



सत्यमेव जयते

GOVERNMENT OF INDIA

MINISTRY OF RAILWAYS

SPECIFICATION FOR

**220kV/132kV/110kV/100kV/66kV/55kV DOUBLE POLE,
TRIPLE POLE, OUTDOOR SF₆ CIRCUIT BREAKER (VCB)
FOR
INDIAN RAILWAY.**

FINAL DRAFT SPECIFICATION No. TI/SPC/PSI/HVCB/0121

**This Specification supersedes the Specification No.
TI/SPC/PSI/HVCB/0120 (June, 2014) Rev. 0 with A&C Slip No. 1 & 2.**

ISSUED BY

**TRACTION INSTALLATION DIRECTORATE
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1. SCOPE

- 1.1. It is to be noted that "The Make in India Policy of Government of India shall be applicable."
- 1.2. This Specification applies to Outdoor Type, Double Pole & Triple Pole SF₆ High Voltage Circuit Breakers for use in Traction Sub Stations of Indian Railways for controlling Power Supply to 25kV AC 50 Hz single phase Traction Overhead Equipment and 2x25 kV AC 50 Hz AT Feeding System for Traction Overhead Equipment (OHE).
- 1.3. All the provisions contained in RDSO's ISO procedures laid down in Document No. - QO - D-8.1-11 Ver. 1.2 dated 22.06.2020 (titled "Vendor-changes in approved status") and subsequent versions/amendments thereof, shall be binding and applicable on the successful vendor/vendors in the contracts floated by Railways to maintain quality of products supplied to Railways.
- 1.4. This Specification supersedes the specification no. TI/SPC/PSI/HVCB/0120 (June, 2014) Rev. 0 with A & C slip No. 1 & 2.
- 1.5. The Circuit Breaker shall be complete with all Parts, Fittings and accessories as necessary for its efficient operation including SF₆ Gas for the first filling, mounting frame work of steel. All such Parts, Fittings and Accessories shall be deemed to be within the scope of this Specification, whether specifically mentioned or not. The CB shall be of proven design. Criteria of proven design shall be advised by RDSO as and when the need arises.
- 1.6. The Circuit Breaker shall be erected by the Purchaser. However, in case a defects/deficiencies are noticed, the manufacturer/Vendor will have to depute his engineer for necessary remedial action without any cost to the Railways. In all the cases in which an order is placed either on new manufacturer or for a new type /design of the Circuit Breaker, the services of manufacture's engineer shall be made available free of cost during the erection and proving/pre- commissioning test for the first order of their Circuit Breaker. For this purpose, prior intimation regarding the date and the location shall be given by the purchaser to the Vendor/ manufacturer.

2. Governing Standards, Specification

- 2.1. The Circuit Breaker unless otherwise specified, shall conform to the following specifications and the Indian Electricity Rules, wherever applicable in line with standards engineering practice unless specifically brought forth:

S.N.	IS/IEC/RDSO Specification with latest amendments.	Description
(i)	IS/IEC 62271-100	High-voltage switchgear and controlgear - Part 100: Alternating-current circuit-breakers.
(ii)	IEC: 60376/IS: 13072	Specification of technical grade Sulphur hexafluoride (SF ₆) and complementary gases to be used in its mixtures for use in electrical equipment.
(iii)	IS/IEC:62271-1	High-voltage switchgear and controlgear - Part 1: Common specifications for alternating current

		switchgear and controlgear.
(iv)	IS: 456	Code of Practice for plain and reinforced concrete.
(v)	IS: 996	Single Phase A.C. Induction Motors for general purpose.
(vi)	IS: 2099	Specification for Bushing for Alternating Voltages above 1000V.
(vii)	IS: 2544	Specification for Porcelain Post Insulators for System with Nominal Voltages greater than 1000V.
(viii)	IS: 5561	Specification for Electric Power Connectors.
(ix)	IS: 5621/IEC:62155	Specification for Hollow Insulators for Use in Electric Equipment.
(x)	IS:13947-Part V : Sec.1/IEC60947-5	Specification for Control Switches (Switching Device Control and Auxiliary Circuits including contactor Relay) for Voltages up to and including 1000V AC and 1200 DC General requirements and Tests.
(xi)	IS:7906 (Pt.I)/ EN 10270-2 FdSiCr	Specification for Helical Compression Springs.
(xii)	IS:7907(Pt.I)/ EN 10270-2 FdSiCr	Specification for Helical Extension Springs.
(xiii)	IS:13118	Specification for High Voltage Alternating Current Circuit Breakers.
(xiv)	IS:1554 (Pt. I)/ IS 694	Specification for PVC Insulated (heavy duty) Electrical Cables for working Voltage up to & Including 1100V.
(xv)	IS: 808	Dimension for Hot Rolled Steel Beam, Column, Channel and Angle sections.
(xvi)	IS/IEC-60529	Degrees of protection provided by enclosures (IP Code)
(xvii)	IS/IEC 60947-1	Low-voltage switchgear and controlgear - Part 1: General rules
(xviii)	RDSO Specification No. TI/OHE/13(4/84) with A & C Slip No.1 to 4.	For Hot Dip Galvanization.
(xix)	RDSO Specification No.- TI/SPC/OHE/FASTERNE RS/0120 Rev. 1	For Steel and Stainless Steel Bolts, Nuts and Washers.
(xx)	RDSO Specification No. M&C/PCN/102/2020, Amendment 1B (Rev-2.0)	For Epoxy based Zinc Phosphate Primer (two pack).
(xxi)	RDSO Specification No. M&C/PCN/110/2006	For Polyurethane based Aluminum Paints (three pack)
(xxii)	AC Traction manual	Issued in 1994 or latest.

- 2.2. Any deviation from this Specification as proposed by the manufacturer to improve upon the performance, utility and efficiency of the equipment shall be given due consideration, provided full particulars of the deviation

with justification thereof are furnished; subject to approval of RDSO. In case of any contradiction between the provision of the Indian Standards / IEC standards and this Specification. This specification shall prevail.

3. DUTIES OF THE CIRCUIT BREAKER

- 3.1. The Circuit Breaker is used as Transformer Circuit Breaker on Primary Side of Traction Transformer for Voltage of 55kV, 66KV, 100KV, 110KV, 132KV and 220KV and also for incoming and Outgoing Transmission Line at Traction Substation.
- 3.2. The Circuit Breaker would be subjected to vibrations on account of trains running on nearby Railway Tracks. The amplitude of these vibrations which occur with rapidly varying time periods are in the range of 15ms to 70ms lie in the range of 30 to 150 microns at present, with the instantaneous peak going up to 350 microns.

4. TECHNICAL SPECIFICATION

4.1. The rating and other particulars

The Circuit Breakers shall be designed for the following rating and other Particulars:

S.N	Particulars	RATED SYSTEM VOLTAGE (kV)				
		55	66	100 /110	132	220
(i)	Number of poles	2	2 /3	2 /3	2 /3	2 /3
(ii)	Nominal voltage(kV) system	55	66	100/110	132	220
(iii)	Highest voltage(kV) System	60.5	72.5	123	145	245
(iv)	Rated insulation level					
	(a)Rated 1min Dry/wet power frequency withstand voltage	140kV (rms)		230 kV (rms)	275 kV (rms)	460 kV (rms)
	(b)Rated impulse (1.2/50µs) withstand voltage	325 kV (peak)		550 kV (peak)	650 kV (peak)	1050 kV (peak)
(v)	Rated frequency	50Hz ± 3%				
(vi)	Rated Normal Current	2000A	1250A	1600 A	1600 A	2000 A
(vii)	Rated short Circuit Breaking Current	31.5 kA		40.0 kA	40.0 kA	40.0 kA
viii)	Rated breaking capacity (symmetrical)					
	(i) Two Pole	2284 MVA		4920 MVA	5800 MVA	9800 MVA
	(ii)Three Pole	3956 MVA		8522 MVA	10046 MVA	16974 MVA
(ix)	Out of phase breaking	7.9 kA (rms)		10 kA (rms)		

	current				
(x)	Rated single capacitor bank breaking current	400 A			
(xi)	Rated line charging breaking current	10 A	31.5 A	50 A	125 A
(xii)	Rated small inductive breaking current	10 A			
(xiii)	Rated making current	78.8 kA (peak)	100 kA(peak)		
(xiv)	Rated operating Sequence	O - 0.3 sec - CO - 3 min - CO			
(xv)	Total break Time	Not more than 60 ms			
(xvi)	Rated short time current	31.5 kA for 1 sec	40 kA for 1 sec		
(xvii)	First pole to clear factor	1.5 for 2 parameters	1.5 for 2 parameters	1.3 for 4 parameters	1.3 for 4 parameters
(xviii)	Corona Voltage Extinction	53 kV	88 kV	106 kV	176 kV
(xix)	Rating of Auxiliary Switch Contacts (a) Rated Voltage (b) Rated Current (continuous) (c) Rated Braking Current	110 V DC 10 A 2 A at 220 V DC with 20 ms circuit time constant			

4.2. CLEARANCES

The design of the Circuit Breaker shall be such that when it is erected on the supporting Structure, the following clearances / distance of lowest live part of the Circuit Breaker from the ground level or earth are achieved:

Sl. No.	Clearances/ Distances Particulars (in mm)	RATED SYSTEM VOLTAGE (kV)			
		55/66	100/110	132	220
1.	Minimum height of lowest live part of the CB from ground level (mm)	4600			5500
2.	From a point where a man may be required to stand for operation or for attending the breaker (sectional clearance). (mm)	3500		4000	5000
3.	Minimum height of the bottom most part of any insulator from the ground level. (mm)	2500			

4.	* Minimum clearance between live part and earth part. (mm)	900	1100	1300	2100
5.	* Distance between pole centers for 2/3 poles (mm)	2000	3000	3000	4000

*Technically lesser clearance can be considered if these are well proven by lightning impulse and switching impulse tests as per RDSO specification and as per IS/IEC: 60071-2 or latest.

5. TYPE AND GENERAL CONSTRUCTION

5.1. The Circuit Breaker shall be of outdoor type suitable for mounting on steel structure. The Circuit Breaker shall be of Double Pole or Triple Pole (as required) identical to Single pole units operated through common operating mechanisms or operated through individual operating mechanisms for each pole suitably connected for ~~in step~~ **simultaneous** operation. The Circuit Breaker shall comprise of-

- i. The pole (interrupting chamber and support Insulators)
- ii. Operating Mechanism Cubicle and
- iii. Mounting steel frame

5.1.1. THE POLE (INTERRUPTING CHAMBAR AND HOLLOW INSULATORS)

5.1.1.1. The operating mechanism, pole assembly and supporting structure shall be separate and capable of being packed and handled individually and erected in a given sequence. The interrupting chamber comprising fixed and moving contacts with in an insulating enclosure shall be filled with SF₆ gas and mounted on a supporting insulator. The design and construction of the Circuit Breaker shall be such that the SF₆ gas leakage rate per year shall be limited to less than 1 % by mass of the first filling. No condensation of SF₆ gas shall take place on internal insulating surfaces. Inside the interrupting chamber there shall be an absorbent to absorb products of decomposition of SF₆ gas and moisture, if any. It shall be convenient to enable the pole being dismantled and removed from the operating mechanism without SF₆ gas escaping. The material used in the construction of the interrupting chamber shall be fully compatible with SF₆ gas. The position of vents, diaphragms and pressure relief devices, if used, shall be so arranged as to minimize danger to the operator in the vicinity of the Circuit Breaker in the event of SF₆ gas escaping under pressure.

SF₆ gas used in the Circuit Breaker shall confirmed to IS: 13072/IEC-60376(2005) or the latest. The gas for the first filling shall be supplied with the Circuit Breaker.

5.1.1.2. PORCELAIN HOLLOW INSULATOR

The porcelain hollow insulators used as the support insulators and interrupting chamber insulator for the Circuit Breaker shall be outdoor type conforming to IS: 5621 (1980) or IEC 62155 with latest amendments if any. The porcelain hollow insulator shall be of single piece construction i.e., there shall be no joint with in the porcelain. To reduce

joints for leakage of SF₆ gas, more than one porcelain hollow insulator shall not be used for interrupting chamber insulator or support insulator. The shed profile shall have a lip at the extremity but free from ribs on the ~~under~~ **either** side so as to avoid accumulation of dust and pollutants and permit easy cleaning. These insulators shall be procured from reputed sources only. The Test Certificate of these shall be verified during Prototype Testing. ~~Vacuum~~ **SF6** Circuit Breaker manufacturer shall declare make of the Hollow Insulator used in QAP and SOGP (to be approved by RDSO).

The porcelain insulators for the support and interrupting chamber shall have minimum creepage distance as given in the table below.

Rated voltage (kV)	55/66	100/110	132	220
Minimum creep age distance (mm)				
(i) Support insulator	1813	3075	3625	6125
(ii) Interrupting chamber insulator	1450	2460	2900	4900

5.1.1.3. TERMINAL CONNECTORS

- (i) The Circuit Breaker shall have Aluminum Terminal pads and shall be supplied with the Flexible Terminal Connectors as per RDSO Drawing No. ETI/PSI/P/11030 Mod C or latest suitable for connecting to "ZEBRA" 28.62 mm ACSR conductors for 55kV, 66kV, 100/110kV, 132kV and 220kV Circuit Breaker.
- (ii) The connectors shall conform to IS:5561 (1978) or latest and design shall be such, so as to be connected to the equipment Terminal pads with minimum four 12 mm diameter Bolts, Nuts, Lock-Nut of Stainless Steel conforming to IS:1570 (Pt.) (1978) or latest grade 04Cr, 17Ni and Mo2 each of these bolts shall have two flat washers.

5.1.1.4. CONTACTS FOR SF₆ CIRCUIT BREAKER

(i) MAIN CONTACTS

The main, fixed and moving contacts of the Circuit Breaker shall have ample cross-section and contact pressure for carrying the rated current and short time current without excessive Temperature rise, pitting and welding. Arcing tips shall be made up of ~~copper~~ **Copper - tungsten** alloy or any other suitable material. The nozzle, main contacts and arcing contacts or parts thereof which are liable to wear shall be replaceable.

(ii) AUXILIARY SWITCH CONTACTS

Apart from the auxiliary switch contacts required exclusively by the Manufacturer for the functioning of the Circuit Breaker at least 6 pairs of normally open (NO) contacts and 6 pairs of normally closed (NC) contacts shall be provided additionally for the exclusive use of the purchaser. The auxiliary contacts which are operated in conjunction with the main contacts shall be positively driven in both the directions.

5.1.2. OPERATING MECHANISM CUBICLE/CUBICLES

- 5.1.2.1. The Circuit Breaker shall be operated by a motor charged spring stored energy mechanism. Both opening and closing operations shall be done by the stored energy of spring (s). The motor shall be so rated that the time required for fully charging the closing spring is not more than 15 seconds. The closing action of the CB shall charge the opening spring so that the Circuit Breaker is ready for opening any time thereafter. The spring shall be of robust design, using Tested steel as per IS: 7906 or IS: 7907 (1976) or latest (If any other equivalent international standard is being referred by manufacturer, a comparison of parameters is to be submitted by manufacturer to RDSO for consideration of other standard). The ends of the compression springs if used shall be flattened to enable proper fixing and shall minimize the possibility of misalignment.
- 5.1.2.2. The motor for spring charging shall be suitable for operation from a 110V dc power from a battery. The voltage at motor is Likely to vary between 110% and 85% of the normal value. The Carbon Brushes provided shall have copper pigtailed for Carrying Motor Current. A Miniature Circuit Breaker of adequate ratings and of reputed make shall be provided in the Motor circuit for protection of the motor against over current and earth faults.
- 5.1.2.3. The Operating Mechanism shall be designed so that, the Circuit Breaker can be operated from the itself as well as remotely from the control panel in the TSS and also from the remote control Centre (RCC) which is situated away from the Circuit Breaker. For this purpose "LOCAL/REMOTE" two way selector switch shall be provided in the operating mechanism. When the switch is in the "LOCAL" position, the Circuit Breaker can be operated locally and when it is in the "REMOTE" position the Circuit Breaker can be operated from the control panel or from the RCC. The selector switch shall be ~~spring loaded type~~ or stay put type. For closing and opening the Circuit Breaker from itself, the switch shall be of the push button type or knob type.
- 5.1.2.4. The Operating Mechanism shall also be provided with a suitable emergency device to manually open the Circuit Breaker in the failure of any part of DC control circuit including the opening coil in the Operating Mechanism.
- 5.1.2.5. In addition, a detachable handle/ crank shall be provided for manually charging the closing spring. The height from ground/ platform level at which the handle / crank is to be inserted in the operating mechanism shall be between 1500mm and 2000mm so as to enable its operation conveniently by the operator standing on the ground/ platform. The height of other devices like interlock, ON-OFF switches, selector switches etc. to be operated from ground/ platform shall also be at a height between 1500mm and 2000mm.
- 5.1.2.6. The closing coil and opening coil shall be suitable for operation from 110V dc power supply from a battery. The closing coil shall be suitable for operating at a voltage variation of +10% to -15%, while the opening coil shall be suitable for operating at a voltage variation of +10% to -30%.
- 5.1.2.7. The Circuit Breakers shall be fitted with an electrical anti- pumping device, to give priority to tripping command in case of a persisting closing

command being simultaneously present.

- 5.1.2.8. Facility for trip circuit supervision shall be provided with indication to Remote Locations (RCC).
- 5.1.2.9. An operation counter having five digit recording mechanism for the number of tripping operation shall be provided at a suitable location so as to be conveniently read by the operator standing on the ground/**platform**. The operation counter shall be of Lock type and shall not be of resettable type.
- 5.1.2.10. Mechanical indicators clearly visible from ground shall be provided for "CLOSED" and "OPEN" conditions of the CB.
- 5.1.2.11. All working parts of the operating mechanism shall be of corrosion resisting material, bearings, if any, shall be sealed type. Bearing, pins, bolts, nuts and other parts shall be adequately locked to prevent loosening.
- 5.1.2.12. In case of drop in pressure of SF₆ gas below the set value the temperature compensated alarm pressure switch shall get actuated for generating an alarm. If the drop in the pressure continues, the temperature compensated Lock out pressure switch shall get actuated to cause the Circuit Breaker to trip and get locked in the tripped condition. Separate auxiliary contact from pressure switches shall be made available for tele-signalling the alarm condition from the alarm pressure switch and the trip and Lock out condition from the Lock out pressure switch. The maximum pressure, normal pressure, alarm actuating pressure and tripping & Lock out pressure of the Circuit Breaker shall be furnished by the Manufacturer on the schematic drawing of the Circuit Breaker. Maximum and minimum permissible pressure of SF₆ shall be indicated on the rating plate also.
- 5.1.2.13. The operation of closing device when Circuit Breaker is already in "CLOSED" condition shall not cause damage to any part of the Circuit Breaker or endanger the operator standing near the Circuit Breaker. The power requirement for tripping coil or closing coil shall not exceed 750W and power requirement at any time including spring charging motor shall not exceed 2500W.
- 5.1.2.14. In the event of 110V battery supply voltage dropping below 85V ±3V which is the minimum voltage prescribed for operation of tripping coil to trip the Circuit Breaker, the Circuit Breaker should trip automatically at 85V ± 3V by means of a suitable arrangement like Capacitive trip Device (CTD) etc..
- 5.1.2.15. Shock absorbers used (if any) shall not require any maintenance during the entire life of the Circuit Breaker.
- 5.1.2.16. The operating mechanism and associated accessories shall be enclosed in Weather, Dust and Vermin Proof Cabinet or Cubical. The Cabinet or Cubical made of at least 2 mm thick Sheet Steel (of Tested quality) with provision for Pad Locking. Alternative minimum 3 mm for load bearing members and bottom, 2 mm for top and 1.6 mm for side cover. The cubical shall be tested for Dust and Water Proofing as per IP 55 as per IS/IEC: 60529 or latest from any National Laboratory.
- 5.1.2.17. Suitable Heater(s) shall be provided in to operate at 240V ac, 50Hz single

phase supply to prevent condensation of moisture during monsoon/winter. A 240V ac, 5A, 3 pin socket outlet for an inspection lamp shall also be provided. Miniature Circuit Breaker of reputed make & of adequate rating shall be used for protection of heater circuit for overload and earth fault.

- 5.1.2.18. The entry of all Cables into the Cubical shall be only through suitable Cable Glands which shall not allow ingress of Vermin, Insects etc. into the cubicle. The Cable Gland shall be supplied with the Circuit Breaker. Five Cable Glands shall be provided of which three shall be **suitable for cable** of 16.5 mm outside diameter while the balance two Glands shall be **suitable** for cable of 14 mm outside diameter.
- 5.1.2.19. The Wiring inside the Cubical shall be with 1100 V grade PVC insulated single core cable conforming to IS: 694 (2010 or latest) or IS:1554 (Pt.I-1988 or latest), with stranded copper conductors of adequate cross-section (with min 2.5 sq.mm stranded copper) so proportioned as to reduce voltage drop and I²R losses to minimum. The ends of wires shall be terminated with crimped eye type lugs or without crimping in self-locking spring loaded terminal blocks. The wiring of 110V DC control circuit and 240V AC circuit shall be segregated and properly identified. The positive and negative wires of dc circuits shall also be segregated. The length of the cables used shall be kept to the minimum. Wire inside the Cubical shall be properly laid on trays and anchored to avoid breakage during vibration.
- 5.1.2.20. The Terminal end of all wires shall be provided with numbered interlock type ferrules which shall be of PVC or other durable material with markings (numbers) either engraved or punched or **printed (with indelible ink)** so as to be indelible. The ferrules shall be of white color with lettering there on black. All wiring shall be properly supported and suitably protected to avoid rubbing against any metallic part.
- 5.1.2.21. Terminal blocks of standard type shall be provided in the operating mechanism cubicle. There shall be insulating barriers between adjacent terminals. The terminals shall be stud type with spring washers/self-locking spring loaded type. The Terminal blocks used for DC and AC circuits shall be clearly distinguished and separated from each other. Similarly positive and negative Terminations of the wiring of the DC Circuit shall be segregated and separated by insulating barriers.
- 5.1.2.22. The following gauges/switches shall be provided for monitoring the pressure/density of SF₆ gas. The pressure gauge shall have no oil to avoid leakage. The gauges shall be so positioned as to clearly and conveniently readable from ground/platform (~~1500mm to 2000 mm from ground/platform~~). The density (s) monitor and pressure gauges shall be common for all the poles of the breaker **up to 145kV CB and for 245kV CB may be common or separate for all the poles as per the design of the CB.** These shall indicate and actuate for any loss of pressure in the Circuit Breaker.
- (i) An accurate pressure gauge of adequate range.
 - (ii) Gas density temperature compensated pressure switch(es)
- 5.1.2.23. For earthing of the operating mechanism, two earthing terminals of adequate capacity to carry the rated short circuit current shall be provided with 17.5 + 0.5/-0.0 mm Diameter stud/hole for fixing the earthing flat.

6. STEEL SUPPORTING FRAME

- 6.1. The steel supporting frame for Circuit Breaker shall be designed with a factor of safety not less than 2.5 with respect to the yield point under conditions of maximum loading for a basic wind pressure of 200 kg/m² on 1.5 times the projected area of each member of one face and taking into account to IS: 808 (1989) or latest and Test certificate shall be furnished to RDSO.
- 6.2. Typical design calculations for the steel supporting frame shall be furnished by the Manufacturer to the RDSO during design approval stage for checking the safety of the supporting frame proposed to be used.
- 6.3. For earthing at least 2 legs of the steel supporting frame shall be provided with Stud/Hole type of adequate capacity to carry the rated short circuit current safely. The earthing shall be provided with 50 x 8 mm MS flat (**MS Flat are not in the scope of vendor of CB**). The Terminal shall be provided with 17.5 + 0.5/-0.0 mm diameter stud/hole for fixing the earthing flat.

7. FOUNDATIONS

Gravity Foundation of Plain Mass Concrete to M 10 mix as per IS: 456 (2000) or latest shall be designed considering the normal impact loading in opening/closing operations. The basic wind pressure shall be taken as 200 kgf/m². Two alternative designs of foundations, one for a normal soil of bearing capacity 5500 kgf/m² and other for black-cotton soil of bearing capacity 16500 kgf/m² shall be furnished by the Manufacturer. The foundation block design shall give complete details of its size and size of pockets provided for grouting the fixing bolts. Detailed design calculation for proposed foundation shall be submitted to DG (TI) RDSO for scrutiny and approval.

8. CORROSION PREVENTION SYSTEM

8.1. GALVANIZING

The Operating Mechanism Cubical and Steel Supporting Frame shall be Hot Dip Galvanized in accordance with RDSO Specification No. ETI/OHE/13 (4/84) with A & C Slip No.1 to 4 and the weight of zinc coating shall not be less than 1000 gm/m².

8.2. PAINTING

If the Vendor/Manufacturer is not able to Hot Dip Galvanize the operating mechanism cubicle and the Steel Supporting frame as per Clause 8.1, it shall be painted conforming to RDSO's Specification No. M&C/PCN/110/2006 (Reaffirmed-2013) or latest for polyurethane based aluminum paint (three packs) and specification no. M&C/PCN/102/2020, Amendment 1B (Rev-2.0) or latest for epoxy based zinc phosphate primer (two packs).

8.3. FASTENERS

All fasteners of 12 mm diameter and less exposed to atmosphere shall be of Stainless Steel and those above 12 mm diameter shall be of preferably Stainless Steel or of Mild Steel Hot Dip Galvanized, to RDSO's Specification No. TI/SPC/OHE/FASTERNERS/0120 Rev. 1 or latest.

9. PARTS, FITTINGS AND ACCESSORIES

9.1. The following parts, fittings and accessories shall be provided for each Circuit Breaker:

- i. SF₆ Gas Pressure Gauge
- ii. Temperature compensated gas density pressure switch(es)
- iii. Provision for replenishment of SF₆ gas, preferably in the Operating Mechanism Cubicle.
- iv. Operating Mechanism Cubical Door Padlocking arrangement with Padlock.
- v. Local operated opening and closing device.
- vi. ~~Spring loaded type or~~ Stay put type Local/Remote selector switch.
- vii. Local operated electrical closing and opening device (Push or Knob).
- viii. Operation Counters.
- ix. Interlocking device (as required)
- x. Terminal connectors.
- xi. Earthing Terminals
- xii. Name/ rating plate.
- xiii. "ON" and "OFF" position indicators.
- xiv. Supporting Frame work.
- xv. Lock out device
- xvi. Capacitor Trip Device (CTD) Relay to Trip at 85 V \pm 3 Volts DC, When the Control Supply Voltage of 110V DC drooping to 85 V \pm 3 Volts.
- xvii. Anti-pumping device.
- xviii. Foundation Bolts.
- xix. Handle/crank for charging the closing spring manually.

9.2. The Name/ Rating Plate shall contain the following particulars:

Each Circuit Breaker shall be provided with Rating Plates (both in Hindi & English) of weather proof material fitted in a visible position showing the items indicated below. The letters/numbers on the plate shall be indelibly

marked by etching/engraving.

- i. Manufacturer's name and country of origin.
- ii. Type designation and No. of pole.
- iii. Serial number.
- iv. Rated voltage.
- v. Rated normal current.
- vi. Rated frequency.
- vii. Rated short circuit breaking current.
- viii. Rated short circuit peak making current.
- ix. Rated single capacitor bank breaking current.
- x. Rated out of phase breaking current.
- xi. Rated short time withstands current and its duration.
- xii. Rated insulation level.
- xiii. Rated operating sequence.
- xiv. Control circuit voltage with permissible variation for
 - a) Closing coil
 - b) Opening coil
 - c) Motor voltage
- xv. Total weight of Circuit Breaker.
- xvi. Specification conforming to IS/IEC/RDSO.
- xvii. Quantity of SF6 gas (by mass).
- xviii. SF6 Gas Pressure
 - a) Maximum
 - b) Normal
 - c) Alarm
 - d) Lock out
- xix. Order reference
- xx. Month/Year of Manufacture

10. TESTING

10.1. GENERAL

10.1.1. BEFORE MANUFACTURE OF PROTOTYPE

The Vendor has to offer drawing & design for approval of RDSO including Quality Assurance Plan (QAP), Schedule of Guaranteed Performance (SOGP) and Design Calculations as required and mentioned in the relevant Clauses of Specification.

Only after all submitted documents have been approved and clearance given to this effect by RDSO, the manufacturer shall take up manufacture of the prototype for inspection/testing by RDSO. It is to be clearly understood that if, there are any changes to be done on the prototype as required by RDSO, same shall be done expeditiously.

10.1.2. PROCEDURE FOR OFFERING PROTOTYPE

Prior to giving a call to the Purchaser/Director General (Traction Installation), Research Designs and Standards Organization, Lucknow (DG(TI),RDSO, Lucknow) for inspection and testing of the prototype, the Vendor/ manufacturer shall submit a detailed test schedule of prototype testing indicating the name of the test with internal test report (Test report of Routine Test) and the number of days required to complete all the tests at one stretch.

The schedule shall also indicate the venue of each of the test. Once the schedule is approved, the test shall invariably be done accordingly.

However, during the process of type testing or even later, the Purchaser/DG/TI/RDSO, Lucknow reserves the right to conduct any additional test(s), besides those specified herein, on any equipment so as to test the equipment/ item to his satisfaction or for gaining additional information and knowledge. In case any dispute or disagreement arises between the Vendor/manufacturer and the representative of Purchaser/ DG /TI/ RDSO, Lucknow during the process of testing as regards the procedure for type tests and for the interpretation and acceptability of the results of type tests. It shall be brought to the notice of the DG/TI/ RDSO, Lucknow, whose decision shall be final and binding. Only after the prototype of the equipment is manufactured and ready in all respects, shall the Vendor/manufacturer give the actual call for the inspection and testing with at least 15 days' notice for the purpose.

10.1.3. Type test shall be carried out on Prototype unit of Circuit Breaker with relevant standards as modified or amplified by this specification where applicable at the works of the manufacturer or at any Government approved testing laboratory, if testing is done in India. At the works of the manufacturer the testing shall be conducted in the presence of the authorized representative of the purchaser/DG (TI)/RDSO, Lucknow. However for the tests in the any Government approved testing laboratory, the presence of representative of the purchaser/DG (TI)/RDSO, Lucknow may be decided by the RDSO.

10.1.4. For the tests which are conducted in the laboratories of Central Power Research Institute (CPRI), Electrical Research Development Association (ERDA) or any such testing house or laboratory a clear certificate to the effect that the equipment has passed the tests as per the Specification

shall be obtained by the manufacturer and submitted to the Purchaser/DG (TI)/RDSO, Lucknow. Full details of the tests and the test parameters shall be furnished along with the test reports. These test reports shall be considered for acceptance, provided there is no any design change between already tested material and offered material.

In any case, the prototype tests, which can be conducted in- house at manufacturer's works shall be required to be carried out and witnessed by RDSO during initial approval.

10.2. Type Tests

The type Tests comprises of:

S.N.	Description of Test	Refer in
1.	Mechanical Operation Test	10.2.1
2.	Temperature Rise Tests	10.2.2
3.	Dielectric Tests	10.2.3
	a. Rated Lightning Impulse Voltage withstand Test.	10.2.3.1
	b. Rated One Minute Dry Power Frequency withstand Voltage Test	10.2.3.2
	c. Rated One Minute wet Power Frequency withstand Voltage Test	10.2.3.3
4.	Rated Short Circuit Making and Breaking Capacity Test (Basic Short Circuit Test duties)	10.2.4
5.	Rated Short Time Withstand Current & Peak Withstand Current Test	10.2.5
6.	Line Charging Breaking Current Test	10.2.6
7.	Test to prove the rated transient recovery voltage (TRV) and Rate Of Rise Of Recovery Voltage (RRRV)	10.2.7
8.	Short Line Fault Test (Kilometric Faults)	10.2.8
9.	Out Of Phase Making And Breaking Test	10.2.9
10.	Capacitor Current Switching Test	10.2.10
11.	Measurement Of Radio Interference Voltage Level (For 145kV & 245kV CB only)	10.2.11

10.2.1. Mechanical Operation Test

10.2.1.1. The Test shall be conducted in accordance with Clause 6.101.2.1 to 6.101.2.3 of IS/IEC 62271-100 (2008) or latest but the number of operations shall be 5000 of 55kV, 66kV, 100kV, 110kV, 132kV and 220kV instead of 2000 specified therein. For this purpose, Circuit Breaker shall be tested in accordance with Table XIII of IS/IEC 62271-100 or latest. However, the sequence shall be repeated 2.5 times to complete 5000 operations.

10.2.1.2. Following checks/Tests shall be done before the commencement of operation Test.

- (i) General visual inspection of the equipment to check its conformity with the approved drawings.
- (ii) Operation of various circuits and devices of the Circuit Breaker.

- (iii) Measurement of Gas pressure at ambient temperature.
 - (iv) Measurement of dimensions of components liable to wear, dimension of opening, closing and wipe springs, lift of tripping and closing coil plunger, and clearances of opening and closing coil armatures.
 - (v) Measurement of Insulation Resistance of auxiliary and motor circuits with 500V Insulation Resistance Tester.
 - (vi) Measurement of Contact Resistance of Main Circuit by dc voltage drop.
 - (vii) Operation comprising 5 closing and 5 opening operations at the specified, normal, minimum and maximum control voltages.
 - (viii) Closing and opening travel characteristics of contacts to record the following at the specified normal, minimum and maximum control voltages.
 - (a) Opening Speed(Opening Velocity) & Time
 - (b) Closing Speed (Closing Velocity) & Time
 - (c) Contact Bounce &
 - (d) Contact Travel
- 10.2.1.3. The measurement of items (vi) & (viii) above shall be repeated after 2500 operations of Circuit Breaker and observations made/ results obtained shall be evaluated by comparing with the figures and the tolerances given by the successful tenderer/Manufacturer in the SOGP.
- 10.2.1.4. After completion of 5000 operation of 55kV, 66kV, 100kV, 110kV, 132kV and 220kV Circuit Breaker and before dismantling the Circuit Breaker for Internal inspection, the following checks/Tests shall be performed.
- (i) Measurement of Gas pressure at ambient temperature. The same shall be within 99% of pressure recorded at the beginning of the operation.
 - (ii) Dielectric Tests on control and auxiliary circuit (110 V dc) by applying 2 kV (rms) for 1 minutes after disconnecting the motor.
 - (iii) Spring charging motor shall be Tested at 1kV (rms) for 1 minute.
 - (iv) Power frequency dry withstand voltage Test on complete Circuit Breaker for 1 minute as per Clause 10.2.3.2.
 - (v) Measurement of Insulation Resistance of auxiliary and motor circuits with 500V Insulation Resistance Tester.
 - (vi) Temperature rise Test on opening and closing coils as per clause 10.2.2.5.
 - (vii) Closing and opening travel characteristics of contacts to record the following at the specified normal, minimum and maximum control voltages.

- (a) Opening speed (Opening Velocity) & time
- (b) Closing speed (Closing Velocity) & time
- (c) Contact bounce &
- (d) Contact travel

The above parameters shall be within the specified limits declared by the Manufacturer in SOGP.

- (viii) The tightness of gas sealing arrangement shall be measured by Tests conducted on either a complete Circuit Breaker or on sub-assemblies in combination with tightness co-ordination chart as provided in the Appendix "EE" of ~~IS/IEC 62271-100~~ or latest **Annex E of IS/IEC 62271-1: 2007 (reaffirmed: 2018)** or latest to ascertain total system leakage rate and time between refilling of SF₆ Gas. Drop in pressure shall not be used to detect the leakage rate of the SF₆ Gas as it will not indicate the correct readings.

10.2.2. Temperature Rise Test

10.2.2.1. On main contact

The temperature rise Test on the main circuit (contacts) and Terminal Connectors shall be carried out as per clause 4.4.2 Table III of IS/IEC62271-1(2007) or latest. Contact resistance of the main circuit shall be determined by DC Voltage Drop and recorded before and after this Test. **If the terminal connectors are not connected with CB during the temperature rise test, temperature rise test report of the terminal connector should be submitted separately.**

10.2.2.2. Procedure

Unless otherwise specified, temperature rise test on the main circuit shall be carried out on a new Circuit Breaker in closed position with clean contacts. The Test shall be carried out with rated normal current in indoor environment substantially free from air currents, except those generated by heat from the Circuit Breaker being tested. Temporary connections to the Circuit Breaker shall be such that no significant amount of heat is conducted away from, or conveyed to the Circuit Breaker during the Test. The temperature rise at the Terminal of main circuit and the temporary connections at a distance of 1 meter away from the Terminal shall be measured. The difference of temperature rise shall not exceed 5°C. The type and sizes of temporary connections shall be recorded in the Test report.

- 10.2.2.3. The maximum temperature rise of contacts, for connection to external conductors by bolts, material used as insulation and metal parts in contact with insulation shall not exceed the values given in Table 3 of IS/IEC:62271-1(2007) or latest, when carrying rated normal current continuously. These values shall conform to IS/IEC: 62271-1(2007) or latest.

- 10.2.2.4. In case a layer of coating of silver over the contact area is not maintained, at the end of any test the contacts shall be regarded as bare for the purpose of temperature rise limits.

10.2.2.5. On Auxiliary Equipment (Closing & Opening coils)

The temperature rise Test on the coils shall be carried out as per

clause 4.4.2 of IS/IEC: 62271-1(2007) or latest.

10.2.2.6. Procedure

The temperature rise on auxiliary equipment (closing and opening coils) shall be carried out by the method of measuring variation of resistance before and after energisation at 110V dc. For this purpose the coil(s) shall be energised 10 times for 1 second, the interval between the instant of each energising being 2 second. The resistance of the coil shall be measured immediately before and after such energisation. The value of temperature rise, over the ambient shall be computed.

10.2.2.7. The maximum temperature rise shall be as per table III of IS/IEC: 62271-1(2007) or latest, considering the insulating material of the coil. The temperature rise shall not exceed the value as guaranteed by the Manufacturer in SOGP.

10.2.3. Dielectric Tests

Dielectric Tests shall be carried out generally in accordance with Clause ~~6.1~~ 6.2 of IS/IEC: 62271-1 (2007) or Latest. Humidity and air density correction factor if less than 1.0 shall not be applied. The Tests shall be carried out at minimum SF₆ Gas pressure.

The Test shall comprise of:

10.2.3.1. Rated Impulse withstand voltage Test

The Circuit Breaker shall withstand rated impulse voltage of 1.2/50µs wave shape as per table below:

	NOMINAL SYSTEM VOLTAGE OF Circuit Breaker (KV)			
	55/66	100/110	132	220
APPLIED VOLTAGE (kVp)	325	550	650	1050

10.2.3.2. Rated One Minute Dry Power Frequency Voltage Withstand Test

The Circuit Breaker shall withstand rated one minute wet power frequency withstand voltage as per table below:

	NOMINAL SYATEM VOLTAGE OF Circuit Breaker (kV) rms			
	55/66	100/110	132	220
APPLIED VOLTAGE (KVrms)	140	230	275	460

10.2.3.3. Rated One Minute Wet Power Frequency Voltage Withstand Test

The Circuit Breaker shall withstand rated one minute wet power frequency withstand voltage as per table below.

	NOMINAL SYATEM VOLTAGE OF Circuit Breaker (kV) rms			
	55/66	100/110	132	220
APPLIED VOLTAGE (KVrms)	140	230	275	460

10.2.4. Rated Short Circuit Making & Breaking Capacity Test (Basic short circuit Test duties):

The basic short circuit Test duties 1 to 5 shall be in accordance to

Clause 6.106 of IS/IEC-6227-100 or latest. The Power Frequency Recovery Voltage shall be as per clause 6.104.7 of IS/IEC -62271-100 or latest.

10.2.5. Rated short time withstand current & peak current Withstand Test:

This Test shall be conducted as per clause 6.6 of IS/IEC 62271-1 (2007) or latest and the values shall be under:

Description	NOMINAL SYATEM VOLTAGE OF CB (kV)			
	55/66	100/110	132	220
Value of current & duration	31.5 kA (rms) for 1 second		--- - 40kA (rms) for 1s--	
	78.75 kA (peak)		-----100kA (peak)-----	

10.2.6. Line charging current switching Test:

This Test shall be conducted as per clause 6.111.5.1 of IS/IEC 62271-100(2008)/ or latest. Test values shall conform as given in SOGP.

10.2.7. Test to prove rated transient recovery voltage (TRV):

The measurement shall be done as per clause 6.104.5 of IS/ IEC 62271-100(2008)/ or latest.

10.2.8. Short line fault Test (Kilometric Faults):

This Test shall be conducted as per clause 6.109 of IS/IEC: 62271-100 or Latest.

10.2.9. Out of phase making and breaking Test

This Test shall be conducted as per clause 6.110 of IS/IEC 62271-100(2008) or latest at its rated out of phase breaking current. The applied voltage and power frequency recovery voltage shall be set as per table below.

	NOMINAL SYATEM VOLTAGE OF CB (kV)			
	55/66	100/110	132	220
Current	7.9 kA rms	-----10kA rms-----		
Recovery Voltage	144 kV rms	246 kV rms	290 kV rms	490 kV rms

10.2.10. Capacitor bank breaking current Test

The Test shall be carried out at rated single capacitor bank breaking current generally as per clause 6.111 of IS/IEC62271- 100(2008) or Latest. No restriking shall occur during the Test. The breaking current shall conform to the guaranteed value.

10.2.11. Measurement of Radio Interference Voltage Level:

This Test shall be conducted as per clause 6.3 of IS/IEC 62271-1(2007) or latest.

10.3. Condition of Circuit Breaker during the Tests conducted as per clause no. 10.2.4, 10.2.5, 10.2.6, 10.2.7, 10.2.8, 10.2.9, 10.2.10 & 10.2.11 of this Specification shall conform as under:

- 10.3.1. During these tests the Circuit Breaker shall neither show signs of excessive distress nor endanger the operator. No disruptive discharge between energised parts and earth shall occur during the test. There shall be no indication of significant leakage current to the earth structure or screens whenever fitted during the test. The earthed part shall be connected to earth through a fuse consisting of copper wire of 0.11 mm diameter and 5 cm length. The fuse wire shall be intact after the test.
- 10.3.2. The Mechanical functions and insulation of Circuit Breaker shall be essentially in the same condition as before the Test. The wear of the contacts shall not be disproportionate to its original shape and size. The Circuit Breaker shall be capable of carrying its rated normal current and also capable of performing its assigned duty provided in clause 3.0 of the Specification. The Circuit Breaker shall withstand for 1 minute dry power frequency withstand voltage condition as per table below:

	NOMINAL SYATEM VOLTAGE OF CB (kV)			
	55/66	100/110	132	220
Power frequency withstand voltage	140 kV rms	230 kV rms	275 kV rms	460 kV rms

- 10.4. If the prototype of the Circuit Breaker conforming to the Specification has been approved for earlier supplies to Indian Railways, testing of prototype again may be waived provided that no changes in the design and Materials have been made. For this purpose the Vendor/manufacturer shall approach Purchaser/DG (TI), RDSO Lucknow with complete documents to ascertain whether the equipment is identical to the prototype approved earlier. Once prototype approval is accorded after conducting all or part of the type tests by RDSO, the prototype approval shall normally be valid subject to the no changes in the design and Materials.
- 10.5. Only after written approval of the prototype by Purchaser/DG/TI/, RDSO Lucknow to the Vendor/Manufacturer, they shall take up bulk manufacture of the Circuit Breaker which shall be strictly with the same design, material and process as adopted for the prototype. In no circumstances the material from sources other than those approved in the design/drawings shall be used for bulk manufacture.
- 10.6. During Prototype Inspection, the Vendor/Manufacturer shall furnish copies of Test Certificate for all the important items including items listed at Annexure "B".
 Suitable monogram in the form of engraving/embossing or other similar means shall be provided on each of these items to identify their Manufacturer/ source and shall also be verified during inspection.
- 10.7. Details of the important parts/sub-assemblies and accessories listed at Annexure B shall be furnished by the Vendor/Manufacturer to DG/(TI), RDSO Lucknow for approval.
 Copy of the same shall also be furnished to purchaser along with SOGP.

10.8. Routine Tests

Every Circuit Breaker shall be subjected to the routine Tests at the Manufacturer's works as per Clause 7 of IS/IEC 62271-100 or latest. Routine Test reports of items/components used shall be made available to the inspecting authority whenever required. The routine Tests comprise –

S.N	Name of the Test	Refer Clause
1.	Rated one -minute power frequency dry withstand voltage test on the main circuit	10.8.1
2.	Dielectric Test on control and auxiliary circuits	10.8.2
3.	Measurement of contact resistance of main circuit	10.8.3
4.	Mechanical operation Tests	10.8.4
5.	Design and visual checks	10.8.5

10.8.1 Rated one minute power frequency dry withstand voltage Test

The Circuit Breaker shall withstand following dry power frequency voltage for one minute as per Clause 10.2.3.2.

10.8.2 Dielectric Tests on control and auxiliary circuits

The control and auxiliary circuits shall withstand 2000 V ac for one minute according to IEC: 61180:2016 or equivalent Indian Standard with latest. After disconnecting spring charging motor. The spring charging motor shall withstand 1500 V ac for one minute.

10.8.3 Measurement of contact resistance of main circuit:

The resistance shall be measured by dc voltage drop. The measured value shall not exceed 1.2 times the value of resistance recorded before temperature rise Test during the type Tests approved by DG(TI), RDSO.

10.8.4 Mechanical Operation Test:

The Test comprising five opening and five closing operations at each of the rated, maximum and minimum control voltages i.e. at 110 V dc, +10% and -15% for closing operations and at 110 V dc -30% for opening operations shall be performed. The contact travel characteristics shall be recorded for each closing and opening operations. The characteristics shall be within the tolerances specified in SOGP/ type Test values approved by DG (TI), RDSO.

10.8.5 Design & visual check:

The Circuit Breaker shall be checked to verify its compliance with this Specification. In particular following items shall be checked:

- (i) Verification of dimension of equipment and assembly as per drawings approved by RDSO.
- (ii) Verification of operation under local and remote.
- (iii) Verification of clearances as per approved drawing.
- (iv) Visual check of Quality of painting / galvanizing of cubicles and mounting structure.
- (v) Cubical shall be dust and vermin proof conforming to IP 55 of IEC: 60529-2001/IS: 13947(Part-1) 1993 or latest. **(The report of the IP: 55 conducted during type test is to be**

provided).

- (vi) Fasteners used in various assembly shall be of Stainless Steel for 12 mm dia or below and those above 12 mm may be hot dip galvanized or Stainless Steel.
- (vii) Verification of behavior of Circuit Breaker Operation as under:

Position of Switch	Electrical Command	Circuit Breaker Operation
Local	Local	CB should operate
Local	Remote	CB should not operate
Remote	Local	CB should not operate
Remote	Remote	CB should operate

- (viii) Verification of manual opening operation.
- (ix) Verification of rated operating sequence
- (x) Verification of Interlocking.
The Circuit Breaker should not close either on remote or on local (Mechanical or Electrical) if key of the Interlocking key is removed From the Circuit Breaker Operating Mechanism.
- (xi) Verification of emergency device for opening of Circuit Breaker in the event of failure as per clause 5.1.2.4.
- (xii) Measurement of spring charging time.
- (xiii) Measurement of current drawn by the motor.
- (xiv) Verification of function of tripping device in the event of 110 V DC Supply failure or DC Voltage dropping below 85 V \pm 3 V in CTD of Circuit Breaker.
- (xv) Verification of function of anti- pumping device.
- (xvi) Measurement of resistance of operating coils.
- (xvii) Verification of SF6 gas alarm and Lock out setting.
- (xviii) Verification of wiring and numbering of cables.
- (xix) Verification of signal positions for close/ trip and spring Charged/ spring discharged.
- (xx) Verification of make, type designation and rating of Parts/ Components.
- (xxi) Verification of name plate details.
- (xxii) Verification of Test Certificates of Parts/Components used.
- (xxiii) Verification of tightness of sealed SF6 gas pressure System to ensure there is no leakage.
- (xxiv) Checking of proper fixing and support of springs, gas pipes, relays, gauges and tripping/ closing coils.
- (xxv) Checking of free movement of armature of opening and closing coils.
- (xxvi) Checking of valve and pipe coupling.

11. The Vendor shall submit Clause wise compliance of this specification with his offer. A separate deviation statement shall be attached in case any deviation observed by the tenderer Vendor with the detailed remarks/justification. If either the statements of the compliance or statements of deviation are not attached with the offer, it is not likely to be considered. For the reason that it is an incomplete offer which cannot be properly evaluated and compare with other offers if any. If there are no deviations, a "NIL" statement shall be attached.
12. Following drawings/ documents to be furnished along with the tender:
 - (i) Full dimensioned General Arrangement drawing indicating clearances, fixing arrangement of the mounting structure on the Foundation.
 - (ii) Schematic drawing.
 - (iii) QAP for the equipment.
 - (iv) ISO certification.
 - (v) List of essential plant, machinery and testing facilities.
 - (vi) Type Test report for relevant rating as per RDSO/IS/IEC Specification.
 - (vii) List of supplies and performance reports for the tendered equipment from user railway/ other customer.
 - (viii) Information furnished in the Schedule of Guaranteed Technical Performance, data and other particulars (Annexure A & B) shall be complete in all respects. If there is any entry like "shall be furnished later" or blanks are left against any item, the tender is not likely to be considered as such omissions cause delays in finalizing the tender.
13. Technical data and drawing to be furnished by Vendor/ Manufacturer.
 - 13.1. Details of the important parts and sub-assemblies listed at Annexure B shall be furnished by the Vendor/ Manufacturer to RDSO after award of contract.
 - 13.2. The Vendor shall submit the following details/ dimensioned drawings as per Indian Railways Standard in sizes of 210mm x 297mm or any integral multiples thereof for approval.
 - (i) Name / rating plate both English and Hindi.
 - (ii) General assembly showing mounting arrangement, overall dimensions and bill of materials as per SOGP.
 - (iii) Schematic and wiring diagram with explanation sheet.
 - (iv) Cross-section of interrupting chamber indicating the arcing/main contacts and nozzle (s) or of the vacuum bottle a case may be.
 - (v) Details of main, fixed and moving contacts and arcing contacts.
 - (vi) Operating and coupling mechanism of complete Circuit Breaker along with schematic diagram showing the linkages with explanation sheet.
 - (vii) Detailed drawings for springs for closing and opening.
 - (viii) SF₆ gas circuit showing location of all gauges, pressure switches, feed port, valves, interrupting chamber, piping coupling etc with

explanation sheet.

- (ix) Full details of all sealing points with details of O rings and Gaskets.
 - (x) Details of Terminal Connector.
 - (xi) Details of porcelain hollow insulators for support and Interrupting chamber.
 - (xii) Plain mass concrete foundation drawing and design calculations.
 - (xiii) Design calculation for structural safety along with the details of supporting structure.
 - (xiv) Erection, commissioning, operation and maintenance manual.
 - (xv) Details of main parts/sub assembly as per Annexure B.
 - (xvi) Any other drawing considered necessary by the ~~successful tender~~ Vendor/ Manufacturer and / or Purchaser.
- 13.3. Numbering of drawings shall be so structured as to give information about total number of drawings , data sheets/ instructions sheets relating to the contract for example a drawing designated as "D307 [4-12] sheet 2 of 5" denotes that:
- (i) D 307 is the drawing number – the choice of which is left to the Vendor.
 - (ii) It is the 4th drawing out of a total set of 12 drawings / Data sheet for the contract.
 - (iii) It is the 2nd sheet out of total 5 sheets.
- 13.4. Cross reference of identical drawing if approved for earlier contract shall be given in the drawing information required during commissioning and maintenance of equipment shall be shown in greater detail.
- 13.5. After approval, six copies of approved drawings along with 2 set of reproducible prints shall be supplied to each consignee. One sets of approved drawings of hard copies, shall be sent to RDSO for record.
- 13.6. Five copies of the approved erection, commissioning, operation and maintenance manual shall be supplied to each consignee, in case order is more than 10 nos. In case order is less than 10 nos two copies of manual shall be supplied. Two copies of manuals shall be supplied to the Purchaser/DG (TI), RDSO, Lucknow (India) for record.
- 13.7. Drawings approved by RDSO after prototype approval shall be submitted for the future contracts with a clear certification on the drawing that design, process and material have not been changed in the design of the subject equipment from the prototype already approved by RDSO.

14. Erection, Testing and commissioning

The Circuit Breaker shall be erected and commissioned by the Purchaser /Manufacturer. However, in case a defect/deficiency is noticed, the Manufacturer/ Vendor will have to depute his engineer for necessary remedial action without any cost to the Railways. In all the cases in which an order is placed either on new Manufacturer or for a new type/ design of the Circuit Breaker, services of Manufacturer's engineer shall be made available during the erection and proving/pre commissioning Test for the first order of their

Circuit Breaker free of cost. For this purpose, prior intimation regarding the date and location shall be given by the Purchaser to the Vendor/Manufacturer.

15. Spares

- 15.1. The Vendor shall furnish along with his offer, a list of spares (with cost) recommended by him for maintenance of Circuit Breaker for a period of 10 years. The list should include gaskets/ O rings, parts which are likely to wear and items requiring replacement/ replenishment, besides other items recommended by the Manufacturer. The Vendor shall give an undertaking to the effect that he shall supply the required spares for the total life of the equipment (i.e. 25 years approx.)
- 15.2. The Vendor shall furnish along with his offer, the cost of gas filling arrangement, evacuation plant for SF₆ gas and cost of SF₆ in 10 kg cylinder.

16. Training of Indian Railway's Engineers

The offer shall include the training of two engineers of the Indian Railways free of cost at the manufacture's works in India or abroad and at the maintenance depots/ workshops on a railway System or other public utility where Circuit Breakers of similar/ identical design are in operation. The total duration of training for each engineer shall be two weeks of which approximately one week will be at Manufacturer's works and one week on a railway system or other public utility. If the country of Manufacturer is not India, the cost to travel to that country and back will be borne by the Indian Railways. Other details shall be settled at the time of finalizing the contract/ Purchase order.

17. After sales - service

- 17.1. The Vendor shall make necessary arrangements for closely monitoring the performance of the Circuit Breaker through periodical (preferably once in two months during warranty period) visit to the locations where they are erected for observations and interactions with operating and maintenance personnel of Indian Railways. Arrangements shall also be made by the Vendor/ Manufacturer for emergency/ stand by spare parts being kept readily available. To meet exigencies warranting replacements so as to keep the Circuit Breaker in service with listed on time.
- 17.2. Vendor/ Manufacturer shall respond promptly to any call given by Indian Railway for any assistance by way of attending to failures, investigations into the causes of failures including the Tests, if any, to be done and such other items with a view to see that the Circuit Breaker serves for the purpose for which it is procured. Besides, technical guidance to ensure proper operation and maintenance of the Circuit Breaker shall be constantly rendered.

18. Packing and dispatch

- 18.1. The various components of each Circuit Breaker shall be securely packed in wooden crates/ boxes. General packing list, together with weight and overall dimensions of each packing case shall be furnished to purchaser for each Circuit Breaker indicating the following.

Crate/ Box No.	Description of item/ component in the crate/ box	Gross weight in kg	Approximate outside dimensions

- 18.2. In case of overseas supplies, packing shall be sea worthy.
- 18.3. Necessary instructions for handling and storage shall also be furnished for use at receiving end.
- 18.4. Porcelain ~~housing/ support~~ insulator poles shall be supplied securely packed in wooden crates/~~boxes~~. Not more than ~~two~~ three porcelain ~~housing/ support~~ insulators poles shall be packed in a crate/~~box~~ in order to facilitate manual loading and unloading.

FINAL DRAFT

Annexure "A"

Schedule of Guaranteed Performance Technical and other particulars for 55kV, 66kV, 100kV, 110kV, 132kV, 220kV, Outdoor type, Double Pole/Triple Pole SF₆ Gas Circuit Breakers, guaranteed particulars are to be established by Test reports/ actual Tests.

S.No.	Description	Unit	Values to be supplied by Vendor
1.	Maker's Name		
2.	Country of Manufacture		
3.	Manufacturer's type Designation & Operating Mechanism		
A.	Rating		
4.	Number of poles	No.	
5.	Rated voltage	kV	
6.	Voltage rating class as per standard	kV	
7.	Rated normal current	A	
8.	Rated frequency	Hz	
9.	Rated insulation level of the Circuit Breaker		
	(i) One minute dry and wet power frequency withstand voltage	kV (rms)	
	(ii) Switching surge withstand voltage	kV (p)	
	(iii) Standard lightning impulse withstand voltage 1.2/ 50 μs waveform (full wave)	kV (p)	
	(iv) Corona extinction voltage	kV (rms)	
10.	Rated short circuit breaking current		
	(i) Symmetrical at a recovery voltage of not less than the highest system voltage	kA	
	(ii) Asymmetrical at a recovery voltage of not less than the highest system voltage	kA	
	(iii) Breaking capacity (symmetrical)	MVA	
11.	Rated making current	kA peak	
12.	Rated line charging breaking current	A	
13.	Rated cable charging breaking current	A	
14.	Rated small inductive breaking current	A	
15.	Rated capacitor bank breaking current	A	
16.	Rated short time current		
	(i) for 1 s	kA	
	(ii) for 3 s	kA	
17.	Rated operating sequence		
18.	Rated transient recovery voltage	kV	

19.	Breaking current on out of phase condition	kA (rms)	
B	CONSTRUCTIONAL FEATURES		
20.	Number of breaks per pole		
21.	Total length of break per pole	mm	
22.	Contact travel characteristics(P1,P2,P3) (i) Closing speed & Time (ii) Opening speed & Time (iii) Contact bounce (iv) Bounce duration (Please furnish a graph showing contact travel characteristics)	m/s & ms m/s & ms mm (max) s (max)	
23.	Type of main contacts		
24.	Type of arcing contacts		
25.	SF ₆ Gas pressure (i) Normal (ii) Minimum (iii) Maximum	kg/cm ² kg/cm ² kg/cm ²	
26.	SF ₆ Gas pressure at alarm	kg/cm ²	
27.	SF ₆ Gas pressure at Trip and Lock out	kg/cm ²	
28.	SF ₆ gas leakage rate (by weight) per Year	%	
29.	(i) If absorbent for decomposed SF ₆ gas product provided (ii) Minimum quantity of absorbent per pole	Yes/ No Kg	
30.	Net weight of SF ₆ gas per pole/ Circuit Breaker	Kg	
31.	Weight of pole assembly (i) Per pole (ii) Per Circuit Breaker	kg kg	
32.	Weight of Operating Mechanism	Kg	
33.	Total weight of Circuit Breaker	kg	
34.	Minimum electrical clearance (i) between poles (ii) between live part and earth	mm mm	
35.	Minimum sectional clearance between lowest live part and any part where a person may stand.	mm	
36.	Minimum height of bottom most part of any insulator from ground level.	mm	
37.	Distance between centers of pole for TP & DP Circuit Breaker.	mm	
38.	Overall dimensions of the Circuit Breaker complete with insulators, operating mechanism cubicle etc. mounted on the supporting structure. (i) Length (ii) Width (iii) Height	mm mm mm	

	(Please furnish the General Arrangement drawing with overall dimension)		
C.	OPERATING PARTICULARS		
39.	Closing time from the instant of closing coil energisation (max)	ms	
40.	Opening time from the instant of trip coil energisation (max)	ms	
41.	Make Time (max)	ms	
42.	Arcing Time (i) At rated normal current (ii) At rated short circuit breaking current (iii) At 60% of short circuit breaking current (iv) At 30% of short circuit breaking current (v) At 10% of short circuit breaking current	ms ms ms ms ms	
43.	Total break time from the instance of trip coil energisation to the final extinction of arc (i) At rated normal current (ii) At short circuit breaking current	ms ms	
44.	Rated restriking voltage (i) Amplitude factor (ii) Rate of rise at natural frequency (iii) Type and device used to limit rate of rise of re-striking voltage	kV	
45.	Minimum time interval (t) permissible between successive "CO" operations after first auto reclosures.	s	
46.	Number of operations (close and open) the Circuit Breaker can perform with the available stored energy		
47.	Number of operations permissible without change of SF ₆ gas (i) At 50% of rated current (ii) At 100% of rated current (iii) At 50% of Short circuit breaking current. (iv) At 100% of short circuit breaking current.		
48.	Number of operations permissible without replacement/ inspection of contacts (min) (i) At 50% of rated current (ii) At 100% of rated current (iii) At 50% of short circuit breaking current (iv) At 100% of short circuit breaking current		
49.	First pole to clear factor		

D	OTHER TECHNICAL PARTICULARS		
50.	Maximum rise at temperature over an ambient of 50°C when carrying its normal rated current continuously (i) Main contacts in SF6 (ii) Terminal when connected with external connectors (iii) Metal parts arcing as springs (iv) Metal parts in contact with insulators (v) Auxiliary contacts (vi) Operating coils	 °C °C °C °C °C °C	
51.	Power required for tripping / closing (max)	watts	
52.	Control circuit voltage with permissible voltage variation Closing coil Tripping coil Contactors (if any) Any other item (for which the tenderer feels that the voltage is to be maintained within certain limits)	 V dc ± % V dc ± % V dc ± % V dc ± %	
53.	Type of tripping / closing mechanism		
54.	Manual tripping (lever push button or any other device)		
55.	Spring charging motor (i) Make and type designation (ii) Rating (iii) Voltage with permissible variation (iv) Power frequency withstand voltage (v) Class of insulation (vi) Time required by the motor to charge the spring(s) fully (vii) Power required at normal controlled voltage to charge the spring (viii) Mode of protection (ix) Specification of design and Testing	 kW V kV (rms) s watts IS/ IEC	
56.	Springs- Closing / Opening (i) No. of springs (ii) Type (Compression/tension) (iii) Specification of Testing and design	 IS/IEC	
57.	Porcelain Insulators (i) Support Insulator (a) Makers name and type designation (b) Minimum creep age distance (ii) Interrupting Chamber Insulator (a) Makers name and type designation (b) Minimum creep age distance		
58.	Insulation grade of PVC control wiring cable.	V	

59.	Approximate height of close/trip switch and socket for spring charging from ground level.		
60.	Details of Operation counter: (i) Make and type (ii) No. of digits		
61.	Auxiliary Switch (contacts) (i) Make and type (ii) Normally open contacts (iii) Normally close contacts (iv) Continuous ratings of contacts (v) Breaking capacity of contacts at 220V dc with inductive load (vi) Life (No. of operations)	Total Spare Total Spare A A No.	
62.	Limit switch (for spring charging motors) (i) Make and type (ii) Continuous ratings of contacts (iii) Breaking capacity of contacts at 220V dc with inductive load (iv) Life (No. of operations)	A A No	
63.	Gas pressure indicator and pressure switch (i) Make and type designation (ii) Range and list count (iii) Governing Specification		
64.	Sulphur Hexa Fluoride gas (SF ₆) Governing Specification	IS/IEC	
E	OTHER DETAILS		
65.	Is the Circuit Breaker having a common operating mechanism /operated through individual operating mechanism?	Yes/No	
66.	Are the main and arcing contacts easily replaceable?	Yes/No	
67.	Is signal provided (audible/visible) in the event of drop of SF ₆ gas to a pre- determined value?	Yes/No	
68.	Is a device for tripping the Circuit Breaker, in the event of 85V ±dc supply failure, provided? (Indicate the type of the device and also furnish Scheme)		
69.	Does provision of trip circuit supervision exist?	Yes/No	
70.	Is electrical anti-pumping device provided?	Yes/No	
71.	Is local electrical closing & tripping device provided?	Yes/No	
72.	Is Terminal connector of CB provided?	Yes/No	
73.	Is mechanical tripping device provided?	Yes/No	
74.	Is handle/crank for manual charging of the closing spring provided?	Yes/No	
75.	Is operating counter visible without opening the mechanism door?	Yes/No	
76.	Is the close and open indicator provided?	Yes/No	
77.	Is two positions LOCAL/REMOTE switch provided? Indicate type-Stay put type or any other	Yes/No	
78.	Are electrical and mechanical Interlocks with keys provided?	Yes/No	

79.	Is the cubical box is dust, weather, vermin proof of minimum 2 mm thick sheet steel construction? (indicate the Class of Protection and relevant Specification i.e. IS/IEC)	Yes/No	
80.	Is a heater provided to prevent condensation in the box?	Yes/No	
81.	Is three pin socket and inspection lamp provided?	Yes/No	
82.	The size and number of cable glands provided.	Dia No Dia No	
83.	What is the insulation grade of PVC cable used?	V	
84.	Are the cables terminated with crimped lugs?	Yes/No	
85.	Is ac and dc +ve & -ve wiring completely segregated?	Yes/No	
86.	Are the Terminal blocks for wiring dust proof and provided with unbreakable transparent shrouds?	Yes/No	
87.	Are the two distinct earthing provided with indication for earth? (i) Support structure (ii) Operating Mechanism Cubicle	Yes/No Yes/No	
88.	Are fasteners of 12 mm dia and less exposed to atmosphere of Stainless Steel?	Yes/No	
89.	Are fasteners of more than 12 mm dia of Stainless Steel or mild steel hot dip galvanized?	Yes/No	
90.	If supervision for erection Testing and commissioning is provided?	Yes/No	
91.	If training of two IR engineers are arranged for a total period of 2 weeks?	Yes/No	
92.	Has list of spares been furnished?	Yes/No	
93.	Has list of special maintenance tools furnished?	Yes/No	
94.	Has erection operation and maintenance manual furnished?	Yes/No	
95.	Have closing/tripping springs properly fixed to prevent their misalignment?	Yes/No	
96.	If any deviations asked? Give number of clauses where deviation has been asked for.	Clause No.	
97.	If painting of steel surfaces exposed to weather done to RDSO's Specifications as per Clause 8.2?	Yes/No	
98.	If the support structure are hot dip galvanized?	Yes/No	
99.	Quantity of zinc for galvanization	Kg/m ²	

Annexure- "B"

The following information shall be furnished by the Manufacturer/ supplier.

Sl. No.	Description	Unit of measurement
1.	Fixed main contact (i) Description and type Designation (ii) Make (iii) Identification mark (iv) Item drawing No. (v)Material Specification No.	
2.	Moving main contact (i) Description and type Designation (ii) Make (iii)Identification mark (iv)Item drawing No. (v)Material Specification No.	
3.	Fixed arcing contact (i) Description and type Designation (ii) Make (iii)Identification mark (iv)Item drawing No. (v)Material Specification No.	
4.	Moving arcing contact (i) Description and type Designation (ii) Make (iii)Identification mark (iv)Item drawing No. (v)Material Specification No.	
5.	Nozzle- Main and Auxiliary (if any) (i) Description and type Designation (ii) Make (iii)Identification mark (iv)Item drawing No. (v)Material Specification No	
6.	Auxiliary contact (i) Description and type Designation (ii) Make (iii)Identification mark (iv)Item drawing No. (v) Governing Specification No. (vi)Rating (a) Voltage (b)Continuous Current (c)Breaking and making Current (d)Electrical & life (No. of operations)	
7.	Motor limit switch (i)Description and type (ii)Type designation (iii)Make (iv)Identification mark (v) Governing Specification No. (vi)Rating (a) Voltage (b) Continuous Current (c) Breaking and making Current (d) Electrical & life(No. of operations)	

8.	MCB"s (i)Description and type (ii)Type designation (iii)Make (iv)Identification mark (v) Governing Specification No. (vi) Rating (a) Voltage (b) Continuous Current (c) Breaking and making Current (d) Electrical & life(No. of operations)	
9.	Spring charging motor (i)Description and type (ii)Type designation (iii)Make (iv)Identification mark (v) Governing Specification No. (vi)Rating (a) Voltage(with permissible variation) (b) Wattage (c) Power frequency voltage withstand (d) Class of insulation (e) Time required by the motor to charge the spring fully(max) (f) Power required at normal control voltage to charge the spring (g) Mode of operation	
10.	Spring Closing Tripping Other (i)Description and type (ii)Type designation (iii)Make (iv)Identification mark (v)Governing Specification No. (vi)Drawing No. (vii) Rating (a) No. of springs (b) Type(compression/ tension/spiral) (c) No. of turns (d) Gauge (e) External diameter (f) Stiffness (g) Material (h) Force developed in fully charged position	
11.	Operating coil Closing Tripping (i)Description and type (ii)Type designation (iii)Make (iv)Identification mark (v)Governing Specification No. (vi)Rating (a) Operating voltage (with permissible variation) (b) Power (c) Resistance at 20° C (d) Class of insulation	

12.	<p>Operation counter</p> <p>(i)Description and type (ii)Type designation (iii)Make (iv)Identification mark (v) Governing Specification No. (vi) No. of digits</p>			
13.	<p>Gas Pressure indication and Pressure switch</p> <table border="0" style="width: 100%;"> <tr> <td style="width: 50%;"></td> <td style="width: 25%; text-align: center;">Pressure indication</td> <td style="width: 25%; text-align: center;">Pressure switch</td> </tr> </table> <p>(i) Description and type (ii) Type designation (ii) Make (iv) Identification mark (v) Governing Specification No (vi) Range and least count</p>		Pressure indication	Pressure switch
	Pressure indication	Pressure switch		
14.	<p>Heater</p> <p>(i)Description and type (ii)Type designation (iii)Make (iv)Identification mark (v)Governing Specification No (vi)Rating (a) Voltage (b) Power (vii) Make and type designation of thermostat (if used)</p>			
15.	<p>Interlock</p> <p>(i)Description and type (ii)Type designation (iii)Make (iv) Identification mark (v) Governing Specification No (vi) Electrical rating of switch used</p>			
16.	<p>Terminal connector</p> <p>(i)Description and type (ii)Type designation (iii)Make (iv)Identification mark (v) Governing Specification No (vi)Rating (a) Voltage (b) Current</p>			
17.	<p>Registers</p> <p>(i)Description and type (ii)Type designation (iii)Make (iv)Identification mark (v) Governing Specification No (vi) Rating: (a) Voltage (b) Current/Power</p>			

18.	<p>Relays and contactors(please furnish details for all the types of relays/ contactors used)</p> <p>(i)Description and type (ii)Type designation (iii)Make (iv)Identification mark (v)Governing Specification No (vi)Rating: (a) Operating voltage range (b) Pick up voltage (c) Drop out voltage (d) Burden (e) Auxiliary contact rating (f) Guaranteed life 1. Electrical 2. Mechanical (g) Wiring details (drawing No.)</p>	
19.	<p>"O" Ring and Gasket (please furnish details for all the varieties)</p> <p>(i) Description and make (ii) Dimension/ drawing No. (iii) Material and Specification</p>	
20.	<p>Valves and coupling</p> <p>(i) Description and make (ii) Type designation (iii) Governing Specification</p>	
21.	<p>Shock absorber</p> <p>(i) Description and type (ii) Type designation (iii) Identification mark (iv) Governing Specification (v) Type brand and Specification of fluid used (if any)</p>	

Annexure-C

SER. NO.	DESCRIPTION	PART NO.	MATERIAL	SPECIFICATION	QTY	UNIT
1	CONNECTOR BODY	11031	AL ALLOY	IS 10135 R600-6000	1	PC
2	CLAMPING PIPE	11032	CS	IS 10135	1	PC
3	M 16 X 1.5 LONG BOLT WITH NUT & 2 NOS. WASHERS		STAINLESS STEEL	IS 10135 R600-6000	4	PCS
4	M 16 X 1.5 LONG BOLT WITH NUT & 2 NOS. WASHERS		CS	IS 10135	4	PCS
5	2MM THICK BIMETALLIC STRIP		AL CU		1	PC
6	SPRINGS HARDEN		PA BRONZE	IS 2013	2	PCS

NOTES:-
 1. ALL DIMENSIONS ARE IN MM UNLESS SPECIFIED.
 2. ALL HOLES FOR 12 DIA BOLT SHALL BE 18X10MM DIA.
 3. TERMINAL SECTION IS PERMISSIBLE ON ALL CONNECTIONS UNLESS OTHERWISE SHOWN.
 4. PART NO. AND MANUFACTURER'S NAME IS TO BE SHOWN IN ALL DIMENSIONS SPECIFICATIONS.
 5. THE CONNECTOR SHALL CONFORM TO IS 10135-10135.
 6. THE CONNECTOR SHALL BE MANUFACTURED SEPARATELY BY THE COUNTRY PROCESS AS PER IS 10135-10135.
 7. THE CONNECTOR SHALL BE FREE FROM USUAL CORROSION UPON EXPOSURE TO AIR POLLUTION.
 8. ALL SHARP CORNERS SHALL BE ROUNDED OFF.
 9. THE ARRANGEMENT DRWG FOR CU TERMINAL PAD OF EQUIPMENT FOR ALL TYPES SHALL BE BIMETAL (REF NO. 5) ON THE PAD USE SHALL BE PERMITTED.
 10. MACHINED SURFACES SHOWN THIS WAY.

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220KV SYSTEM BIMETALLIC TERMINAL CONNECTOR TO SUIT
 ZEBRA 28580 ACSR CONDR. & ALICU PAD OF INSULATOR/CT/CB

DATE: 10/10/2021
 DRAWN BY: R. D. S. O.
 CHECKED BY: ETI/PSI/P/11030
 SCALE: INT.S.

FINAL