BHARAT HEAVY ELECTRICALS LIMITED

TRANSMISSION BUSINESS ENGINEERING MANAGEMENT

DOCUMENT No.	**TB-391-316-015A**	Rev. No.	**03**	Prepared	Checked	Approved
TYPE OF DOC.	**TECHNICAL SPECIFICATION**		SIGN			
TITLE **400 kV Isolators**			NAME	**AA**	**SKS**	**AG**
			DATE	26/12/16	26/12/16	26/12/16
			GROUP	**HVDC**	W.O. No	

CUSTOMER	**Power Grid Corporation of India Ltd**
PROJECT	**±800KV, 6000MW, HVDC RAIGARH – PUGALUR TERMINALS**
NOA NO.	CC-CS/651-SR2/HVDC-3063/7/G10/NOA-II/5818 dtd 08.06.2016 for Supplies & CC-CS/651-SR2/HVDC-3063/7/G10/NOA-IV/5820 dtd 08.06.2016 for Services
STATION	**RAIGARH and PUGALUR**

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Rev No.	Date	Altered	Checked	Approved	REVISION DETAILS
03	26.04.17	AA	SKS	AG	Revised as per POWERGRID letter no's : C/ENGG/HVDC/RP800/224/151 dated 17.04.17
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SECTION - 1

Scope, Quantities and Specific Technical Requirements

1.1 Scope

This technical specification covers the requirements of design, manufacture, testing at works, packing, loading at works and transport **to Raigarh and Pugalur *site,*** of 400 kV Isolators complete in all respects and including all fittings and accessories required for efficient and trouble-free operation.

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

The equipment is required for the following project:

Name of customer : **Power Grid Corporation of India Ltd (POWERGRID)**
Name of the project : **±800 KV, 6000MW HVDC terminals associated with HVDC Bipole Link between Western region (Raigarh, Chhattisgarh) and Southern region (Pugalur, Tamil Nadu) – Madakathara/ North Trichur (Kerala)**

Refer section-3 of this document for project details and general specification.

1.2 A) Bill of Quantities for main items

Sl. No	Item Description	Units	Qty	Item designation
Converter Station: **RAIGARH**				
1.	**400kV, 2000A, 63kA, 3-Ph Isolator** with **TWO Earth Switch**, Double Break, motor operated, electrically ganged without insulator & structure but with MOM box and accessories.	No	6	=W1.Z(1,2,3,4,5,6).Q11
2.	**400kV, 2000A, 63kA, 3-Ph Isolator** with **ONE Earth Switch**, Double Break, motor operated, electrically ganged without insulator & structure but with MOM box and accessories.	No	24	=W1.Z(1,2,3,4,5,6).Q(12,13,14,15)
3.	**400 kV, 63kA, 3-Ph free standing Earth Switches**, motor operated,	No	30	=W1.Z(1,2,3,4,5,6).Q(21,22,23,24,25)

	electrically ganged without insulator & structure but with MOM box and accessories.			
4.	Supervision of erection, testing and commissioning of all 400kV Isolators and earth switches.	Lot	1	
Converter Station: **PUGALUR**				
5.	**400kV, 2000A, 50kA, 3-Ph Isolator** with **TWO Earth Switch**, Double Break, motor operated, electrically ganged without insulator & structure but with MOM box and accessories.	No	6	=W1.Z(1,2,3,4,5,6).Q11
6.	**400kV, 2000A, 50kA, 3-Ph Isolator** with **ONE Earth Switch**, Double Break, motor operated, electrically ganged without insulator & structure but with MOM box and accessories.	No	19	=W1.Z(1,2,3,4,5,6).Q(12,13,14); = W1.Z4.Q15
7.	**400 kV, 50kA, 3-Ph free standing Earth Switches**, motor operated, electrically ganged without insulator & structure but with MOM box and accessories.	No	25	=W1.Z(1,2,3,4,5,6).Q(21,22,23,24); = W1.Z4.Q25
8.	Supervision of erection, testing and commissioning of all 400kV Isolators and earth switches.	Lot	1	

Note:

1. Final quantity may vary ± 10%
2. Respective dates for the commencement of erection, testing and commissioning activities of Isolators shall be communicated to manufacturers from time to time as per the readiness of site.

B) Bill of quantities for mandatory spares

Sl. No	Item Description	Units	Qty
A.	**Converter Station: RAIGARH**		
1	**400kV, 2000A, 63kA Isolators:** Two complete pole with two earth switch along with operating mechanism for main isolator and earth switch without support insulators and structure	No	1
2.	**400kV, 2000A, 63kA Isolators:** Two complete pole with one earth switch along with operating	No	1

	mechanism for main isolator and earth switch without support insulators and structure		
3.	**400 kV , 63kA free standing Earth Switch :** Two complete earth switch (1-Ph) along with operating mechanism without insulator and structure	No	1
4.	**Accessories/Components for 400kV AC Isolators**		
4.1	Copper contact fingers for female & male contacts for one pole of each rating	Sets	2
4.2	Relays, power contactors, MCBs, switch fuses, push buttons and resistors. Interlocking coils, timers, key interlock for electrical control circuit as per approved schematic. (one no. of each type)	Set	1
4.3	Limit switches & aux. contact (contact for one MOM box of isolator)	Set	1
4.4	Rotor housing bearing assembly (one no. of each type)	Set	1
4.5	Motor with gear assembly and bevel gear assembly	Set	1
4.6	Corona Shield rings	Set	3
4.7	Bearings	Set	1
4.8	Current Carrying assembly	No	3
4.9	Interlocking coils, timer key interlock of each type with resistor	Set	1
4.10	Terminal pad/stud with connectors for one pole of Isolator	Set	2
4.11	Hinge Pins	No	3
B.	**Converter Station: PUGALUR**		
5.	**400kV, 2000A, 50kA Isolators:** Two complete pole with two earth switch along with operating mechanism for main isolator and earth switch without support insulators and structure	No	1
6.	**400kV, 2000A, 50kA Isolators:** Two complete pole with one earth switch along with operating mechanism for main isolator and earth switch without support insulators and structure	No	1
7.	**400 kV , 50kA free standing Earth Switch :** Two complete earth switch (1-Ph) along with operating mechanism without insulator and structure	No	1
8.	**Accessories/Components for 400kV AC Isolators**		
8.1	Copper contact fingers for female & male contacts for one pole of each rating	Sets	2
8.2	Relays, power contactors, MCBs, switch fuses, push buttons and resistors. Interlocking coils, timers, key interlock for electrical control circuit as per approved schematic. (one no. of each type)	Set	1
8.3	Limit switches & aux. contact (contact for one MOM box of isolator)	Set	1
8.4	Rotor housing bearing assembly (one no. of each type)	Set	1
8.5	Motor with gear assembly and bevel gear assembly	Set	1
8.6	Corona Shield rings	Set	3
8.7	Bearings	Set	1
8.8	Current Carrying assembly	No	3
8.9	Interlocking coils, timer key interlock of each type with resistor	Set	1

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8.10	Terminal pad/stud with connectors for one pole of Isolator	Set	2
8.11	Hinge Pins	No	3

Note: 1) All the associated equipment mounting hardware (like MOM box to steel structure, Base channel to steel structure, Insulator Bottom PCD to Base channel, Insulator Top PCD to Fixed/Moving Contacts etc.) to be supplied by the vendor.
2) Clamps and Connectors for Isolators are excluded from the Scope of this specification.

1.3 Specific Technical Requirements:

1.3.1 A. Technical Parameters of Isolators – RAIGARH STATION

S. No.	*Technical parameter*	*Unit*	*400kV Isolator & Earth Switch*
1	Manufacturer's type designation	-	Outdoor, Horizontal Double Break (HDB)
2	Standard applicable	-	IS:9921/ IEC 62271-102/IEC-60694
3	Rated voltage	kV	420
4	Rated current at 50°C Ambient temperature	A	2000
5	Rated frequency	Hz	50
6	Number of poles	-	Three
7	Whether all three poles are mechanically ganged in case of three phase isolators	-	No, Electrically gang operated for Main Isolators and Earth Switch
8	Phase to Phase spacing	mm	6000
9	Creepage distance	mm	10500
10	Rated short circuit time withstand current of isolator and earth switch	kA	63kA for 1 sec
11	Rated dynamic short circuit withstand current of isolator and earth switch	kA_{peak}	157.5
12	Opening time of isolators and earth switch	Sec	12 (or) less
13	Closing time of isolators and earth switch	Sec	12 (or) less
14	Rated lightning impulse withstand voltage (1.2/50 µs)		
	1. Against ground	kV_{peak}	1425
	2. Across isolating distance	kV_{peak}	1425 (+240)
15	Rated switching impulse withstand voltage (250/2500 µs)		
	1. Against ground	kV_{peak}	1050
	2. Across isolating distance	kV_{peak}	900 (+345)

16	Rated one minute power frequency withstand voltage		
	1. Against ground	kV_{rms}	520
	2. Across isolating distance	kV_{rms}	610
17	Corona extinction voltage	kV_{rms}	320
18	Radio interference level at 1.1*(Ur/√3) for frequency between 0.5MHz to 2MHz	µV	1000 @ 266kV_{rms}
19	Temperature rise over 50°C ambient temperature corresponding to maximum continuous current	-	Within limit as per Table – 3 of IEC 62271-1
20	Rated mechanical terminal load	-	As per Table -III of IEC 62271-102
21	Operating mechanism		
	1. For main blades	-	AC Motor operated (3-phase, 415V)
	2. For earth switches	-	AC Motor operated (3-phase, 415V)
22	Rating of auxiliary contacts	-	10 A at 220 V DC
23	Breaking capacity of auxiliary contacts	-	2 A DC with circuit time constant of not less than 20ms
24	Min. No. of auxiliary contacts On each isolator	-	10 NO + 10 NC
25	Min. No. of auxiliary contacts On each earthing switch	-	10 NO + 10 NC
26	Min. No. of MBB contacts on each Isolator	-	NO = 2 NC = 2
27	Contact of local remote switch on each isolator	-	Remote position = 1 Local position =1
28	Contact of MCB trip and O/L operated on each isolator	-	Set=1
29	Interlocking coil/contactor provided for each isolator and earth switches	-	Yes
30	Size and Type of Terminal Block (TBs) for all circuits	-	(1) TBs shall be stud type. (2) Power Cable: Each TBs Should be Suitable for terminating two wires of 16/25 Sq. mm size on each side (3) Control cable: Each TBs Should be Suitable for terminating two wires of 2.5 Sq. mm size on each side

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31	Number of terminals in Control cabinet (inter-pole Cabling shall be supplied By the supplier)	-	(1) All contacts and control circuits are to be wired up to control cabinet including potential free auxiliary contacts of Isolator/Earth switch. (2) Additional 24 nos. evenly distributed spare TBs in Master to be provided for interpole cabling of Auxiliary contacts (employer's use). (3) Sufficient TBs shall be provided in control cabinet for looping of AC supply from master to follower of Isolator and earth switch.
32	Whether type tests carried out on similar isolators (Yes/ No)	-	If yes, type test reports shall be furnished. If not, tests shall be conducted at no extra cost.
33	Whether any kind of provision is provided to prevent the electrical and manual operation of isolator and earth switch unless the interlocking conditions are met.	-	Yes. Electro mechanical Key Interlock (2 Castle Lock + 1 Key) shall be provided.

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B. Technical Parameters of Isolators – PUGALUR STATION

S. No.	***Technical parameter***	***Unit***	***400kV Isolator & Earth Switch***
1	Manufacturer's type designation	-	Outdoor, Horizontal Double Break (HDB)
2	Standard applicable	-	IS:9921/ IEC 62271-102/IEC-60694
3	Rated voltage	kV	420
4	Rated current at 50°C Ambient temperature	A	2000
5	Rated frequency	Hz	50
6	Number of poles	-	Three
7	Whether all three poles are mechanically ganged in case of three phase isolators	-	No, Electrically gang operated for Main Isolators and Earth Switch
8	Phase to Phase spacing	mm	6000
9	Creepage distance	mm	10500
10	Rated short circuit time withstand current of isolator and earth switch	kA	50kA for 1 Sec
11	Rated dynamic short circuit withstand current of isolator and earth switch	kA_{peak}	125
12	Opening time of isolators and earth switch	Sec	12 (or) less

13	Closing time of isolators and earth switch	Sec	12 (or) less
14	Rated lightning impulse withstand voltage (1.2/50 µs)		
	1. Against ground	kV_{peak}	1425
	2. Across isolating distance	kV_{peak}	1425 (+240)
15	Rated switching impulse withstand voltage (250/2500 µs)		
	1. Against ground	kV_{peak}	1050
	2. Across isolating distance	kV_{peak}	900 (+345)
16	Rated one minute power frequency withstand voltage		
	1. Against ground	kV_{rms}	520
	2. Across isolating distance	kV_{rms}	610
17	Corona extinction voltage	kV_{rms}	320
18	Radio interference level at 1.1*(Ur/√3) for frequency between 0.5MHz to 2MHz	µV	1000 @ 266kV_{rms}
19	Temperature rise over 50°C ambient temperature corresponding to maximum continuous current	-	Within limit as per Table – 3 of IEC 62271-1
20	Rated mechanical terminal load	-	As per Table -III of IEC 62271-102
21	Operating mechanism		
	1. For main blades	-	AC Motor operated (3-phase, 415V)
	2. For earth switches	-	AC Motor operated (3-phase, 415V)
22	Rating of auxiliary contacts	-	10 A at 220 V DC
23	Breaking capacity of auxiliary contacts	-	2 A DC with circuit time constant of not less than 20ms
24	Min. No. of auxiliary contacts On each isolator	-	10 NO + 10 NC
25	Min. No. of auxiliary contacts On each earthing switch	-	10 NO + 10 NC
26	Min. No. of MBB contacts on each Isolator	-	NO = 2 NC = 2
27	Contact of local remote switch on each isolator	-	Remote position = 1 Local position =1
28	Contact of MCB trip and O/L operated on each isolator	-	Set=1
29	Interlocking coil/contactor provided for each isolator and earth switches	-	Yes

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30	Size and Type of Terminal Block (TBs) for all circuits	-	(1) TBs shall be stud type. (2) Power Cable: Each TBs Should be Suitable for terminating two wires of 16/25 Sq. mm size on each side. (3) Control cable: Each TBs Should be Suitable for terminating two wires of 2.5 Sq. mm size on each side.
31	Number of terminals in Control cabinet (inter-pole Cabling shall be supplied By the supplier)	-	(1) All contacts and control circuits are to be wired up to control cabinet including potential free auxiliary contacts of Isolator/Earth switch. (2) Additional 24 nos. evenly distributed spare TBs in Master to be provided for interpole cabling of Auxiliary contacts (employer's use). (3) Sufficient TBs shall be provided in control cabinet for looping of AC supply from master to follower of Isolator and earth switch.
32	Whether type tests carried out on similar isolators (Yes/ No)	-	If yes, type test reports shall be furnished. If not, tests shall be conducted at no extra cost.
33	Whether any kind of provision is provided to prevent the electrical and manual operation of isolator and earth switch unless the interlocking conditions are met.	-	Yes. Electro mechanical Key Interlock (2 Castle Lock + 1 Key) shall be provided.

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The equipment must conform to the latest revision of all relevant IEC standards.

1.3.2 TECHNICAL QUALIFYING REQUIRMENTS

Please refer clause 2.2.

1.3.3 TYPE TESTS

The bidder shall offer type tested equipment for the project and the Employer shall accept the equipment type test reports under the following conditions:

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

(ii) Type tests performed within ten (10) years from the date of first stage bid opening (i.e. 28.07.2015) in line with Section -3.

(iii) The type tested equipment shall be of the same design, insulation class as per the equipment offered under this contract. Technical justification will be submitted for differences between tested and offered equipment. Employer's interpretation for

this shall be final.

In the event that equipment furnished includes important modifications of, or significant departure from, the designs of equipment on which type test report has been furnished or if there is evidence that the equipment does not comply with the requirements of the Specifications, type test procedure was not properly followed as laid down in standards, the bidder shall conduct the type test without any cost implication to the Employer.

In case equipments of same design and rating are supplied under this contract from different works, they shall be type tested separately.

Acceptance of the type test reports shall be at the discretion of the employer. All type tests performed after the date of award of the contract shall be witnessed by the Employer unless authority to proceed with the tests in his absence is received from the employer in writing.

1.3.4 QUALITY PLAN

Bidder to follow valid POWERGRID approved quality plan at contract stage. In case the bidder does not have POWERGRID approved QP, it will be the bidder's responsibility to get its QP approved directly from POWERGRID.

1.3.5 SPECIAL TOOLS & TACKLES

The bidder shall include in his proposal the deployment of all special tools and tackles required for erection, testing, commissioning and maintenance of the equipment. The Special tools and tackles shall only cover items which are specifically required for the equipment offered and are proprietary in nature. A list of all such devices shall be furnished.

1.4 SUPERVISION OF ERECTION, TESTING & COMMISSIONING

Bidder shall quote charges for supervision of erection, testing & commissioning of all offered isolator and earth switch (Voltage class wise). Field test Reports of Isolators and Earth switches should be signed by supplier's representative. BHEL site will inform the supplier regarding readiness of site. Bidder may have to visit site multiple times depending on the readiness of site.

1.5 DEVIATIONS

The bidder shall list all the deviation from the specification separately. Offers without specific deviation will be deemed to be totally in compliance with the specification and NO DEVIATION on any account will be entertained at a later date.

SECTION – 2

EQUIPMENT SPECIFICATION

2.1 General

This section covers the general technical requirements of isolators. In case of any discrepancies between the requirements mentioned in this section and those specified in section-3 of this specification, this section shall prevail and shall be treated as binding requirement.

a) The isolators (disconnectors), earth (ground) switches and accessories shall conform in general to IEC-62271-102 except to the extent explicitly modified in the specification.

b) Isolators shall be of double break, outdoor, off-load type. Earth switch (ES) shall be provided on isolators wherever called for, with possibility of being mounted on any side of the isolator.

c) Complete isolator with all the necessary items for successful operation shall be supplied including, but not limited to, one central (common) control cabinet for each 3 phase isolator/earth switch and one control cabinet for each pole with all the required electrical devices mounted therein, complete base frame, linkages, complete operating mechanism etc. All necessary parts to provide a complete and operable isolator installation, control parts and other devices whether specifically called for herein or not.

Isolators / Earth Switches shall alternatively have a standard design of master - follower integrated in three boxes only.

2.2 Technical requirements of equipments

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The manufacturer whose Isolators are offered, should have designed, manufactured, tested as per IEC/IS or equivalent standard and supplied the isolator for the specified system voltage and fault level and should be in satisfactory operation for at least 2 (two) years as on *as on the originally scheduled date for the dead line for submission of first stage bid i.e. 19.05.2015*. Supplier who have supplied 400kV equipment rated for 40kA earlier, may supply 50kA/63kA rated equipment subject to fulfilling specified requirements.

In case the bidder offers AC switchyard equipment from manufacturer(s) who have recently established production line in India for the offered equipment(s), based on technological support of a parent company or collaborator for the respective equipment(s) can also be considered provided the parent company (Principals) or collaborator meets the qualifying requirements stipulated above.

In such cases the bidder shall have to fulfil the following conditions:

i) The bidder shall be fully responsible for the equipments manufactured from such works.
ii) Complete design and engineering of the equipments shall be the responsibility of the bidder.
iii) The bidder shall furnish (jointly with the Subsidiary or collaboration partner) a legally enforceable undertaking to guarantee quality, timely supply, performance and warranty obligations as specified.

Whenever a material or equipment is specified herein by reference to a particular brand name, manufacturer, or vendor the Contractor may supply another manufacturer's equivalent product if the products proposed are equivalent or superior to those named subject to approval of the employer.

2.3 Standards

The isolator shall strictly conform to the following Indian and International standards, as appropriate

IS: 325 – 1978	Three phase induction motors
IS: 9921	Alternating current disconnectors & earthing switches
IEC-62271-102 IEC-60265	Alternating current disconnectors and earthing switches High Voltage Switches
IEC60694	Common Specification for High Voltage Switchgear and control-gear
ANSI-C37.32	Schedule of preferred ratings, Manufacturing specification and Application Guide for High Voltage Air Switches, Bus Supports and Switch accessories
ANSI-C37.34	Test Code for high voltage air switches
NEMA-SG6	Power switching equipment
IS: 2633- 1986	Method for testing uniformity of coating of zinc coated articles
IS: 2629 - 1985	Recommended practice for hot dip galvanizing on iron & steel
IS: 4759 - 1984	Hot dip Zinc coating on structural steel and other allied products.
IS: 5561- 1970	Electric power connectors
IS: 6745-1972	Method for determination of mass of zinc coating on iron and steel

	articles.
IS: 13947- 1993	Low voltage switchgear and Control gear General rules (Part 1)
IS: 1730- 1989	Dimension for steel plates, sheets, strips and flats for general engineering purposes
IS: 2676- 1981	Dimension for wrought Al and Al alloy sheet & strip

2.4 Design and constructional features

2.4.1 General

The equipment shall be single pole/ three pole type. Three pole units shall be electrically gang operated to perform the service requirement as specified in section 1. The design shall be such that changes in mounting and connection can be made at site without excessive labour and with minimum replacement of parts. Live metal parts (except insulator caps & bases) shall be non-rusting, non-corroding metal. The current carrying parts shall be non-ferrous.

Factory adjustment shall be so made that field adjustments will not be required on the isolators and earth switch. When inter-phase connections are attached to the rotating insulator in the field all phases shall make and break simultaneously.
The equipment shall be designed for the rated normal current and shall be capable of withstanding the electrical and mechanical stresses imposed by the system fault current as specified in Section 1. The switches shall be complete with rigid bases and shall be supplied with suitable channels, nuts and bolts for mounting on steel structure. All ferrous parts shall be hot dip galvanised in accordance with relevant standards as detailed in clause 2.3.

Design of isolators and associated earthing switches shall provide positive control of blades in all position with minimum mechanical stress on the insulators.

2.4.2 Duty Requirement

a) Isolators and earth switches shall be capable of withstanding the dynamic and thermal effects of the maximum short circuit current of the system in their closed position. They shall be constructed such that they do not open under influence of short circuit current.

b) The earthing switches shall be capable of discharging trapped charges of the associated Lines/buses.

c) The isolator shall be capable of making/breaking normal currents when no significant change in voltage occurs across the terminal of each pole of the isolators on account of make/break operation.

d) The isolator shall be capable of making/breaking magnetizing and capacitive currents of at least 0.7A at 0.15 power factor.

e) Isolator and earth switches shall be able to bear on the terminals the total forces including wind loading and electro-dynamic forces on the attached conductor without impairing reliability or current carrying capacity accordance with IEC-62271-102

f) The earth switch should be able to carry the same fault current as the main blades of the isolator and shall withstand dynamic stresses.

g) Isolator rated for above 72.5kV shall be of extended mechanical endurance class – M2 as per IEC 62271- 102. Isolator rated for 72.5kV and below shall be of extended mechanical endurance class – M1 as per IEC – 62271-102. All earth switches shall be of M0 duty.

Design of the isolator shall be such as to permit addition of earth switches at a future date. It shall be possible to interchange position of earth switch to either side of pole even at site.

2.4.3 Main Contacts

a) The isolator shall be provided with high pressure current carrying contacts made of copper on the hinge and jaw ends and all contact surfaces shall be silver plated. The thickness of silver plating shall not be less than 25 microns. The contacts shall be accurately machined and self-aligned.
b) The contacts shall be of sufficient pressure to ensure effective contact and low contact resistance throughout the life of the switch. The contact pressure shall not exceed a safe working value for the materials in contact and shall cause no abrasion or scarring of the contacts.

c) The contacts shall be of self-aligning and self- cleaning type and shall be so designed that binding can-not occur after remaining closed for prolonged periods.

d) No undue wear or scuffing shall be evident during the mechanical endurance tests. Contacts and spring shall be designed so that readjustments in contact pressure shall not be necessary throughout the life of the isolator or earth switch. Each contact or pair of contacts shall be independently sprung so that full pressure is maintained on all contacts at all time. Provision shall be made to adjust the contact pressure.

e) Contact spring shall not carry any current and shall not lose their characteristic due to heating effects.

f) The isolator shall be so designed that when operated within their specified rating, the temperature of each part shall be limited to values consistent with a long life for the material used. The temperature shall not exceed the permissible limits given in IEC-62271-102 under specified ambient conditions.

g) The moving contact of double break isolator shall have turn and twist type or other suitable type of locking arrangement to ensure adequate contact pressure.

Arcing contacts, where provided, shall close first and open last so that no damage due to arcing whatsoever shall be caused to the main contacts.

The fixed contact of double break isolators shall be provided with springs which ensure that there is always a positive contact with adequate pressure to give enough contact surfaces for passage of current. The springs provided shall not go out of alignment or get entangled with the moving contact during operation. The springs provided shall be of non-ageing type and its strength shall not reduce appreciably during the life span of the isolator.

2.4.4 Base

Each single pole of the isolator/earth switch shall be provided with a complete galvanised steel base provided with holes and designed for mounting on a supporting structure. The base shall be rigid and self-supporting and shall require no guying or cross bracing between phases other than the supporting structures. The frame of each isolator and earthing switch shall be provided with two reliable ground terminals for connection to the ground mat.

The position of movable contact system (main blades) of each of the isolators and earthing switches shall be indicated by a mechanical position indicator. The indicator shall be of metal and shall be visible from operating level.

2.4.5 Blades

a) All metal parts shall be of non-rusting and non-corroding metal. All current carrying parts shall be made from high conductivity electrolytic copper/aluminium. Bolts, screws and pins shall be provided with lock washers. Keys or equivalent locking facilities if provided on current carrying parts shall be made of copper silicon alloy or stainless steel or equivalent. The bolts, pins or springs used in current carrying parts shall be made of non-ferrous and non- corroding material. All castings and hardware other than those in the current carrying parts shall be of malleable cast iron or cast- steel. No grey iron shall be used in the manufacture of any part of the isolator.

b) The live parts shall be designed to eliminate sharp joints, edges and other corona producing surfaces, where applicable. Where this is impracticable, adequate corona shields shall be provided. Corona shields/rings etc. shall be made of aluminium/aluminium alloy.

c) The isolators/earth switch shall be so constructed that the switch blade shall be locked in the open/close position and shall not fall to the closed/open position if the operating shaft gets disconnected.

d) Isolators and earthing switches including their operating parts shall be such that they cannot be dislodged from their open or closed positions by short circuit forces, gravity,

wind pressure, vibrations, shocks or accidental touching of the connecting rods of the operating mechanism.

e) The Isolators and earthing switches shall be designed such that lubrication of any part is not required except at very long intervals i.e. after every 1000 operations or after 5 years whichever is earlier.

f) The switch blade contact shall enter into the counter contact even if it is misaligned by 45 mm in any direction.

2.4.6 Insulator (Excluded from Scope)

a) The Insulator shall conform to IS: 2544 and/or IEC-60168. The Porcelain of the insulator shall conform to the requirements stipulated under section-3 and shall have a minimum cantilever strength 1000kG for 420kV Insulators. The insulators shall be of solid core type.

b) Pressure due to contact shall not be transferred to the insulators after the main blades are fully closed.

c) The Parameters of the insulators shall meet the requirements specified under section-3.

d) The insulators shall be so arranged that leakage current shall pass to earth and not between terminals of same pole or between phases.

e) Insulator shall be type and routine tested as per IEC 60168.

Besides following additional tests shall also be conducted:

i. Bending load test in four direction at 50 % of minimum bending load guaranteed on all insulators, as a routine test.

ii. Bending load test in four directions at 100% of minimum bending load as a sample test on each lot.

iii. Torsional test on sample insulator of a lot.

iv. Ultrasonic test as a routine test.

Insulators technical data for base channel design:

a) 420kV Insulator: (For Isolator)

Top PCD	=	127mm
No. of holes	=	4 X M16
Bottom PCD	=	325 mm
No. of holes	=	8 X 18 dia

Post insulators for Isolators shall be supplied by BHEL separately.

2.4.7 Earthing Switches

a) Where specified, the isolators shall be equipped with earthing switches and these shall form an integral part of the isolator and shall be mounted on the base frame of the isolator. The earthing switches shall have complete operating mechanism and auxiliary contacts. The operating mechanism for the earthing switches shall be only locally (motor) operated.

b) The earthing switch shall be constructional interlocked with the isolator so that earthing switches can be operated only when isolator is open and vice versa. The construction interlock shall be built in construction of isolator and shall be in addition to the electrical and mechanical interlocks provided in the operating mechanism.

c) In addition to the constructional interlock, isolator and earth switch shall have provision to prevent their electrical and manual operation unless the interlocking conditions are met. All these interlocks shall be of fail-safe type. Suitable individual interlocking coil arrangements shall be provided. The interlocking coil shall be suitable for continuous operation from dc supply and within a variation range as stipulated.

d) Each earth switch shall be provided with flexible copper/aluminium braids for connection to ground mat. These braids shall have the same short time current carrying capacity as the earth blades. The transfer of fault current through switch connection will not be accepted.

e) The plane of movement and final position of the earth blades shall be such that adequate electrical clearances are obtained from adjacent live parts in the course of its movement between ON and OFF position.

f) The frame of each isolator and earthing switches shall be provided with two reliable earth terminals for connection to the earth mat.

g) Isolator design shall be such as to permit addition of earth switches at a future date. It should be possible to interchange position of earth switch to either side.

h) The earth switch should be able to carry the same fault current as the main blades of the Isolators and shall withstand dynamic stresses.

i) Earth Switch shall also comply with the requirements of IEC-62271-102, in respect of induced current switching duty as defined for Class-B and short circuit making capability class E-0 for earthing switches.

2.4.8 Operating Mechanism and Control

a) The isolators and earth switches shall be ac motor operated.

b) Limit switch for control shall be fitted on the isolator/earth switch shaft, within the cabinet to sense and ensure the open and close positions of the isolator and earth switch.

c) After final adjustment has been made it shall not be possible for any part of the mechanism to be displaced at any point in the travel sufficient enough to allow improper functioning of the isolator/earth switch whenever it is opened or closed at any speed. All holes in cranks, linkage etc. having moving pins shall be drilled to accurately fit so as to maintain the minimum of slack and loose motion in the entire mechanism.

d) A "Local/Remote" selector switch and a set of "Open/Close" push buttons shall be provided in the control cabinet of the isolator to permit its operation. A "Local/Remote" selector switch and "Open/Close" push buttons shall also be provided in central control cabinet to permit simultaneous operation of all three phase.

e) Provision shall be made in the control cabinet to disconnect power supply to prevent local/remote power operation.

f) Suitable reduction gearing shall be provided between the motor and the drive shaft of the isolator. The mechanism shall stop rapidly when motor supplies are switched off. If necessary a quick electro-mechanical brake may be fitted on the higher speed shaft to effect rapid braking.

g) Each motor operated mechanism shall be subjected to blocked rotor test.

h) Control cabinet/operating mechanism box shall conform to the requirement stipulated in Section-3 and shall be made of cast aluminium/aluminium sheet of adequate thickness (minimum 3 mm) or stainless steel (grade-304) of minimum thickness 2mm.

i) Manual operation facility (with handle) should be provided with necessary interlock to disconnect motor.

j) Gear should be of forged material suitably chosen to avoid ending/jamming on operation after a prolonged period of non-operation. Also all gear and connected material should be so chosen/surface treated to avoid rusting.

k) Only stranded conductor shall be used for wiring. Minimum size of the conductor for control circuit wiring shall be 1.5 sq.mm. (Copper).

l) The operating mechanism shall be located such that it can be directly mounted on any one of the support structure.

The enclosure of the control cabinets shall provide a degree of protection of not less than IP 55 as per IS: 13947 (Part 1). All doors, removable covers and plates shall be gasketed all around with good quality neoprene gaskets.

Cable entry shall be from the bottom. Suitable removable cable gland plate shall be provided on the cabinet for the purpose. Cable glands shall be of double compression type, made of brass and supplied loose. Cable sizes and no. of cable glands will be indicated at the contract drawing approval stage. Suitable space heaters shall be mounted in the cabinet to prevent condensation. Heater shall be suitable for 240V, 50 Hz, single phase A.C. supply.

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

The terminal blocks to be provided shall be of either ELMEX OR PHOENIX make, clip on type and shall be such that adjacent terminals can be shorted with the help of links. All terminals shall be clearly marked with identification numbers or letters to facilitate connection to external wiring.

For looping the auxiliary power supply cable, suitable terminals should be provided, for 16/25 sq. mm cables. These terminals are to be separated from the others and fitted with transparent plastic covers and shall have warning labels with red lettering.

The terminal shall be staggered that the connection of external cable to terminal block should be possible without disturbing the rest of the connections. The terminal block arrangements shall be such as to provide maximum accessibility to all conductor terminations and any arrangement preventing ready access to other terminal screws shall not be accepted.

The arrangements shall be such that it is possible so safely connect or disconnect terminals and replace fuse links on live circuits. Easy access shall be provided for all components on which adjustment or tightening is expected to be done at site, without removal of other components.

2.4.9 Operation

a) Each pole of the isolator and earth switch shall have individual drives for main blades. The operating mechanism of the three poles shall be well synchronized and interlocked.

b) The design shall be such as to provide maximum reliability under all service conditions. All operating linkages carrying mechanical loads shall be designed for negligible deflection. The length of inter insulator and inter-pole operating rods shall be capable of adjustments, by means of screw thread which can be locked with a lock nut after an adjustment has been made. The isolator & earth switches shall be provided

with "over centre" device in the operating mechanism to prevent accidental opening by wind or vibration or short circuit forces or movement of the support structures.

c) Each isolator and earth switch shall be provided with a manual operating handle enabling one man to open or close the isolator or earth switch with ease in one movement while standing at ground level. The manual operating handle shall have provision for padlocking. The operating handle shall be located at 1000 mm from the base of isolator support structure.

d) The isolator/earth switch shall be provided with positive continuous control throughout the entire cycle of operation. The operating pipes and rods shall be sufficiently rigid to maintain positive control under the most adverse conditions and when operated in tension or compression for isolator closing. They shall also be capable of withstanding all torsional and bending stresses due to operation of the isolator/earth switch. Wherever supported the operating rods shall be provided with bearings on either ends. The operating rods/pipes shall be provided with suitable universal couplings to account for any angular misalignment.

e) The transmission of motion from the electrical operating mechanism shall be by rigid members. It is required that, in the event of over torque of the switch mechanism, no part of the main switch mechanism shall bend, twist or shear and so allow the auxiliary switch contacts to operate erroneously.

f) All rotating parts shall be provided with grease packed roller or ball bearings in sealed housings designed to prevent the ingress of moisture, dirt or other foreign matter. Bearings pressure shall be kept low to ensure long life and ease of operation. Locking pins wherever used shall be rustproof.

g) The position of movable contact system (main blades) of each of the isolators and earth switches shall be indicated by a mechanical indicator at the lower end of the vertical rod of shaft for the isolators and earth switch. The indicator shall be of metal and shall be visible from operating level.

h) Signalling of closed position shall not take place unless it is certain that the movable contacts, have reached a position in which rated normal current, peak withstand current and short time withstand current can be carried safely. Signalling of open position shall not take place unless movable contacts have reached a position such that clearance between contacts is at least 80% of the isolating distance.

i) Counter balance springs shall be provided for counter balancing the isolators to prevent impact at the end of travel both on opening and closing of the isolator. The spring shall be made of non-rusting type alloy.

2.4.10 Motor operated mechanism

The motor operated mechanism shall be suitable for operation on 415V, 3 phase and 50Hz power supply. The motor shall satisfy the requirements specified in IS: 325.

The scheme shall be so designed that during manual operation the motor drive shall be automatically electrically de-coupled. Suitable reduction gearing shall be provided between the motor and the drive shaft of the isolator. A quick electro mechanical brake shall be fitted on the higher speed shaft.

Limit switches for motor control shall be fitted on the isolator shaft within the cabinet to sense the open and close positions of the isolator. The switches shall be snap type and shall have adequate number of NO/NC contacts for use in the indication scheme. The switches shall be adjusted in a manner so that moving contacts reach their final open and close position with proper alignment.

2.4.11 Auxiliary Switch

10 NO plus 10 NC for Isolator, 10 NO plus 10 NC auxiliary contacts for earth switch shall be provided respectively, besides those used for the Isolator control schematics. All these contacts shall be kept wired to the terminals in their respective operating mechanism box.

All auxiliary switches shall have a continuous current carrying capacity of at least 10 Amps at the rated control voltage and shall be wired up to the terminals in the operating mechanism box. Auxiliary switches which are installed on the frame of isolators or earthing switches shall be suitably protected against accidental arcing from the main circuit. Auxiliary switches shall be mounted in a weather proof housing which shall have provision for entry of conduits of proper sizes, or for fixing of cable glands.

Auxiliary switches which are installed on the frame of the isolators or earthing switches shall be suitably protected against accidental arcing of the main contact. The breaking capacity of the auxiliary switches shall be adequate for the circuit to be controlled.

The contacts shall be capable of breaking at least 2 Amp in a 220V D.C circuit with a time constant of not less than 20 milliseconds. Fixing hardware on the auxiliary contacts shall not cause hindrance to the movement of the contact fingers.

Auxiliary Contacts shall be capable of being set such that:

a) Signalling of the closed position shall not take place unless the contact system has reached such a position that the rated normal and rated short time current can be carried safely.

b) Signalling of the open position shall not take place unless the contact system has reached

such a position of at least 80 percent of the isolating distance.

c) A simultaneous signalling device for all poles of an isolator shall be arranged in such a way that the signal is given only when all poles of the isolator have a position in accordance with (a) and (b) above.

2.4.12 Safety Interlocking

All isolators and isolator-cum-earthing switches shall be suitable for electrical interlocking. In addition to the provision of electrical interlocking, the Isolator and the earthing switch shall also be interlocked through the castle key electro-mechanical interlock. Mechanical interlocks, if applicable, shall be so designed that force cannot be transmitted to points remote from the point at which hand force is applied.

The earth switches wherever provided shall be mechanically and electrically interlocked so that they can be operated only when the isolator is open and vice versa.

In addition to the interlock between isolator and its earth switch, they shall have provision to prevent their electrical and manual operation unless the associated and other interlocking conditions are met. The interlocking arrangement shall be such that operation is prevented even if interlocking conditions change at any stage during electrical or manual operation of isolator. All these interlocks shall be of the `failsafe' type and shall be suitable for continuous operation from DC supply between 80% and 110% of the rated voltage i.e. 220 volts. Constructional interlock of isolator with earth switch operating mechanism to be provided in case of manually operated isolators.

The operation of earth blade shall not take place when corresponding main isolator is in operation stroke and vice versa. The electrical interlocking scheme shall operate on auxiliary supply as given in Section 1 and shall be subject to purchaser's approval at contract stage.

2.4.13 Control Wiring

All the control and secondary circuits and auxiliary contacts of the isolator shall be wired completely and up to the terminal blocks in the operating mechanism box. The control wiring shall be of adequate cross-section and not less than 2.5mm^2 copper. All wires shall have PVC insulation for 1100 Volts and shall be suitable for switch board wiring.

At least 20 percent terminals with a minimum of 24 Nos. as spare for future use shall be provided over and above the numbers required, in the MOM box.

2.4.14 Terminal Connector Stud/Pad and Earthing Terminals

The isolators shall be provided with terminal power connectors conforming to IS 5561. All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be deburred and rounded off to prevent corona.

All ferrous parts shall be hot dip galvanised in accordance with the relevant standards mentioned in clause 2.3. Flexible connectors shall be made from tinned copper sheets.

For bimetallic terminal connectors wherever applicable, copper alloy liner of minimum thickness of 4mm shall be cast integral with aluminium body. All the connectors shall be designed and manufactured to have minimum contact resistance. Each isolator and operating mechanism box shall be provided with two number grounding terminals for connecting galvanised MS earth strip to earth mat.

The isolator terminal pads/studs shall be made of high quality copper or aluminium and shall be conforming to Australian standard AS-2935 for rated current. The terminal pad shall have protective covers which shall be removed before interconnections.

The terminal pad of the isolator shall be capable of taking 4.5”/4”/3” aluminium tube or Twin/Quad - Moose/ Bersimis ACSR conductor under normal, short circuit and meteorological conditions specified.

The terminal of the isolator shall be designed:
For 400 kV: 4.5”/4” Aluminium tube

2.4.15 Grounding

Each disconnect switch operating rod shall be separately grounded at a point above the mechanism box. This shall be done by flexible copper braid of adequate section but in no case less than 70mm^2.

All ferrous parts, except the operating mechanism box shall be hot dip galvanised as per the relevant Indian standards specified in clause 2.3. Electro galvanised hardware may be used only where the hot dip galvanised hardware is not available in the required sizes. Generally, all steel hardware above M10 size should be hot dip galvanised. Hardware should be of GKW or equivalent POWRGRID approved make. If any other make is used, the same shall be subject to purchaser's approval.

2.4.16 Name Plate

The name plate shall conform to the requirements of IEC 62271-102 incorporating year of manufacture.

2.5 TESTS

The each type of isolator and earth switch along with their operating mechanism shall be subjected/conform to the type tests and shall be subjected to routine tests in accordance with IEC-62271-102. Any other tests if required as per relevant IEC/IS shall be conducted and included.

2.5.1 Type tests

2.5.1.1 Dielectric tests (Only applicable for isolators)

2.5.1.1.1 Power frequency voltage test
As per IEC 62271-102, Clause-6

2.5.1.1.2 Switching impulse voltage test
As per IEC 62271-102, Clause-6

2.5.1.1.3 Lightning impulse voltage test
As per IEC 62271-102, Clause-6

2.5.1.1.4 Test on auxiliary and control circuits
As per IEC 62271-102, Clause-6.2.10

2.5.1.1.5 Voltage test as condition check
As per IEC 62271-102, Clause-6.2.11.

2.5.1.1.6 Partial discharge test
As per IEC 62271-102, Clause-6.2.9 Not Applicable.
Disconnectors are provided with air insulations and it is all supported with porcelain insulators. There is no organic materials are used. Hence not applicable.

2.5.1.2 Radio interference voltage test (Only applicable for isolators)
As per IEC 62271-102, Clause-6.3

2.5.1.3 Measurement of the resistance of the circuits (Only applicable for isolators)
As per IEC 62271-102, Clause-6.4

2.5.1.4 Temperature rise test (Only applicable for isolators)
As per IEC 62271-102, Clause-6.5

2.5.1.5 Short time withstand current and peak withstand current tests
As per IEC 62271-102, Clause-6.6

2.5.1.6 Verification of the protection
As per IEC 62271-102, Clause-6.7.

2.5.1.7 Test to prove the short-circuit making performance of earthing switches
As per IEC 62271-102, Clause-6.101.

2.5.1.8 Operating and mechanical endurance tests
As per IEC 62271-102, Clause-6.102

2.5.1.9 Induced current switching tests for earth switches

As per IEC 62271-102, Clause-6.107

2.5.1.10 Blocked Rotor test

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2.5.1.11 For operating mechanism boxes following tests shall be carried out :

- Dielectric test according to IEC 60439.1 clause 8.3.2

2.5.1.12 Additional Type tests

The following additional type tests reports shall also be submitted for customer's review and acceptance. (Additional type tests are required for isolators rated above 72.5kV only)

(i) Radio interference voltage test (Included in Clause 2.5.1.2) as per Annexure-A of Section-3

(ii) Corona Extinction Voltage test as per Annexure-A of Sectiion-3

(iii) Seismic withstand test on isolator mounted on Support structure as per Annexure-B of Section-3.

The test shall be performed in the following position:

Isolator open	E/S Closed
Isolator open	E/S Open
Isolator Closed	E/S Open

2.5.2 Routine tests

2.5.2.1 Dielectric test on the main circuit

As per IEC 62271-102 clause 7.1

2.5.2.2 Dielectric test on control and auxiliary circuits

As per IEC 62271-102 clause 7.2

2.5.2.3 Measurement of resistance of main circuit (Only applicable for isolators)

As per IEC 62271-102 clause 7.3

2.5.2.4 Design and visual checks

As per IEC 62271-102 clause 7.5

2.5.2.5 Mechanical operating tests

As per IEC 62271-102 clause 7.101

Minimum 1000 Nos. mechanical operations in line with mechanical endurance test, M0 duty, shall be carried out on 1 (one) isolator out of every lot of Isolators, assembled completely with all accessories, as acceptance test for the lot. The travel characteristics measured at a suitable location in the base of insulator along with motor current/power drawn, during the entire travel duration are to be recorded at the start and completion and shall not vary by more than (+/-) 10% after completion of 1000 cycles of operation. After completion of test, mechanical interlock operation to be checked.

2.5.3 PRE-COMMISSIONING TESTS

An indicative list of tests on isolator and earth switch is given below. For pre-commissioning procedures and formats for Isolators and ground switch, Doc. No. MR/CF/ISO/08/R-2, dated 01/04/08 under POWERGRID Document no. D-2-01-03-01-02 will be the reference document. This document will be available at respective sites and shall be referred by the contractor. Contractor shall perform any additional test based on specialties of the items as per the field Q.P./instructions of the equipment Supplier or Purchaser without any extra cost to the Purchaser. The Contractor shall arrange all instruments required for conducting these tests along with calibration certificates and shall furnish the list of instruments to the Purchaser for approval.

(a) Insulation resistance of each pole.

(b) Manual and electrical operation and interlocks.

(c) Insulation resistance of control circuits and motors.

(d) Ground connections.

(e) Contact resistance.

(f) Proper alignment so as to minimize vibration during operation.

(g) Measurement of operating Torque for isolator and Earth switch.

(h) Resistance of operating and interlocks coils.

(i) Functional check of the control schematic and electrical & mechanical interlocks.

(j) 50 operations test on isolator and earth switch.

SECTION – 3

PROJECT DETAILS & GENERAL TECHNICAL REQUIREMENTS

Please refer TB-391-316-00- Rev-03: 'General Technical Requirements- Section 3'