extension in time or for extra payment.

3.14.4 Storage of Equipment

a. The Contractor shall provide and construct adequate storage sheds for proper storage of equipment. Sensitive equipments shall be stored indoors. All equipment during storage shall be protected against damage due to act of nature or accidents. The storage instructions of the equipment manufacturers shall be strictly adhered to.

b. The necessary transport packing shall be removed as soon as possible after receipt of equipment at the work site(s).

3.15 CLAMPS AND CONNECTORS INCLUDING TERMINAL CONNECTORS

3.15.1 The material of clamps and connectors shall be Aluminium alloy casting conforming to designation A6 of IS:617 for connecting to equipment terminals and conductors of aluminium. In case the terminals are of copper, the same clamps/connectors shall be used with 2mm thick bimetallic liner.

3.15.2 The material of clamps and connectors shall be Galvanised mild steel for connecting to shield wire.

3.15.3 Bolts, nuts and plain washers shall be hot dip galvanised mild steel for sizes M12 and above. For sizes below M12, they shall be electro-galvanised mild steel. The spring washers shall be electro-galvanised mild steel.

3.15.4 All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be rounded off to meet specified corona and radio interference requirements.

3.15.5 They shall have same current rating as that of the connected equipment. All current carrying parts shall be at least 10 mm thick. The connectors shall be manufactured to have minimum contact resistance.

3.15.6 Flexible connectors, braids or laminated strips shall be made up of copper/aluminium.

3.15.7 Current rating and size of terminal/conductor for which connector is suitable shall be put on a suitable sticker on each component which should last atleast till

erection time.

3.16 CONTROL CABINETS , JUNCTION BOXES, TERMINAL BOXES & MARSHALLING BOXES FOR OUTDOOR EQUIPMENT .

3.16.1 All types of control cabinets, junction boxes, marshaling boxes, lighting panels, terminal boxes, operating mechanism boxes, Kiosks etc. shall generally conform to IS:5039, IS:8623 and IEC:439 as applicable.

3.16.2 They shall be of painted sheet steel or aluminium. The thickness of sheet steel shall be 2mm cold rolled or 2.5mm hot rolled. The thickness of aluminium shall be 3mm and shall provide rigidity. Top of the boxes shall be sloped towards rear of the box. The paint shall be of grey RAL 9002 on the outside and glossy white inside. However, the junction and switch boxes shall be of hot dip galvanised sheet steel of 1.6mm thickness.

3.16.3 The cabinets/boxes/kiosks/panels shall be free standing or wall mounting or pedestal mounting type. They shall have hinged doors with padlocking arrangement. All doors, removable covers and plates shall be gasketed all around with neoprene gaskets.

3.16.4 The degree of protection of of all the outdoor boxes shall not be less than IP 55 as per IS 2147.

3.16.5 The cable entry shall be from bottom, for which removable gasketed cable gland plates shall be provided.

3.16.6 Suitable 240V, single phase, 50Hz ac heaters with thermostats controlled by switch and fuse shall be provided to maintain inside temperature 10deg. above the ambient.

3.16.7 The size of enclosure and the layout of equipment inside shall provide generous clearances. Each cabinet/box/kiosk/panel shall be provided with a 15A, 240V ac, 2 pole, 3 pin industrial grade receptacle with switch. For incoming supply, MCB of suitable rating shall be provided. Illumination of each compartment shall be with door operated incandescent lamp. All control switches shall be of rotary switch type.

3.16.8 Each cabinet/box/kiosk/panel shall be provided with two earthing pads to receive 75mmx12mm GS flat. The connection shall be bolted type with two bolts per pad. The hinged door shall be connected to body using flexible wire. The cabinets/boxes/kiosks/panels shall also be provided with danger plate, and internal wiring diagram pasted on inside of the door. The front label shall be on a 3mm thick plastic plate with white letters engraved on black background

3.17 TERMINAL BLOCKS

3.17.1 They shall be non-disconnecting stud type of extensible design equivalent to Elmex type CAT-M4.

3.17.2 The terminal blocks shall be of 1100 V grade, and rated to continuously carry maximum expected current. The conducting part shall be tinned or silver plated.

3.17.3 They shall be of moulded, non-inflammable thermosetting plastic. The material shall not deteriorate with varied conditions of temperature and humidity. The terminal blocks shall be fully enclosed with removable covers of transparent, non deteriorating
plastic material. Insulating barriers shall be provided between the terminal blocks so that the barriers do not hinder the wiring operation without removing the barriers.

3.17.4 The terminals shall be provided with marking tags for wiring identification.

3.17.5 Unless otherwise required (expected current rating) or specified, terminal blocks shall be suitable for connecting the following conductors on each side:
All CT & VT circuits - Min. four 2.5 sq.mm. copper flexible conductor
AC & DC power supply -Two 16 sq.mm. aluminium conductor
Circuits
Other control circuits - Min. two 2.5 sq.mm. copper flexible conductor
3.18.02 The terminal blocks for CT and VT secondary leads shall be provided with test links and isolating facilities. CT secondary leads shall also be provided with short circuiting and earthing facilities.

3.18 Wiring

3.18.1 All wiring shall be carried out with 1100 V grade stranded copper wires. The minimum size of the stranded conductor used for internal wiring shall be as follows:
a) All circuits except CT circuits 2.5 sq.mm
b) CT circuits 4 sq. mm (minimum number of strands shall be 3 per conductor).

3.18.2 All internal wiring shall be securely supported, neatly arranged readily accessible and connected to equipment terminals and terminal blocks.

3.18.3 Wire terminations shall be made with solderless crimping type of tinned copper lugs which firmly grip the conductor and insulation. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with the wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wires shall not fall off when the wires and shall not fall off when the wire is disconnected from terminal blocks.

3.18.4 All wires directly connected to trip circuit breaker shall be distinguished by the addition of a red coloured unlettered ferrule. Number 6 & 9 shall not be included for ferrules purposes.

3.18.5 All terminals including spare terminals of auxiliary equipment shall be wired upto terminal blocks. Each equipment shall have its own central control cabinet in which all contacts including spare contacts from all poles shall be wired out. Interpole cabling for all equipment's shall be carried out by the Contractor.

3.19 CABLE GLANDS AND LUGS

3.19.1 Cable glands shall be Double compression type, tinned/Nicked plated (coating thickness not less than 20 microns in case of tin and 10 to 15 microns in case of nickel) brass cable glands for all power and control cables. They shall provide dust

and weather proof terminations. They shall comprise of heavy duty brass casting, machine finished and tinned to avoid corrosion and oxidation. Rubber components used in cable glands shall be neoprene and off tested quality. Required number of packing glands to close unused openings in gland plates shall also be provided.

3.19.2 The cable glands shall be tested as per BS:6121. The cable glands shall also be duly tested for dust proof and weather proof termination.

3.19.3 Cables lugs shall be tinned copper solder less crimping type conforming to IS:8309 and 8394 suitable for aluminum or copper conductor (as applicable). The cable lugs shall suit the type of terminals provided. The cable lugs shall be of Dowell make or equivalent.

3.20 CONDUITS, PIPES AND ACCESSORIES

3.20.1 The Contractor 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, bushing reduces, enlargers, wooden plugs, coupling caps, nipples, gland sealing fittings, pull boxes, etc.

3.20.2 Rigid conduits shall be flow-coat metal conduits of Nagarjuna Coated Tubes or equivalent make. The outer surface of the 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 galvanised. All rigid conduits/ pipes shall be of a reputed make.

3.20.3 Flexible conduits shall be heat-resistant lead coated steel, water-leak, fire and rust proof, and be of PLICA make or equivalent.

3.21 MOTOR CONTROL CENTRE

3.21.1 The 415 Volt motor control centres (if provided separately) shall conform to the requirements for boxes/cabinets/kiosks. They shall be fixed type, shall be fully sectionalised and shall be equipped with load break switches. Motor feeders shall be provided with isolating switch fuse unit and Contractor with thermal overload relay and single phase protection. The motor Contractor shall have one normally open auxiliary contact for alarm purposes. The motor control circuit shall be independent from all other control circuits.

3.21.2 Isolating Switches

The incoming power supply isolating switch operation handle shall be interlocked with the control cabinet door as to prevent opening of door when main switch is closed. Device for by passing the door interlock shall also be provided. Switch handle shall have provision for locking in both fully open and fully closed positions.

3.21.3 Fuses

All fuses shall be of the HRC cartridge type, conforming to IS:2208 and suitable to mount on plugin type of fuse bases. Fuses shall be provided with visible operation indicators to show that they have operated. All accessible live connections shall be adequately shrouded, and it shall be possible to change fuses with the circuit alive, without danger of contact with live conductor. Insulated fuse pulling handle shall be

supplied with each control cabinet.

3.22 MOTORS

3.23.01 Motors shall be "Squirrel Cage" three phase induction motors of sufficient size capable of satisfactory operation for the application and duty as required for the driven equipment and shall conform to type tests and shall be subjected to routine tests as per applicable standards.

3.23.02 Enclosures

a) For motors to be installed outdoor, the motor enclosure shall have degree of protection IP:55. For motors to be installed indoor, i.e. inside a box, the motor enclosure shall be dust proof equivalent to IP:44.
b) Two independent earthing points shall be provided on opposite sides of the motor for bolted connection of earthing conductor.
c) Motors shall have drain plugs so located that they will drain water resulting condensation or other causes from all pockets in the motor casing.
d) Motors weighing more than 25 kg shall be provided with eyebolts, lugs or other means or facility for lifting.

3.23.03 Operational Features :

a) Continuous motor ratings (name plate rating) shall be at least suitable for the driven equipment at design duty operating point of driven equipment that will arise in service.
b) Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously in the given system.

3.23.04 Starting Requirements

a) All induction motors shall be suitable for full voltage direct on-line starting. These shall be capable of starting and accelerating to the rated speed alongwith the driven equipment without exceeding the acceptable winding temperature even when the supply voltage drops.
b) Motors shall be capable of withstanding the electrodynamic stresses and heating imposed if it is started at a voltage of 110% of the rated value.
c) The locked rotor current shall not exceed six(6) times the rated full load current for all motors subject to tolerance given in IS:325.
d) Motors when started with driven equipment imposing full staring torque and supply voltage conditions specified shall be capable of withstanding at least two successive starts from cold condition at room temperature and one start from hot condition without injurious heating of winding. The motors shall also be suitable for three equally spread starts per hour under the above referred supply condition.
e) The locked rotor withstand time under hot condition at 110% of rated voltage shall be more than starting time with the driven equipment of minimum permissible voltage by a least two seconds or 15% of the accelerating time whichever is greater. In case it is not possible to meet the above requirement, the Contractor shall offer centrifugal type speed switch mounted on the motor shaft which shall remain closed for speeds lower than 20% and open for speeds above 20% of the rated. The speed switch shall be capable of withstanding 120% of the rated speed in either directions of rotation.

3.23.05 The maximum permissible temperature rise over the ambient temperature shall be

within the limits specified in IS:325 (for 3 phase induction motors) after adjustment due to increased ambient temperature specified.

3.23.06 The double amplitude of motor vibration shall be within the limits specified in IS:729. Vibration shall also be within the limits specified by the relevant standard for the driven equipment when measured at the motor bearings.

3.23.07 All the induction motors shall be capable of running at 80% of rated voltage for a period of 5 minutes.

3.23 AUXILIARY SWITCH

The auxiliary switch shall conform of following type tests:

a) Electrical endurance test - A minimum of 1000 operations for 2A. D.C. with a time constant greater than or equal to 20 milliseconds with a subsequent examination of mV drop/ visual defects/ temperature rise test.
b) Mechanical endurance test - A minimum of 5000 operations with a subsequent checking of contact pressure test/ visual examination
c) Heat run test on contacts
d) IR/HV test, etc.

3.24 LAMPS AND SOCKETS

3.25.1 Lamps:

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

3.25.2 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.

3.25.3 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.

3.25.4 Switches and Fuses:

Each control 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 switch-fuse 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.

All control switches shall be of rotary type. Toggle/piano switches shall not be accepted.

3.25 BUSHINGS, HOLLOW COLUMN INSULATORS, SUPPORT INSULATORS

3.25.1 Bushings shall be manufactured and tested in accordance with IS:2099 & IEC:137 while hollow column insulators shall be manufactured and tested in accordance with IEC 233/IS 5284. The support insulators shall be manufactured and tested as per IS:2544 / IEC 168/IEC 273. The insulators shall also conform to IEC 815 as applicable.
Support insulators/ bushings/ hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used.

3.25.2 Porcelain used shall be homogenous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture. Hollow porcelain should be in one integral piece in green & fired stage.

3.25.3 Glazing of the porcelain shall be uniform brown in colour, free form blisters, burns and other similar defects.

3.25.4 When operating at normal rated voltage there shall be no electric discharge between conductor and insulators which would cause corrosion or injury to conductors or when operating at normal rated voltage.

3.25.5 The design of the insulator shall be such that stresses due to expansion and contraction in any part of the insulator shall be lead to deterioration. All ferrous parts shall be hot dip galvanised.

3.25.6 Contractor shall make available data on all the essential features of design including the method of assembly of shells and metal parts, number of shells per insulator, the manner in which mechanical stresses are transmitted through shells to adjacent parts, provision for meeting expansion stresses, results of corona and thermal shock tests, recommended working strength and any special design or arrangement employed to increase life under service conditions.

3.25.7 Post type insulators shall consist of a porcelain part permanently secured in metal base to be mounted on supporting structures. They shall be capable of being mounted upright. They shall be designed to withstand all shocks to which they may be subjected to during operation of the associated equipment.

3.25.8 Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps, the shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.

3.25.9 All iron parts shall be hot dip galvanised and all joints shall be air tight. Surface of joints shall be trued; porcelain parts by grinding and metal parts by machining. Insulator/ bushing design shall be such as to ensure a uniform compressive pressure on the joints.

3.25.10 Bushings, hollow column insulators and support insulators shall conform to type tests and shall be subjected to routine tests and acceptance test/ sample test in accordance with relevant standards.

3.25.11 Insulator shall also meet requirement of IEC - 815 as applicable, having alternate long & short sheds.

3.26 CORONA AND RIV TESTS AND SEISMIC WITHSTAND TEST:

The corona (for 400kV only) and RIV tests shall confirm to the requirements as per **Annexure A** to this chapter. The seismic withstand test for 400kV shall conform to requirements as per **Annexure B** to this chapter.

3.27 Enclosures:

1. Annexure- A - CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST
2. Annexure- B - SEISMIC WITHSTAND TEST

Annexure – A

CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST

1.0 **General**

Unless otherwise stipulated, all equipment 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 measurement of radio interference voltage (RIV).

2.0 **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.

3.0 **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 – I. 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 result 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 measurement 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% for the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 420 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 recommendations 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 the voltage read by the noise meter.
4.0	**Test Methods for visible Corona** The purpose of this test is to determine the corona extinction voltage of the 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 %, the voltage level shall be raised till inception of corona or rated voltage whichever is lower. The voltage will then be decreased slowly until all visible corona disappears. The test 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 the 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 procedure 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 connectors so as to show corona on bushing, insulators and all parts of energized connectors. The photographs shall be framed such that test object essentially fills the frame with no cut off.
4.1	For recording purposes, modern devices using UV recording methods such as image intensifier may also be used.
4.2	The test shall be recorded on each photograph. Additional 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.
4.3	In addition to photographs of the test object preferably four photographs shall be taken of the complete test assembly showing relative positions of the test equipment and test object. Thes e 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.,
4.4	The test to determine the visible corona extinction voltage need not be carried out simultaneously with test to determine RIV levels.
4.5	However both tests shall be carried out with the same test set up and as little time duration between tests as possible. No modification or treatment of the sample between tests will be allowed. Simultaneous RIV and visible corona extinction voltage testing may be permitted at the discretion of the owner's engineer, if in his opinion it will not prejudice other test.
5.0	**Test Records:**
	In addition to the information previously mentioned and requirements specified as per CISPR or NEMA 107-1964 the following data shall be included in the test report-
a)	Background noise before and after the test
b)	Detailed procedure of application of test voltage
c)	Measurement of RIV levels expressed in microvolts 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 micro volt in each direction.
f)	Onset and extinction of visible corona for each of the four tests required shall be recorded.

Annexure – B

SEISMIC WITHSTAND TEST
(For 400kV Only)

The seismic withstand test on the complete equipment (except BPI) shall be carried out along with supporting structure.

The bidder shall arrange to transport the structure from his contractor's premises / owner's sites for purpose of seismic withstand test only.

The seismic level specified shall be applied at the base of the structure. The accelerometers shall be provided at the terminal pad of the equipment and at any other point as agreed by the owner. The seismic test shall be carried out in all possible combinations of the equipment. The seismic test procedure shall be furnished for approval of the purchaser.

Attributes / Characteristics Items/Components Sub Systems	Make, model, Type & Rating, Test Certificate	Routine & Acceptance Test as per IS / IEC	Functional requirements as per NTPC Specification
Circuit Breaker (IEC:56)	Y	Y	Y
Interrupter & hollow insulator (IEC:233/ IS:5284)	Y	Y	Y
Isolator (IEC:129 / IEC:694)	Y	Y	Y
Current Transformer (IEC:185)	Y	Y	Y
Capacitor Voltage Transformer (IEC:186 / 358)	Y	Y	Y
Bus Post Insualtor (IEC:168 / 273 / IS:2544)	Y	Y	Y
Disc,Pin & String Insualtor (IEC:383 / IS:731)	Y	Y	Y
Long Rod Insualtor (IEC:433)	Y	Y	Y
Surge Arrestor (IEC:99-4)	Y	Y	Y
Hardware fittings for Insulator (IS:2486 / BS:3288)	Y	Y	Y
Spacer Clamps & Connector (IS:10162 / 5561)	Y	Y	Y
Aluminium Tube (IS:5082 / 2673 / 2678)	Y	Y	Y
Wave Trap (IEC:353 / IS:8792 / 8793)	Y	Y	Y
Conductor (IS:398-P-II)(V)	Y	Y	Y
Galvanised Steel Structures (IS:2062/2629/4759/6745)	Y	Y	Y
Vibration Damper (IS:9708)	Y	Y	Y
Sag Compensating Spring DIN:2089/2096 IS:3195 / 7906	Y	Y	Y
Control & Relay Panel	Y	Y	Y
SF6 Gas filling & evacuating plant	Y	Y	Y
SF6 Gas Leak Detector	Y	Y	Y
Leakage Current Analyser	Y	Y	Y
Nitrogen Gas Filling Device	Y	Y	Y
Protection Relays	Y	Y	Y
Event Logger	Y	Y	Y
Operation Analyser	Y	Y	Y
Disturbance Recorder	Y	Y	Y
Tariff Metering System	Y	Y	Y
Synchronising Trolly	Y	Y	Y

Attributes / Characteristics Items/Components Sub Systems	Make, Type Rating,and Model, Test Certificates	Routine & Acceptance Test as per relevant IS/IEC	Functional requirements as per NTPC Specification
Relay Test Kit	Y	Y	Y
LT Switchgear /LT Panels (IEC:947 / IS:13947)	Y	Y	Y
Battery IS:1652	Y	Y	Y
Lighting Panels	Y	Y	Y
Surge Monitor	Y	Y	Y

Notes : 1) This is an indicative list of test/checks. The manufacture is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents during QP finalisation for all items.

2) All major Bought Out Items will be subject to NTPC approval.

SECTION - IV

GUARANTEED TECHNICAL PARTICULARS FOR CIRCUIT BREAKERS

- **NTPC datasheet for Circuit Breaker (6 pages)**
- **NTPC datasheet for Bushing/Hollow Insulators (2 pages)**

CLAUSE NO.	BIDDER'S NAME	
	E 1 **EHV CIRCUIT BREAKERS**	
	(Bidder to fill up seperately for each type of breaker)	
1.	General	
	a) Name & country of the Manufacturer	.....
	b) Type of Circuit breaker	.....
	c) Manufacturer's type designation	.....
	d) Standards Applicable	.....
	e) Rated Voltage (KV)	.....
	f) Rated Current	.....
	i) Under normal condition (Amps)	.....
	ii) Under site conditions (Amps)	.....
	g) Rated frequency (Hz)	.....
	h) Number of poles	.....
	i) Whether 3 poles or single pole unit	.....
	j) Whether dead tank or live tank design	.....
	k) No. of breaks per pole	.....
2.	Guaranteed Ratings	.....
	a) Rated short circuit breaking current	.....
	i) Symmetrical component at highest system voltage (kA)	.....
	ii) DC Component (%)	.....

CLAUSE NO.	BIDDER'S NAME	
	iii) Asymmetrical breaking current at highest system voltage (kA)	.....
	b) Rated Making capacity	.....
	i) at higher rated voltage (kA peak)	.....
	ii) at lower rated voltage (kA peak)	.....
	c) Maximum break time for any current upto rated breaking current (ms)	.....
	i) For Test duties 2,3 & 4 at rated values	.....
	ii) For other duties at limiting conditions of voltage and pressure	.....
	d) Closing times (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) First pole to clear factor	.....
	h) Short time current rating (kA)	.....
	i) 1 Second	.....
	ii) 3 Second	.....
	i) Rated operating duty	.....
	j) Maximum line charging breaking current with temporaty over voltage	

CLAUSE NO.	BIDDER'S NAME	
	up to 1.4 p.u. (kA)	.....
	k) Maximum arc duration and corresponding current under lockout pressure.	.....
	l) Pre-insertion resistor (if applicable)	.....
	i) Value / pole (Ohms)/with tolerance	.....
	ii) Minimum and maximum duration of insertion per pole (ms)	.....
	iii) Thermal rating for the C-1m-0-CO-2m-C-1m-O-CO for terminal fault considering maximum resistance and time setting	.....
	iv) Thermal rating for the same duty as (iii) above for reclosing against trapped charges	.....
	3. Dielectric with-stand of Complete Breaker	.....
	a) One minute dry & wet power frequency withstand voltage	.....
	i) Between live terminal and ground (kV rms)	.....
	ii) Between terminals with	

CLAUSE NO.	BIDDER'S NAME	
	breaker contacts open (kV rms)	.....
	b) 1.2/50 micro second impulse withstand test voltage	.....
	i) Between live terminal and ground (kV peak)	.....
	ii) Between terminals with breaker contacts open (kV peak)	.....
	c) 250/2500 micro second impulse switching surge withstand test voltage	.....
	i) Between live terminal and ground (kV peak)	.....
	ii) Between terminals with breaker contacts open (kV peak)	.....
	d) Total creepage distance	.....
	i) To ground (mm)	.....
	ii) Between terminals (mm)	.....
4.	Operating Mechanism	.....
	a) Type of operating mechanism for	.....
	i) Closing	.....
	ii) Opening	.....

CLAUSE NO.	BIDDER'S NAME	
5.	Quenching Media	
	a) Quantity of SF6 per pole at rated pressure (Kg)	.....
	b) Guaranteed maximum leakage rate per year	.....
	c) Rated pressure of SF6 in operating chamber (Kg/cm^2)	.....
	d) Limit of pressure at which breaker operates correctly (Kg/cm^2)	.....
6.	Constructional Details	
	a) Type and capacity of device used to obtain uniform voltage distribution between breaks	.....
	b) Number of auxiliary contacts per pole provided	.....
	i) NO	.....
	ii) NC	.....
	iii) Adjustable	.....

CLAUSE NO.	BIDDER'S NAME	
7.	Detailed Literature	.....
	(Whether the following are enclosed)	
	a) Type test reports	Yes/No
	b) OGA drawing of breaker	Yes/No

CLAUSE NO.	BIDDER'S NAME	
	E - 13	
	EHV INSULATORS FOR CHAPTER E1 TO 6&12	
A.	**BUSHING / HOLLOW INSULATORS**	
	(Bidder shall furnish these data for each equipment separately i.e . for circuit Breakers, Instrument Transformer, Surge Arrestors, etc.)	
	1. Manufacturer's Name	.....
	2. Country of Manufacturer	.....
	3. Type	.....
	4. Applicable Standards	.....
	5. i) Height	.....
	ii) Diameter (Top)	.....
	iii) Diameter (Bottom)	.....
	6. Creepage distance	.....
	a) Total (mm)	.....
	7. Rated Voltage	.....
	8. Power frequency withstand voltage for 1 min. (kv rms)	.....
	i) Dry	.....
	ii) Wet	.....
	9. 1.2/50 micro sec. impulse withstand voltage (kVp)	.....
	10. 250/2500 Micro sec. switching impulse withstand voltage (kVp)	.....
	i) Dry	.....
	ii) Wet	.....

CLAUSE NO.	BIDDER'S NAME	
	11. Weight (Kg)	.....
	12. Cantilever Strength (Kg)	.....
	13. OGA drawing enclosed	Yes/No
B.	**BUS POST INSULATOR**	
	(Bidder shall furnish these data for solid core Insulators for Disconnecting switches, bus support, etc. separately)	
	1. Manufacturer's Name	.....
	2. Country of Manufacturer	.....
	3. Type of Insulator (Product No.)	.....
	4. Applicable Standards	.....
	5. No. of units per Stack	.....
	6. Diameter & No. of Bolts	.....
	ii) Top	.....
	ii) Bottom	.....
	7. Bolt circle diameter (mm)	.....
	ii) Top	.....
	iii) Bottom	.....
	8. Height of complete stack (mm)	.....
	9. Total Creepage distance (mm)	.....
	10. Power frequency withstand voltage of insulator with corona ring	.....
	i) Dry (kV rms)	.....
	ii) Wet (kV rms)	.....

SECTION - 5

QUALITY PLAN

Supplier shall follow valid approved Quality Plan of NTPC.

-X-

SECTION - VI

CHECK LIST FOR 420 & 145 KV CIRCUIT BREAKERS

Put a tick mark (√) on 'YES' if the specified requirement is met, or put a tick mark on 'NO', if the specified requirement is not met and give comments in the "Remarks" column.

Sl. No.	Parameters	420 kV	YES/NO	145 kV	YES/NO	Remarks
1	Type/class of Circuit Breaker	SF6 / C2M1	YES/NO	SF6 / C2M1	YES/NO	
2	Manufacturer's type designation					
3	Standard Applicable	IEC 62271 - 100	YES/NO	IEC 62271 - 100	YES/NO	
4	Rated Voltage (kV rms)	420	YES/NO	145	YES/NO	
5	Rated Current					
	Under normal condition (A)	(a) 3150 A	YES/NO	(a) 2000 A	YES/NO	
		(b) 2000 A	YES/NO	(b) 1250 A	YES/NO	
6	Max fault level (1 s)	50 kA	YES/NO	31.5 kA	YES/NO	
7	Phase to phase spacing	7000 mm		3000 mm		
8	Rated frequency (Hz)	50	YES/NO	50	YES/NO	
9	Number of poles	3	YES/NO	3	YES/NO	
10	Whether All The 3 poles ganged electrically or mechanically	Electrically	YES/NO	Mechanically	YES/NO	
11	Whether dead tank or live tank design	Live	YES/NO	Live	YES/NO	
12	No. of break per pole		YES/NO		YES/NO	
13	Rated short circuit breaking current					
	i. Symmetrical component at highest system voltage (kA)	50	YES/NO	31.5	YES/NO	
	ii. DC Component (%)	(a) 49 %	YES/NO	(a) 49 %	YES/NO	
		(b) 36 %	YES/NO	(b) 36 %	YES/NO	

Sl. No.	Parameters	420 kV	YES/NO	145 kV	YES/NO	Remarks
14	Rated short circuit Making Current (kAp)	125	YES/NO	80	YES/NO	
15	Rated break time (ms)	i) 40 ms under test duties 2,3 &4 at rated voltages		60	YES/NO	
		ii) 45 ms under test duties 1 to 5 and short line fault test duties and combined variation of trip coil voltage, operating pressure and quenching media pressure, etc.		-		
	Rated small inductive current Breaking capacity	Corresponding to interrupting steady and transient Breaking capacity magnetising current of 50 to 630 MVA transformers with overvoltage less than 2.3 pu		0.5 to 10 A		
16	Total break time	-		65	YES/NO	
17	Closing time (ms)	150	YES/NO	150	YES/NO	
18	First pole to clear factor	1.3	YES/NO	1.5	YES/NO	
19	Short time current rating (kA) for 1s	50 kA	YES/NO	31.5	YES/NO	
20	Rated operating duty	O-0.3 Sec –CO - 3 min –CO	YES/NO	O-0.3 Sec – CO -3 min – CO	YES/NO	
21	Out of phase breaking current	12.5 kA	YES/NO	7.8 kA	YES/NO	

Sl. No.	Parameters	420 kV	YES/NO	145 kV	YES/NO	Remarks
22	Maximum line charging breaking current with temporary over voltage upto 1.4 p.u. (A)	600A at 90° C leading power factor with maximum permissible switching overvoltage of 2.3 pu	YES/NO	As per IEC	YES/NO	
23	Maximum over voltage (p.u.) under any switching conditions	2.3	YES/NO	2.3	YES/NO	
24	Maximum pole discrepancy (ms)	Opening – 3.3 ms	YES/NO	Opening – 3.3 ms	YES/NO	
25	Small fault current breaking capacity (kAp)	As per IEC	YES/NO	As per IEC	YES/NO	
26	Maximum temperature rise for main contacts over design ambient temperature of 50°C	As per IEC	YES/NO	As per IEC	YES/NO	
27	Rated voltage & pick up range for trip coil (V)	220 V DC, Range – 70 % to 120 %	YES/NO	220 V DC, Range – 70 % to 120 %	YES/NO	
28	Rated voltage & pick up range for closing coil (V)	220 V DC, Range 85 % to 120 %	YES/NO	220 V DC, Range 85 % to 120 %	YES/NO	
29	Reclosing	Single and three phase high speed auto reclosing	YES/NO	Three phase high speed auto reclosing	YES/NO	
30	Rated terminal load	Adequate to withstand 100 kg static load as well as wind, seismic and short circuit forces without impairing reliability or curretn carrying capability				
31	**Dielectric withstand of complete Breaker**					
a)	One minute dry & wet power frequency withstand voltage					

Sl. No.	Parameters	420 kV	YES/NO	145 kV	YES/NO	Remarks
	i. Between live terminal and ground (kV rms)	520	YES/NO	275	YES/NO	
	ii. Between terminals with breaker contacts open (kV rms)	610	YES/NO	275	YES/NO	
b)	1.2/50- micro second impulse withstand test voltage					
	i. Between live terminals and ground (kVp)	±1425	YES/NO	650	YES/NO	
	ii. Between terminals with breaker contacts open (kVp)	1) ±1425(+240)	YES/NO	650	YES/NO	
c)	250/2500 micro second switching surge withstand test voltage					
	i. Between live terminals and ground (kVp)	±1050	YES/NO		YES/NO	
	ii. Between terminals with breaker contacts open (kVp)	1) 900(+350)	YES/NO		YES/NO	
d)	Corona extinction voltage (kV rms)	320	YES/NO	N.A.		
e)	Maximum radio interference voltage for Frequency between 0.5 MHz and 2 MHz	1000 (max) at voltage 266 kV rms.	YES/NO	1000 (max) at 92 kV rms (Micro volts)	YES/NO	
f)	Total creepage distance					
	i) To ground (mm)	1) 10500 for 420 kV	YES/NO	3) 3625 for 145 kV	YES/NO	
	ii) Between terminals (mm)	1)10500 mm for 420 kV	YES/NO	2) 3625 for 145 kV	YES/NO	
32	**Pre-insertion resistor requirement**					
	Rating (ohms)					
	Minimum pre-					

Sl. No.	Parameters	420 kV	YES/NO	145 kV	YES/NO	Remarks
	insertion time (ms)					
	opening of PIR contacts					
33	**Operating Mechanism**					
	a) Type of operating mechanism for					
	i. Closing	1) Spring	YES/NO	1) Spring	YES/NO	
		2) Pneumatic	YES/NO	2) Pneumatic	YES/NO	
	ii. Opening	1) Spring	YES/NO	1) Spring	YES/NO	
		2) Pneumatic	YES/NO	2) Pneumatic	YES/NO	
34	**General**					
a)	Whether OGA drawing enclosed		YES/NO		YES/NO	
b)	Filled in GTP furnished		YES/NO		YES/NO	
d)	Interpole cabling included in Scope alongwith required Glands, Lugs etc. Termination chart shall be submitted alongwith the drawings.		YES		YES	
e)	TBs for auxiliary supply	Stud type TBs provided for terminating 4Cx16 sqmm aux power cable			YES	
f)	L/R switch	Spare way of "Local/remote switch provided, wired till spare TBs for its use in SAS.			YES	
g)	All Type Test Reports as per IEC 62271 – 100, not older than **10** years are available with bidder.				YES	
h)	Bidder's unconditional acceptance of "Undertaking on Type Test Reports" –enclosed.				YES	
i)	**Whether GI support structure included in Supply**		YES		YES	

Sl. No.	Parameters	420 kV	YES/NO	145 kV	YES/NO	Remarks
j)	**Whether foundation bolts for breakers and cabinets included in scope of supply**		YES		YES	
k)	Whether documentation schedule as per attached enclosure agreed by bidder.		YES		YES	
l)	No. of Aux. contacts per pole for purchaser's usage	14 NO + 14 NC	YES		YES	
m)	Min clearance in Air (mm) as per section-3					
	(i) Between Live Parts		YES/NO		YES/NO	
	(ii) Live Part to Earth		YES/NO		YES/NO	
	(iii) Live Part to ground with Support Structure / Stool		YES/NO		YES/NO	
n)	Control Cabinet –					
	Degree of Protection	IP 55 (Min.)	YES/NO	IP 55 (Min.)	YES/NO	
	Type Tested for IP 55 within last **10** years		YES/NO		YES/NO	
o)	**Mandatory spares included in scope of supply as per section 1**		YES/NO		YES/NO	
p)	**Mandatory maintenance included in scope of supply as per section 1**		YES/NO		YES/NO	
p)	**Supervision of Erection, testing and commissioning included in scope**		YES/NO		YES/NO	