Islamic Republic of Iran
Vice Presidency for Strategic Planning and Supervision

General Technical Specification and Execution Procedures for Transmission and Subtransmission Networks Circuit Breakers

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Description **PAGE**

Technical Specification of Busbar and Conductors

1- SCOPE

This specification covers the requirement for the design, manufacturing, factory testing, marking packing, Transportation, storage, installation and commissioning tests of SF_6 Circuit breakers in 63 to 400 kV power systems.

Circuit breakers shall be deigned, manufactured and tested according to the requirements of the latest edition of the following standards. All amendments, supplements and reference publications of the mentioned standards shall also be applied.

- IEC 62271-100: High voltage alternating current circuit breaker
- IEC 60694: Common clauses for high voltages switchgear and control gear standards
- IEC 62271: 308: Out of phase testing of high voltage circuit breaker
- IEC 60427: Synthetic testing for high voltage circuit breaker.
- IEC 61634: Specification and acceptance of new sulphur hexafluoride.
- IEC 61166: Seismic qualification guide for high voltage circuit breaker.
- IEC 61233: High voltage alternating current circuit breaker inductive load switching
- ISO 1461: Metallic coating – hot dip galvanized coating on fabricated ferrous products requirements

Circuit breakers shall be as specified in schedule CB (I) and be suitable at the specified environmental conditions.

2- GENERAL REQUIREMENTS:

Circuit breaker operation shall be essentially restrict free.

Circuit breaker shall be complete with operating mechanism, linkage and wiring between poles, and mechanism, and all other necessary accessories.

Circuit breaker shall be capable of interrupting maximum design voltage and at any kind of load, any power factor with any percentage of magnitude (from zero up to 100%) of continuous current rating.

Circuit breaker shall be capable of completely interrupting 50 Hz, single and three phase fault at rated voltage of any type from zero to 100% of the specified interrupting rating and specified time.

Circuit breaker for 400 kV if specified shall be equipped with closing resistor with 400-600 ohms and the duration should be minimum 8 mille seconds, prior to main contact closing. Switch sync can also be used instead of closing resistor. For selecting a proper switch sync, type and the degree of compensation of transmission line and also single / three pole operation of circuit breaker should be considered.

Circuit breaker shall be electrically and mechanically trip – free and it shall be provided with an anti – pumping device.
Circuit breaker line terminals shall be parallel to the breaker.
The autorecloser time shall be adjustable form a minimum value to be specified by the manufacturer up to a maximum value of 50 cycles.

3- DESIGN AND CONSTRUCTION

3.1 General

Design, construction and assembly of the circuit breaker shall be of a design to facilitate operation, and ease of inspection and maintenance. It shall be possible to assemble and dismantle the circuit breaker with minimum amount of special tools. Lugs shall be provision at suitable location for lifting each pole and various unit assemblies. Provided shall be made for removing the interrupting chamber and contacts without removing other parts of the circuit breaker.
The frames or bases shall be fabricated of hot-dipped galvanized structural steel. Bolts, nuts, washers, steel shapes, plates, etc. shall be galvanized in accordance with the requirements of ISO 1461 of equivalent standards.
The design and construction of the contacts and of any arc control devices and details of any device (i.e.garding capacitor) incorporated in the circuit breaker to limit or control the rate of rise of restricting voltage across the circuit breaker contacts or to divide the voltage between the contacts shall be submitted.
Within a pole the difference between individual break units shall be maximum 2 ms for breaking and 2 ms for closing. Maximum time between poles for opening and closing shall be 2 and 5 ms respectively.
The main contacts shall be designed to have adequate thermal and current carrying capacity for the duty specified. The contacts shall have long life so that frequent replacement will be unnecessary.
The circuit breaker contacts shall have ample area and contacts pressure and shall be deigned to have adequate thermal and current carrying capacities for carrying the rated continuous current and rated short time current of the breaker without exceeding the allowable temperature rise as specified. Contact material shall be copper or copper alloy with high conductivity. If connections are made of aluminum, it shall be bimetallic. The surfaces of main contacts shall be faced with suitable conductive material for reduction of surface resistance (silver faces). Arcing contacts shall be faced with suitable arc resistance materials (tungsten alloy ripping).
The main contacts shall be capable of interrupting any current from zero to its rated interrupting value when used on resistive, inductive or line charging circuits.
The contacts shall be equipped with modern and effective arc extinguishing devices and shall be designed for ease of replacement.

Main contacts shall be the first to open and the last to close so that will be little contacts burning and wear damaging. Arcing contacts shall be easily accessible for inspection and replacement.

If multibreak interrupters are used, they shall be so designed that a fairly uniform voltage distribution is developed across them.

Each unit assembly shall be provided with two grounding pads located on opposite sides. Each grounding connection shall include a clamp type terminal connector attached to the pad with not less than two bolts.

The entire circuit breaker assembly shall be designed and constructed so as to safety withstand the short circuit and operating stresses which may be imposed upon it.

Each circuit breaker shall be provided with either a frame or unit base mounting for all three poles or individual bases or frames for each pole.

The mounting structures for individual pole units shall have their bases at the same elevation.

The circuit breaker shall be equipped with porcelain insulators, enclosures and supports, as appropriate. All insulators enclosures and supports of same ratings shall be interchangeable. All porcelain used shall be manufactured by the wet process and shall be homogeneous, free from laminations, cavities or other flaws affecting its mechanical strength or dielectric quality and shall be impervious to moisture.

All portions of assembled porcelain insulators enclosures and supports including gaskets, which may in any way be exposed to the atmosphere, shall be composed of completely non-hygroscopic material, such as metal or glazed porcelain, and approved rubber – like or plastic materials for gaskets.

All porcelain bushings and enclosures shall be so designed that there will be no stressing of any parts due to temperature changes and adequate means shall be provided to accommodate the expansion of current carrying parts and conductors .

All shall be free from objectionable radio interference and free from external and internal corona.

The porcelain bushing assembly shall be gas tight.

Circuit breaker units shall be designed to be lifted by mechanical devices so that insulators are not under stress during lifting.

External parts of circuit breaker shall be of porcelain and suitable for type of pollution specified.

Internal parts of the circuit breaker normally under continuous stress shall be of resin materials, impregnated glass fiber cloth or other suitable shall be submitted to engineer.

The circuit breaker shall be mechanically dimensioned for terminal load, and following stresses:

- Inner pressure due to SF_6 gas
- Impact load due to operation

The circuit breaker shall function correctly under the combination of action of above forces.
The circuit breaker design shall be such as to reduce the mechanical shocks to a minimum during operation in order to prevent inadvertent operation due to vibration or other reasons.
All the auxiliaries for the circuit breaker as heaters, motors, lights, etc, shall be suitable for operation at 50 Hz, and specified ac supply. The manufacturer shall furnish one MCB for each individual load circuit as appropriate.
All ac auxiliaries shall operate satisfactorily in the range of 85% to 110% of the rated voltage and 90% to 105% of the rated frequency.
SF6 circuit breaker shall be of the single low – pressure puffer type or thermal – blast (auto puffer) type.
Circuit breaker shall be designed so as to ensure that the rate of gas leakage is maintained at an absolute minimum and that the moisture content of the SF6 gas is maintained sufficiently low so as to avoid condensation forming on the internal insulating surfaces of the circuit breaker.
Gas density in the SF6 circuit breaker shall at all times be not less than the density which is required for dielectric voltage.
Proper gas density monitoring equipment (dial type is preferred) shall be provide with minimum four stages for 230 kV, 400 kV CBs and two stages for 63 kV , 132 kV. CBs. Alarms of operation locking shall be provided for remote indicating.
Sufficient SF6 gas shall be provided to fill the circuit breakers supplied plus and additional 20 percent of the total quantity for future usage.
The SF6 gas shall comply with IEC 61634 and be suitable in all respects for use in the switchgear when it is operated under conditions specified.
Material used in the construction of circuit breakers shall be such as to be fully compatible with SF6 gas.
Circuit breaker shall be so designed that conditioning air or heaters are not required to maintain a satisfactory level of internal insulation.
An adequate means of filtering the SF6 gas shall be provided so as to remove all products and other contaminates such as moisture from gas.
Facilities shall be provided to reduce the gas pressure within the circuit breaker to a value not exceeding 8 mbar. The time to achieve this degree of vacuum shall be a minimum and shall not exceed 4 hours. Each circuit breaker shall be capable of withstanding this degree of vacuum without distortion or failure of any part.
Filters, drains, gauges, valves, piping, moisture control equipment etc, shall be provided.
The gas system shall be of the type in which the gas is reused after filtering and reconditioning.
Provisions shall be made to ensure that the SF6 gas remains in its gaseous state when the circuit breaker operating at the minimum temperature as specified.
The circuit breaker shall have a well proved sealing system and the leakage of gas shall be less than 1% per year under all operating conditions.

3.2. Operating Mechanism

Type of operating mechanism shall be as specified.

The operating mechanism shall be maintenance free at least for 5 years. Some lubrication is accepted. The need for lubrication with grease or oil shall be as small as possible. A corrosion protection treatment carried out before delivery shall not require removal and replacement by an other treatment at commissioning.

Manual closing shall be possible for maintenance works.

The operating mechanism shall be provided with a counter for counting at least 9999 CO – cycles.

The manufacturer shall specify the maximum force (restoring force) the operating mechanism can produce. The design of support shall be done based on this information.

The operating mechanism and the circuit breaker poles shall be provided with mechanical position indicator. The indicator shall be mechanically operated and be labeled open and closed with black color on the green and red color basis respectively.

The different parts of the operating mechanism shall be designed and manufactured for possible operating forces without damage in the mechanism.

The operating mechanism shall be provided with two independent trip coils per pole, and all necessary circuits, each circuit shall be capable of operating normally with or without any voltage on the other circuit. These trip coils shall not have common flux parts and shall not be connected in series and shall operate simultaneously and shall be arranged such that a failure of either coil will not jeopardize the operation of the other coil.

Each trip coil shall be suitable for supervision by a lamp or relay which are in series with the trip coils.

A mechanism designed for rapid reclose may have a coil for this function (the coil may not have a back –up).

Due to quick action of the circuit breaker, the coils ought to be designed for quick action. The power consumption shall be low. The manufacturer shall specify the magnitude and duration of the impulses required for operating the circuit breaker.

All electrical devices shall operate satisfactorily within specified the voltage limits, and ambient temperature range.

The trip coils shall have a correct function between 70% and 110% of rated voltage and closing coil between 85% and 110% of specified ac voltage. If the mechanism has heaters to assure safe function at low temperatures, these must be intact.

Each pole of circuit breaker shall have a mechanically independent operating mechanism and shall be designed to permit either single pole or three poles tripping and closing.

All circuit breakers shall be provided with means to prevent contact pumping while the closing circuit remains energized. This arrangement shall not involve paralleling of the trip and close circuits.

The following facilities shall be provided at each circuit breaker local control point:

- local / remote/disconnect selector switch. The selection of "local" operation shall inhibit the closure of the breaker from any remote source including the protection scheme, with a contact for alarming this situation.
- open /neutral / close control switch
- Emergency trip device, suitable for operation in event of failure of electrical supplies. The device shall be distinctively labeled and protected against inadvertent operation.

Provisions shall be made for remote indication of the following operations by using a pair of NC and NO voltage free contacts:

- circuit breaker opened
- circuit breaker closed
- circuit breaker tripped
- failure to complete closing operation for each phase

The test voltage for the operating mechanism shall be at least 2000 V, 50Hz, 1 minute.

All the breakers shall be free to open immediately after the trip coil is energized. On simultaneous receipt of close and trip signals, the trip signal shall be predominant.

Where operating mechanism are provided for each phase of the circuit breaker they shall be electrically interconnected so as to ensure simultaneous operation of each phase when operating on three phase duty.

Under conditions of phase disagreement, namely if one or more phase fail to operate correctly, in auxiliary contacts the interlocking arrangement shall initiate a trip signal to all three phases and provided a remote alarm.

Motors shall be protected against switching over voltages caused by operating mechanism auxiliaries. The voltage amplitude shall not exceed 50% of the rms value of insulation level.

Motors, according to their specified type, shall be suitable to be supplied by ac or dc power supply.

The mechanism shall not be damaged by remaining operating impulses.

The motor and parts, shall be designed, so that the mechanism can, without sustaining damage, perform at least 10 consecutive making and breaking operations at rated voltage.

Upon the request, the mechanism shall be provided with a heater for protection against dampness and condensation and also additional heater which shall be controlled by an adjustable thermostat placed in side the mechanism.

Heaters shall have cover. Separate MCBS shall be considered for heater circuit and control circuits.

The manufacturer shall submit the power consumption of motors and all coils.

The manufacturer shall submit the making condition and trip capabilities of the end position indicating contacts and other auxiliary contacts.

End position contacts and auxiliary contact for positions indicating, as well as the contacts of the low pressure blocker and alarm device, shall have a rated making current of at least 10 A and a breaking current of at least 10 A with a current time constant of at least 40 ms.

It shall be possible to switch the circuit breaker using the operating mechanism into the open or closed positions electrically by close and trip coils either remote operation or locally by pushbuttons or similar devices working directly in the mechanism. In addition another pushbutton working with and without auxiliary voltage shall be provided for emergency trip. This pushbutton shall be accessible without opening the case of the operating mechanism but be protected with covers etc. To prevent unauthorized operation, it shall be labeled emergency close.

The operating mechanism shall have a device for ending the operation for both electrical and mechanical operation.

The operating mechanism shall have at least 24 single – pole auxiliary contacts of a reliable design in addition to the followings contacts needed for the duty of the mechanism itself:

- Two contacts which are open when circuit breaker is close and are close when circuit breaker is in intermediate position.
- One contact which is open when circuit breaker is open / close and is close when circuit breaker is in intermediate position.
- Three contacts which are close when circuit breaker is open and are open when circuit breaker is in close / intermediate position.
- Three contacts which are close when circuit breaker is close and are open when circuit breaker is in open / intermediate position.

The auxiliary contacts shall reflect the position of the circuit breaker, so that a correct indication given when the circuit breaker is completely closed, completely open or when its position is between these normal end positions.

Extra 5 NO, 5 NC auxiliary Contacts shall be provided for client use.

The operating mechanism shall be so designed that the close releases is blocked during an existing trip impulse. The mechanism shall be so designed that the trip impulse has precedence over the close impulse when the circuit breaker is in a position to transfer the current (either by touch of the contact or an arc between them).

A faultless shall be guaranteed at specified maximum and minimum ambient temperatures.

The operating mechanism shall be reliable and durable so as to function faultlessly regardless of the frequency of operation. The manufacturer shall supply the following information:

- The time interval between two consecutive maintenance periods.
- The number of operations after which maintenance is necessary.
- The total number of possible operations (the "lifetime" of the operating mechanism) if stipulated maintenance is performed.
- A description of required maintenance.

- List of parts that need to be repaired in a specific period
- List of spare parts
- List of special tools

The damping device for breaking the movement shall be so designed that damping will be unaffected even after many operations. The damping device shall not be sensitive for variations in temperature and, where constructed of hard material, be unaffected by water or oil.

Circuit breaker mechanisms and all parts requiring lubrication shall be housed in enclosures weather proofed, IP54 or IP55.

Mechanism housing shall be of minimum 2 millimeter thickness and shall have hinged inspection doors provided with necessary fittings for padlocking when closed. The doors shall be arranged to provide complete access for maintenance and removal of all equipment.

All doors and openings to each operating mechanism shall be provided with gaskets made with neoprene or other suitable material as required to render the housing weather proof when the doors or openings are closed.

The case of control mechanism housing shall be of corrosion resistant material, or of galvanized steel in accordance with standard ISO 1461.

The operating mechanism shall be provided with suitable lugs for lifting it.

For putting the documents, a pocket must be considered inside of the operating mechanism.

Internal components are considered adequately protected against corrosion if they are painted.

The roof of the housing shall project over the doors and be designed to direct water away from the opening.

Doors shall have stops for locking in open positions.

When the circuit breaker has one operating mechanism per phase, common equipment for the three phases shall be placed in a central or separate cubicle.

Housing cabinet shall be provided with a controlled door switch light and with one single phase ac convenience outlet complete with suitable MCB. It shall also be equipted with Anti pumping relay, gas supervision and interlocking relays and also fuses and switches necessary for dc control power.

Windows shall be furnished on the door for observation of the instruments.

The mechanism shall be specious and the components well located. Components, which require control, handling or adjustment and also components which must be accessible for location of faults or can be specially subject to wear, shall be ease to reach without dismantling other components. This requirement particularly applies to, coils, auxiliary contacts, relays and terminal blocks.

3-.3 Additional Requirements for Pneumatic Operating Mechanism

Pneumatic operating mechanism ought to be complete with air storage reservoir, motor driven compressor with timer, pressure relays, pressure gauge and safety valve to protect the pneumatic system and the breaker moving parts against excessive pressure. This device so arranged which dust can not make it inoperable.

The rated pressure is normal pressure specified by the manufacturer of the circuit breaker, measured at the point where distribution tube is connected to the circuit breaker.

The mechanism and the circuit breaker shall be mechanically designed to operate with a pressure of 130% of the rated pressure without damage.

The mechanism shall be provided with alarm contacts to warn for abnormal pressure in the compressed air receiver. This can be done by a pressure switch or alarm contacts at the manometer. There shall be two alarm contacts, one alarming too high pressure and one too low pressure.

The mechanism shall be provided with a manometer so placed that it can be read from the ground without opening a cover. The manometer shall be provided with a plain scale between 0 and 150% of the rated pressure of the circuit breaker. The precisions shall be at least 1% of the maximal value of the scale, between 90 and 110% of the rated pressure of the circuit breaker, in other parts 3%. The manometer shall be provided with and equalizing receiver to damp fast variations in pressure. There shall be a red marking at the manometer for pressures not permitted for the system.

An electrically operated air control valve shall be provided for admitting air to the closing cylinder by means of remote electrical control. Provisions shall be made for local control of this valve.

The reservoir shall be provided with an inspection man hole and a cock for emptying. The reservoir shall be galvanized both inside and outside.

A suitable blow off valve shall be provided on the reservoir for removing water and oil. Air coolers shall be provided as required to assure successful operation of the breaker under severe atmospheric conditions.

A manually shut – off valve shall be provided between the storage reservoir and the operating mechanism to positively prevent pneumatic operation of the breaker when the valve is closed.

The capacity of air reservoir shall be of sufficient size to close the breaker at least five times before the pressure drops to the minimum operating pressure without operation of compressor.

A tee connection with a manually operated valve shall be provided for connecting an emergency air supply. The tee connections, the alarm switch and the lock- out switch shall be connected to the piping system between the shut off valve and air control valve so that the emergency air supply can be used in conjunction with or in place of the normal air supply.

All air lines shall be of suitable strength for the pressure to which they may be subjected and shall be supported in a manner which will prevent excessive vibration.

The mechanism shall where possible be provided with a flange with cock for connection of a checking manometer. This flange shall be placed in an easily accessible place and the space shall be enough to connect a manometer.

Working parts of the mechanism shall be corrosion resisting material, and all bearings which require grease shall be equipped with pressure – type grease fittings, or shall be permanently lubricated.

All metal parts of valves shall be of corrosion resistant material, preferably bronze. All non – metallic parts of valves shall be of material which will not deteriorate, harden or warp with age (valves is preferred not to be gate type).

The compressor shall be able to charge the system form atmospheric pressure to rated pressure within 60 minutes at site condition.

Compressed air for pneumatic operating mechanisms of circuit breakers shall be supplied by a motor driven air cooled, air compressor furnished complete with accessories and controls and preferably located in the operating mechanism cabinet.

Automatic controls shall be provided to start the compressor after a pressure drop equivalent to not more than 3 successive breaker close – open operations and to keep it in operation until the pressure is normal. The pressure at which the compressor starts shall be adjustable within reasonable limits.

Safety valve or other device shall be provided on the air reservoir to protect it.

The operation of the circuit breaker shall be blocked if the pressure falls under the lowest value at which the circuit breaker can close and open (guarantee value). The blocking shall be cancelled with a rising pressure which is max. 85% of the rated pressure of the circuit breaker.

A circuit breaker deigned for rapid reclose shall be designed so that the rapid reclose will be blocked if the pressure falls under the lowest value at which the operating cycle O-C-O can be performed at both openings. The blocking shall be cancelled with rising distribution pressure which is max. 95% of the rated pressure.

The mechanism shall be provided with a cut – off cock by which the air reservoir and other equipment for compressed air can be disconnected from the air supply of the distribution system. The cut – off cock hall be readily accessible.

An air filter shall be installed in each compressor intake suitable for operation in an atmosphere containing severe dust contamination. The filter shall be accessible.

The mechanism shall be provided with a non return valve to the compressed air form the distribution system.

The initial pressure shall be the rated pressure and the circuit breaker shall be disconnected from the air supply.

The highest pressure, at which the live circuit breaker is allowed to operate shall be at least 105% of the rated pressure, and at least one bar higher than the rated pressure.

The noise level should be reduced to a reasonable level by providing silencer. The mechanism shall be provided with pushbuttons for pneumatic operation of the circuit breaker. These pushbuttons shall be protected with guard – covers against unauthorized handling.

The covers hall be labeled emergency open and close.

The running time of the compressor motor shall be monitored by running meter and in the event of that in each internal the operation time this exceeding the normal period, remote indication of this conditions shall be given.

A lock – out device with provision for remote alarm indication shall be incorporated in each circuit breaker to prevent operation whenever the pressure of the operating medium is below that required for satisfactory operation whenever the pressure of the operating medium is below that required for satisfactory operation at the specified rating. The scheme should permit operation of all blocking and alarm relays as soon as the pressure transient present during the rapid pressure drop has been damped and reliable pressure measurement can be made. Such facilities shall be provided for the following conditions:

- Trip lockout pressure
- Close lockout pressure
- Auto reclose lockout pressure.

When the circuit breaker is in the closed position a rapid fall in pressure of the operating medium to a level below that at which safe operation is possible shall not result in tripping of the circuit breaker.

3.4. Additional Requirements for Hydraulic Operating Mechanism

Operating oil pressure shall be maintained automatically.

The operating mechanism shall be provide with a sealed fluid and compressed gas system and solenoid control valves for breaker operations.

The breaker shall be provided with a manual emergency tripping device which is easily accessible from the outside of the mechanism housing.

The operating mechanism shall be supplied with a manual device which will permit manual tripping or closing of the circuit breaker at normal speeds.

The accumulator ought to be capable of storing enough energy to perform rated normal operating sequence and a manually operating pump shall be provided for building up the pressure in the accumulator in case of auxiliary power failure.

Convenient means shall be provided to detect the loss of energy storage medium (nitrogen etc) from the accumulator. In the even of a failure if the pump motor, hand charging of the system shall be possible.

The motor vibration shall not be transfer to tubes and connections.

The operating mechanism shall be so designed which the available operating energy stored by the mechanism to be determined prior to operating the circuit breaker, together with an alarm in the event of energy failing to a minimum rated level.

When the circuit breaker is in the closed position a rapid fall in pressure of the operating medium to a level below that at which safe operation is possible shall not result in tripping of the circuit breaker. Additionally, an alarm shall be provided to indicate drop in pressure.

All parts in direct contact with the oil, should be of resistant material against oil and its probable impurities.

All operating valves associated with flow of oil from the high pressure oil system to the low pressure oil system shall be so arranged that valve leakage cannot cause a build – up of pressure sufficient to result in an operation of the circuit breaker.

All hand operated valves shall be provided with approved facilities for locking the valve in the open or close position.

Drain valves shall be provided for all oil storages.

The clamping and arrangement of pipe work where used particularly at tee points shall allow for the expansion of pipe lines.

The mechanism shall be equipped with pressure gauge. The pressure gauge shall be provided with a plain scale between 0 and 135% of the rated pressure of the mechanism. The precision as percent of the maximal value of the scale shall be at least 1% for the range between 90% and 110% of the rated pressure of the circuit breaker and 3% in other parts.

When the circuit breaker is in the closed position, a rapid fall in pressure of oil to a level below which safe operation is not possible, shall not result in tripping of the circuit breaker.

The circuit breakers having independent operating mechanisms on each pole ought to block tripping – closing and autoreclosing of all poles, if the operating oil pressure is low in one or more of the mechanisms.

The running time of the pump motor shall be monitored by running meter and in the even of this exceeding the normal period, remote indication of this conditions shall be given.

The operating mechanism shall be provided with the indicators with following functions:

- Start pump motor
- Block autoreclosing if the pressure is insufficient to complete an OCO operation.
- Block closing if the pressure is insufficient to complete a make - break operation.
- Block tripping if the pressure is insufficient to complete a break operation.

Alarm contacts shall be provided to indicate above conditions.

An oil indicator should be provided.

3.5. Additional Requirement for Spring Operating Mechanism

The mechanism and breaker shall be so designed which the failure of any spring will not prevent tripping and will not cause tripping and closing.

The operating mechanism shall have a device for ending the operation for both electrical and mechanical operation. A slow opening when loading the closing spring shall be prevented.

The different parts of the operating mechanism shall be dimensioned for possible operating forces without damage in the mechanism.

The operating mechanism shall be provided with a device for spring operation for opening the circuit breaker in emergency situation.

The spring of the operating mechanism shall be automatically loaded by a motor. In the case of emergency, it shall also be possible to load the spring manually with a hand crank or similar tool.

The tool shall be placed in a marked place for example on the inside of one of the casing doors.
When hand crank is used. The motor should not to come in service.
Provision should be made for remote indication of "spring charged" and "spring charge fail" conditions.
The spare normally open spring drive limit switch shall operate coincident with the contactor coil and motor limit switches.
It shall be possible to charge the operating springs with the circuit breaker in either the open or closed positions.
In normal operation, recharging of the operating springs shall commence immediately and automatically upon completion of the closing operation. Close action whilst a spring charging operation is in progress shall be prevented, and release of the springs shall not be possible until they are fully charged.
Closing operation should charge the opening spring ready for operation.
The state of charge of the operating springs shall be indicated by a mechanical device which shows "spring charged" when operation is permissible and "spring free" when operation is not possible. An electrical signal lamp shall be considered for more capability.

3.6. Terminal Blocks and Wiring

The mechanism shall be provided with a sufficient number of terminal blocks. The blocks shall be provided with provision for disconnection (this shall be possible only with tools.)
It shall be possible to perform disconnection without disconnecting the leads. The block shall be marked with clear and resistant labels. All control wire shall be of an insulation class not less than 600 volts. The wiring, shall be adequately supported by suitable spacers.
Terminal blocks shall be complete with washer, nuts and lock nuts and long enough for connecting two conductors to one screw connection. No more than two wires shall enter each terminal. Supply circuit entering the housing, shall be equipped with fuse.
Marking strips shall be fastened by screw and correspond to wire numbers on the wiring diagrams. All wires shall be numbered at their stating and ending points and the wire shoes number shall be selected from ring type. 10% spare marking strips shall be provided.
AC circuit terminal shall be fitted with noninflammable transparent plastic covers to prevent contact with any Live parts. They should have warning labels mounted there on. They shall also be separated from DC circuits.
The main mechanism housing shall have enough space for cables which will terminate on the terminal blocks.

All external wiring entering external to the mechanism housings shall be through rigid / flexible metal conduit and shall enter the housings through rain and dust proof tight fittings. A removable plate shall be provided in the bottom of the main mechanism housing to be drilled during installation to receive the rigid/ flexible conduits. The plate shall be made of non magnetic material.
The terminal shall not be become detached from the rail as a consequence of vibration.
Terminal blocks shall withstand acid, alkalis and oils and they shall be resistant to tropical conditions.
All terminating strands will be furnished with suitable standard wire shoes. No copper wires smaller than 2.5 mm^2 shall be accepted for control circuits.

3.7. Cleaning and Painting

All metal surfaces which are not galvanized shall be thoroughly clean by sandblasting or shot blasting before painting.
All interiors, except tanks which shall receive the manufacture's standard treatment shall be given at least one priming coat and one finish coat of light colored paint or enamel. Interiors of operating compartments shall have a finish coat of gloss white.
All exteriors shall be given not less than 3 coats of paint consisting of primer and finish enamel. The total dry film thickness of the 3 or more coats of paints shall not be less than 0.99 mm, of which not less than 50% shall be finish enamel. All bright surfaces shall be thoroughly cleaned, coated with a suitable easily removable corrosion resisting compound.
The paint used for the finish coats shall have special heat, oil and weather resisting properties, and shall be light gray color.

3.8. Rating Plate.

A stainless steel rating plate, or other equivalent weather proof and corrosion proof material shall be provided, fixed in a visible position showing the following information.

Table (I) Information of Name plate

	Symbol	Unit	Circuit breaker	Mechanism of operation	In the following conditions the characteristic shall be mentioned
1	2	3	4	5	6
Manufacturer			X	X	
Type of design and serial No.			X	X	
Nominal voltage	Ur	kV	X		
LIWL	Up	kV	X		
SIWL	Us	kV	Y		For 400kV circuit breakers
Nominal frequency		HZ	Y		If CB is not suitable for working in both 50 and 60 HZ frequency
Rated normal current		A	X		
Rated break time		S	Y		If it is not more than 1 sec.
Rated short circuit breaking current		kA	X		
Dc component of Rated short circuit breaking current		%	Y		If it is more than 20%
First Pole To Clear Factor	K_{pp}		Y		
Rated out of phase breaking current		kA	X		
Rated line – charge breaking current		A	Y		
Rated cable charge breaking current		A	Y		
Rated single capacitor bank breaking current		A	X		
Rated back to back capacitor bank breaking current		A	X		
Rated capacitor bank inrush making current		kA	Y		If rated capacitor bank inrush making current is a assigned to the circuit breaker
Rated back to back capacitor bank inrush making current		kA	X		
Normal operating pressure		MPa		X	
Normal breaking pressure		MPa	X		
Nominal voltage for supply of making and breaking equipments		V		X	
Nominal frequency for supply of making and breaking equipments and auxiliary circuit.		HZ		X	
Nominal voltage for supply of auxiliary circuits		V		X	
Weight of circuit breaker		kg	Y	Y	If it is more than 300 kg
Weight of gas		kg	Y		

	Symbol	Unit	Circuit breaker	Mechanism of operation	In the following conditions the characteristic shall be mentioned
1	2	3	4	5	6
Sequence of nominal operation			X		
Year of construction			X		
Class of heating			Y	Y	If it is other then –5 indoor and -25 outdoor
Classification			Y		If it is other than M1 , C1
Applicable standard and its date of edition			X	X	
X= the parameter shall be mentioned, otherwise, it is zero (X)=it is optional to mention the value of the parameter Y= shall be mentioned according to column 6					
Note: the entries of column 2 can be used on the name plate in stead of column1, in this case, it is not necessary to u use the word 'rated'					

4. Spare Parts and Tools

The manufacture's recommended spare parts for 5 years trouble free operation and any special tools deemed necessary for erection, maintenance and repair shall be provided.

5. TESTS

The following type tests and routine tests shall be carry out for circuit breakers according to IEC 62271-100 and IEC 60694

5.1. Type Tests

A: Type Tests Neassary for All Circuit Breakers

- Dielectric tests on auxiliary and control circuits
- Radio interference voltage tests
- Measurement of the resistance of the main circuit.
- Temperature rise tests
- Short time withstand current and peak withstand current tests
- Tightness tests
- Electromagnetic compatibility tests

- Mechanical operation at ambient temperature tests
- Test related to short circuit making and breaking.
- Capacitive current switching tests; line charge current breaking tests.

B: Type Tests Necessary Due to the Application of the Circuit Breaker

- Degree of protection
- Advanced mechanical endurance for circuit breaker which are used is special operating condition
- Low and high temperature tests
- Static terminal load tests
- Critical current tests
- Tests of short line faults
- Out of phase making and breaking tests
- Single and double phase earth fault tests
- Capacitive current switching tests: Cable charge breaking current tests, Single capacitor bank Breaking current tests, Back to back capacitor bank breaking current tests.

5.2. Routine Tests

- Power frequency voltage withstand dry tests on the main circuit.
- Voltage withstand tests on control and auxiliary circuits.
- Measurement of the resistance of the main circuit
- Tightness tests
- Visual checks
- Mechanical operating tests

6- Transportation, Storage, Installation and commissioning

It is essential that the transport, storage, installation and commissioning of circuit breaker be performed in accordance with instructions given by the manufacturer.

The instructions for the transport and storage should by given before delivery.

The instructions for the installation and commissioning should be given by the time of delivery at the latest.

6.1. Storage

Circuit breaker can be stored in a covered or open air condition according to manufacturer instructions. If circuit breakers are stored in open air, at least they shall be covered with plastic tissues. These plastic tissues shall not be put directly on galvanized surfaces and an air channel shall be mounted to prevent any infiltration of water.

Storage is called to a place that:

- It has a ceiling
- Its floor is firm and uniform.
- Air humidity shall be less than 50%
- Air temperature 20 ± 10 C°

To prevent water from reaching the circuit breaker, it shall be stored in an elevation upper than floor level. To prevent any corrosion caused by the infiltration of water, the plastic cover shall be removed (not for spare parts).

After receiving of each circuit breaker the following items shall be checked:

- circuit breaker delivery is according to order documents.
- There is no damage or shortage in the delivered circuit breaker

If there is any damage, the box shall be opened and all damages shall be photographed. These shall be reported. Storage of a circuit breaker in moist and not well ventilated air may cause the change of color of galvanized surfaces. This change of color is generally named white corrosion and is not a reason for rejecting the goods. All parts shall be stored in away are always accessible. The surrounding ambient of circuit breaker shall be clean of any dust, smoke, flamable or corrosive gasses, steam or salt.

In this condition, the storage shall be cleaned before storing process.

For storing the circuit breaker, the original box shall be used but the plastic cover shall be removed.

Spare parts shall be kept in their original boxes and stored in storage. This is specially important for plastic parts (for water proofing and etc). these parts shall be kept away from sunlight to prevent them drying. Spacer washers can be stored for just a short time in the storage.

6.2. Installation

The manufacturer should provide required information for unpacking and lifting safely to the user. All transport units should be clearly marked and drawings showing assembly of these parts should be provided by the circuit breaker.

Instructions for mounting of circuit breaker, should include sufficient details of locations. and foundations. Additionally, the manufacturer, instructions should also indicate total mass of the circuit breaker, the mass of SF6 gas and the mass of the heaviest part of the circuit breaker to be lifted separately (if it exceeds 300 kg).

The drawings should include information on connection of conductors (comprising the necessary advice to prevent over heating and unnecessary strain on circuit breaker, and provide adequate clearance distances, connection of auxiliary circuit, arrangement of piping (if necessary) the and connection for earthing. Assembly and installation should be done exactly according to the instructions and drawings provided by manufacturer.

6.2.1. Necessary Items for Circuit Breaker Installation

- Lifting device
- Rope
- Drawings of dimensions and installation
- Circuit breaker components according to installation drawings
- Needed wrenches
- Thermometer
- SF6 injector and it's components
- SF6 leak finder

6.2.2. Installation Sequences

a**) Foundation preparation**

The foundation shall be horizontally balanced. Deviation of the distances between the holes mounted on the foundation from the specified values shall be in the permitted limits.

b) Installation of the frame on the foundation

The connection of frame on the foundation is done by using bolts and nuts. the Frame should be installed vertically.

It shall be noted that, the empty space between bolts and foundation shall be as small as possible and shall be filled by space washers. Nuts fastening torque shall be as specified by the manufacturer.

c) Installation of circuit breaker on the frame

Before the installation of each pole, it's tightness shall be checked. Since it may have been damaged during the transport. Leakage check is performed according to the instructions provided by the manufacturer. Unpacking the pole and changing its position from horizontal to vertical shall be done according to the manufacturer recommendations.

d) Installation of operating mechanism

The operating mechanism and it's accessories shall be assembled, adjusted and connected to the circuit breaker according to the manufacturer instructions.

The unpacking of the operating mechanism accessories shall be done according to the manufacturer instructions.

e) Filling the circuit breaker with SF6 gas.

The poles are first evacuated and then filled to the specific pressure at a specific temperature, before the delivery to the user. The pressure shall be raised to the value specified in the name plate. For prevention of any probable danger and injuries during transportation, the gas source shall be for away form the pole and placed behind a barrier.

f)Tightness checks

After the completion of assembly and mounting tosks, gas leak age in circuit breakers poles and connection of the gas density switches should be checked.

6.3. Commissioning

After a circuit breaker has been installed and all connections have been completed, commissioning tests are recommended to be performed to confirm that transportation and storage have not damaged the circuit breaker. In addition when a large part of the assembly and/or of the adjustment is performed on site, the tests are required to confirm compatibility of the sub-components and the functional characteristics dependent upon it.

A minimum of 50 no load operations shall be performed on site on the circuit breaker where major subassemblies are combined at site without previous routine tests on the complete circuit breaker. These operations shall be performed after assembly, all connections and checks having been made and the program of commissioning tests haring been completed.

The manufacturer shall produce a program of site commissioning checks and tests. Repetition of the full program of routing tests, already performed in the factory, shall be avoided as the purpose of commissioning tests is for confirmation of

- Absence of damage
- Compatibility of separate units
- Correct assembly
- Correct performance of the assembled circuit breaker

For this purpose the commissioning tests shall include, but not limited to the following items. The results of the tests shall be recorded in a test report.

6.3.1. Checks after Installation

a) General checks

- Assembly conforms to manufacturer's drawings and instructions
- Tightness of circuit breaker
- External /internal insulation are undamaged and clean
- Paint and other corrosion protection are sound
- Operating devices are free from contamination
- Adequacy and integrity of the earth connection up to and including the interface with the Substation earthing system.

- Where applicable, record the number on the operation connecter(s) at delivery, at the completion of all site testing, at first energization.

b) Checks of electrical circuit

- conformity to the wiring diagram
- correct operation of signaling (position, alarms, lockouts, etc)
- correct operation of heating and lighting

c) Check on SF6 gas

d) Checks on operating fluids (where filled or added to on site)

6.3.2. Mechanical tests and measurements

- Pressure measurement of SF6 gas
- Pressure measurement of operating fluids (if applicable)
- Measurement of consuming during operations (if applicable)
- Verification of the rated operating sequence
- Measurement of time quantities
- Recording of mechanical travel characteristics
- Checks of certain specific operations

6.3.3. Electrical tests and measurements

- Dielectric tests
- Measurement of the resistance of the main circuit

For information on how the tests mentioned in 6.3.2, 6.3.3 IEC 62271-200 is applicable.

7. DRAWINGS & DOCUMENTS

7.1. Documents to be given by tendered

- Filled schedule CB (II)
- Catalogue & technical pamphlets
- Summary of type test reports
- Outline drawing
- Detailed summary of exceptions to tender specifications
- List of spare parts
- Reference list
- List of special tools

7.2. Documents to be given by contractor / supplier

The electrical and mechanical design, fabrication, factory testing, working and packing, transportation, erection, site test, operation and maintenance drawings, documents and manuals shall be submitted not limited to the following:

- Design calculation sheets to establish adequacy of circuit breaker in any respect;
- Outline dimension and cut away drawings
- Loading on structure and foundation
- Packing details
- Shipping, warehousing, assembling, erection, commissioning, operating and maintenance instruction manuals.
- Name plate drawings
- Control and wiring diagrams
- Operating mechanism drawings
- Site test instruction manuals
- Routine test documents
- List of components
- Type test documents
- Work schedules and monthly progress report
- Drawing list
- Final as built Doc/Dwg.
- Dismantling, reassembling & adjusting manuals

SCHEDULE CB(I)
RATING AND CHARACTERISTICS OF CIRCUIT BREAKER

ITEM	DESCRIPTION		Technical Specification for Systems With Following Nominal Voltages:			
			420 kV	**245 kV**	**145 kV**	**72.5 kV**
1	**Particulars of System**					
1.1	Highest system voltage	kV	420	245	145	72.5
1.2	Nominal system voltage	kV	400	230	132	63(66)
1.3	Nominal system frequency	HZ	50	50	50	50
1.4	System neutral earthing		Solidly earthed	Solidly earthed	Solidly earthed/Non solidly earthed	Solidly earthed/ Non solidly earthed
1.5	Number of phases		3	3	3	3
2	**Service Condition**					
2.1	Max. ambient temperature	C°	40/45/50/55	40/45/50/55	40/45/50/55	40/45/50/55
2.2	Min. ambient temperature	C°	-40/-35/-30/-25	-40/-35/-30/-25	-40/-35/-30/-25	-40/-35/-30/-25
2.3	Average value of daily temperature	C°	*	*	*	*
2.4	Solar radiation	w/m^2	*	*	*	*
2.5	Altitude above sea level	M	1000/1500/2000/2500	1000/1500/2000/2500	1000/1500/2000/2500	1000/1500/2000/2500
2.6	Pollution level		Low/medium/high/ Very high/special	Low/medium/high/ Very high/special	Low/medium/high/ Very high/special	Low/medium/high/ Very high/special
2.7	Max. wind velocity	m/s	30/40/45	30/40/45	30/40/45	30/40/45
2.8	Wind velocity at ice condition	m/s	20	20	20	20
2.9	Ice coating thickness	mm	5/10/20/25	5/10/20/25	5/10/20/25	5/10/20/25
2.10	Seismic acceleration	m/s^2	0.2g/0.25g/0.3g/0.35g	0.2g/0.25g/0.3g/0.35g	0.2g/0.25g/0.3g/0.35g	0.2g/0.25g/0.3g/0.35g
2.11	Relative humidity	%	90/95/more than 95	90/95/more than 95	90/95/more than 95	90/95/more than 95
3	**Breaker Characteristic**					
3.1	Class (outdoor / indoor)		Outdoor/indoor	Outdoor/indoor	Outdoor/indoor	Outdoor/indoor

SCHEDULE CB(I)

RATING AND CHARACTERISTICS OF CIRCUIT BREAKER

ITEM	DESCRIPTION		Technical Specification for Systems With Following Nominal Voltages:			
			400 kV	**230 kV**	**132 kV**	**63/66 kV**
3.2	Type of circuit breaker		SF6	SF6	SF6	SF6
3.3	No. of poles		3	3	3	3
3.4	Nominal Voltage	kV	400	230	132	63(66)
3.5	Insulation level at environmental condition of substation					
3.5.1	Rated lighting impulse withstand voltage at IEC conditions					
3.5.1.1	Phase to earth and phase to phase	kV_{peak}	1300/1425	850/950/1050	550/650	325
3.5.1.2	Across open circuit breaker	kV_{peak}	1540/1665	850/950/1050	550/650	325
3.5.2	Rated switching impulse withstand voltage at IEC conditions					
3.5.2.1	Phase to earth and phase to phase	kV_{peak}	950/1050	—	—	—
3.5.2.2	Across open circuit breaker	kV_{peak}	1425/1575	—	—	—
3.5.3	Rated power frequency withstand voltage					
3.5.3.1	Phase to earth and phase to phase		520	360/395/460	230/275	140
3.5.3.2	Across open circuit breaker		610	360/395/460	230/275	140
3.6	Nominal frequency	HZ	50	50	50	50
3.7	Normal rated current	A	800/1250/1600/2000/ 2500/3150/4000	800/1250/1600/ 2000/2500/3150/4000	800/1250/1600/ 2000/2500/3150/4000	800/1250/1600/ 2000/2500/3150/4000
3.8	Rated line charging breaking current	A	400	125	50	10
3.9	Rated cable charging breaking current	A	400	250	160	125

SCHEDULE CB(I)
RATING AND CHARACTERISTICS OF CIRCUIT BREAKER

ITEM	DESCRIPTION		Technical Specification for Systems With Following Nominal Voltages:			
			400 kV	**230 kV**	**132 kV**	**63/66 kV**
3.10	Rated single capacitor bank breaking current	A	400	400	400	400
3.11	Rated back-to-back capacitor bank breaking current	A	400	400	400	400
3.12	Rated small inductive breaking current	A	*	*	*	*
3.13	Rated short circuit breaking current					
3.13.1	AC component at rated voltage (I_{scn})	kA	25-31.5-40-50	25-31.5-40-50	25-31.5-40-50	25-31.5-40-50
3.13.2	DC component	%	*	*	*	*
3.14	Rated capacitor bank inrush making current	kA	20	20	20	20
3.15	First pole – to – clear factor		1.3	1.3	1.5,1.3	1.5,1.3
3.16	Rated transient recovery voltage for terminal faults (TRV)	kV	624	364	215/249	124
3.17	Rated short circuit making current	kA	2.5 I_{scn}	2.5 I_{scn}	2.5 I_{scn}	2.5 I_{scn}
3.18	Rated operating sequence		O-0.3Sec-CO 3min-CO	O-0.3Sec-CO 3min-CO	O-0.3Sec-CO 3min-CO	O-0.3Sec-CO 3min-CO
3.19	Rated duration of short circuit	Sec	1	1	1	1
3.20	Rated out of phase breaking current	kA_{rms}	0.25 I_{scn}	0.25 I_{scn}	0.25 I_{scn}	0.25 I_{scn}
3.21	Rated break time	ms	≤ 40	≤ 40	≤ 40	≤ 40
3.22	Max R.I.V at $\frac{1.1U_m}{\sqrt{3}}$ and frequency of 1 MHZ	mV	2500	2500	2500	-
3.23	Single pole or 3 pole operation		Single pole	Single pole/ 3 pole	3 pole	3 pole

SCHEDULE CB(I)

RATING AND CHARACTERISTICS OF CIRCUIT BREAKER

ITEM	DESCRIPTION		Technical Specification for Systems With Following Nominal Voltages:			
			400 kV	**230 kV**	**132 kV**	**63/66 kV**
3.24	Requirement for simultaneity of poles:					
3.24.1	Max. time interval between closure of the first and last pole	msec	5	5	5	5
3.24.2	Max time interval between opening of the first and last pole	msec	2	2	2	2
3.25	Total creepage distance	mm	*	*	*	*
3.26	Washable in service?	(Yes/No)	Yes	Yes	Yes	Yes
3.27	Tensile force on HV terminal due to connected conductor	N	*	*	*	*
3.28	Preinsertion closing resistor required	(Yes/No)	*	NO	NO	NO
3.29	Preinsertion closing resistor	Ω	400-600	-	-	-
3.30	Min duration that remains in circuit	msec	8	-	-	-
3.31	Switch sync required	(Yes/No)	*	NO	NO	NO
3.32	High speed auto reclosing ?	(Yes/No)	Yes	Yes	Yes	Yes
3.33	Class of circuit breaker		M1/M2	M1/M2	M1/M2	M1/M2
3.34	Operating mechanism:					
3.34.1	Type of operating mechanism	Spring/hydraulic/ pneumatic	Spring/hydraulic/ pneumatic	Spring/hydraulic/ pneumatic	Spring/hydraulic/ pneumatic	Spring/hydraulic/ pneumatic
3.34.2	Rated AC supply voltage	volt	230-400 V	230-400 V	230-400 V	230-400 V
3.34.3	Rated frequency of AC supply	HZ	50	50	50	50
3.34.4	Rated DC supply voltage		110/125	110/125	110/125	110/125

SCHEDULE CB(I)
RATING AND CHARACTERISTICS OF CIRCUIT BREAKER

ITEM	DESCRIPTION		Technical Specification for Systems With Following Nominal Voltages:			
			400 kV	**230 kV**	**132 kV**	**63/66 kV**
3.34.5	No. of independent breaking coils		2	2	2	2
3.34.6	No. of independent making coils		1	1	1	1
3.34.7	Variation of dc(aux.control) voltage required to close CB	%	85-105	85-105	85-105	85-105
3.34.8	Variation of dc (aux/control) voltage required to trip CB	%	70-110	70-110	70-110	70-110
3.34.9	Variation of ac supply voltage to trip and close CB	%	85-110	85-110	85-110	85-110
3.34.10	Required class of protection for outdoor cubicles		IP54/IP55	IP54/IP55	IP54/IP55	IP54/IP55
3.34.11	Mechanism of operation (manual / motor operation)		Motor operated	Motor operated	Motor operated	Motor operated
3.34.12	No. and type of auxiliary spare contacts					
3.34.12.1	No. of normally open contacts		*	*	*	*
3.34.12.2	No. of normally close contacts		*	*	*	*
3.35	Allowable temperature rise	̊C	*	*	*	*

* These will be specified by engineer.

SCHEDULE CB(II)

RATED VALUES AND TECHNICAL SPECIFICATION OF CIRCUIT BREAKER

ITEM	DESCRIPTION		Technical Specification for Systems With Following Nominal Voltages:			
			400 kV	**230 kV**	**132 kV**	**63/66 kV**
1	**General**					
1.1	Manufacturer's name and country					
1.2	Manufacturer's type & designation					
1.3	Class (outdoor/indoor)					
1.4	Applicable standard					
1.5	Applicable site & ambient condition:					
1.5.1	Max. design ambient temperature	℃				
1.5.2	Min. design ambient temperature	℃				
1.5.3	Average value of daily temperature	℃				
1.5.4	Solar radiation	W/m^2				
1.5.5	Design altitude above sea level	m				
1.5.6	Pollution level					
1.5.7	Max. permissible ice thickness	mm				
1.5.8	Design seismic acceleration	m/s^2				
1.5.9	Max. permissible wind velocity	m/s				
1.6	Documents (test reports/ outline drawings/ catalogues/ maintenance & installation manuals/ reference list/ list of spare parts)					

SCHEDULE CB(II)

RATED VALUES AND TECHNICAL SPECIFICATION OF CIRCUIT BREAKER

ITEM	DESCRIPTION		Technical Specification for Systems With Following Nominal Voltages:			
			400 kV	230 kV	132 kV	63/66 kV
2	**Rated values & Characteristics**					
2.1	Type of circuit breaker					
2.2	Nominal voltage (U_n)	kV				
2.3	Highest voltage for equipment (U_m)	kV				
2.4	Number of poles					
2.5	Rated frequency	HZ				
2.6	Rated continuous current at IEC conditions	A				
2.7	Short time current and it's duration	kA/S				
2.8	Maximum temperature rise for current rating at site	℃				
2.9	Rated operating duty					
2.10	Breaking capacity based on rated operating sequence for three phase terminal fault:	kA				
2.10.1	Symmetrical at highest voltage for equipment	kA				
2.10.2	Asymmetrical at highest voltage for equipment	kA				
2.10.3	dc component	%				
2.10.4	Symmetrical at nominal voltage	kA				

SCHEDULE CB(II)

RATED VALUES AND TECHNICAL SPECIFICATION OF CIRCUIT BREAKER

ITEM	DESCRIPTION		Technical Specification for Systems With Following Nominal Voltages:			
			400 kV	230 kV	132 kV	63/66 kV
2.11	Breaking capacity based on rated operating sequence for single phase earth fault:					
2.11.1	Symmetrical at highest voltage for equipment	kA				
2.11.2	Asymmetrical at highest voltage for equipment	kA				
2.11.3	dc component	%				
2.12	Rated out of phase breaking current	kA				
2.13	Rated restriking voltage:					
2.13.1	At 10% breaking capacity	kV				
2.13.2	At 30% breaking capacity	kV				
2.13.3	At 60% breaking capacity	kV				
2.13.4	At 100% breaking capacity	kV				
2.14	First pole to clear factor					
2.15	Type of devices if any used to limit the rate of rise of restriking voltage					
2.16	Rate of rise of restriking voltage:					
2.16.1	For 10% breaking capacity	kV/ *ms*				
2.16.2	For 30% breaking capacity	kV/ *ms*				

SCHEDULE CB(II)

RATED VALUES AND TECHNICAL SPECIFICATION OF CIRCUIT BREAKER

ITEM	DESCRIPTION		Technical Specification for Systems With Following Nominal Voltages:			
			400 kV	230 kV	132 kV	63/66 kV
2.16.3	For 60% breaking capacity	kV/ *ms*				
2.16.4	For 100% breaking capacity	kV/ *ms*				
2.17	Rated short circuit making current at rated voltage	kA_{peak}				
2.18	Rated line charging breaking current	A				
2.19	Rated cable – charging breaking current					
2.20	Rated capacitive breaking current in the case of capacitor bank switching					
2.21	Rated small inductive breaking current in the case of reactor unit switching at 440 KV for 400 KV system	A				
2.22	Rated small inductive breaking current in the case of transformer magnetizing current	A				
2.23	Minimum impulse withstand level to earth at IEC conditions:					
2.23.1	LIWL	kV_{peak}				
2.23.2	SIWL	kV_{peak}				
2.24	Minimum impulse withstand level across open poles at IEC conditions:					

2.24.1	LIWL	kV_{peak}				

SCHEDULE CB(II)

RATED VALUES AND TECHNICAL SPECIFICATION OF CIRCUIT BREAKER

ITEM	DESCRIPTION		Technical Specification for Systems With Following Nominal Voltages:			
			400 kV	230 kV	132 kV	63/66 kV
2.24.2	SIWL	kV_{peak}				
2.25	Impulse wave shape:					
2.25.1	Lightning wave:	*ms / ms*				
2.25.2	Switching wave	*ms / ms*				
2.26	Minimum power frequency withstand voltage across open gaps at IEC conditions:					
2.26.1	One minute dry withstand voltage	kV				
2.26.2	One minute wet withstand voltage	kV				
2.27	Minimum power frequency withstand voltage to earth at IEC conditions:	kV				
2.27.1	One minute dry withstand level	kV				
2.27.2	One minute wet withstand level	kV				
2.28	Visible corona starting voltage	kV				
2.29	Radio influence voltage level measured at 1.1 times highest voltage for equipment and at 1 MHZ	*mvolt*				
2.30	Switching overvoltage:					

SCHEDULE CB(II)

RATED VALUES AND TECHNICAL SPECIFICATION OF CIRCUIT BREAKER

ITEM	DESCRIPTION		Technical Specification for Systems With Following Nominal Voltages:			
			400 kV	230 kV	132 kV	63/66 kV
2.30.1	Maximum peak value of switching over voltage when interrupting rated line charging current	per unit				
2.30.2	Maximum peak value of switching over voltage when interrupting rated small inductive current in the case of reactor and transformer magnetizing current	Peru nit				
2.31	Voltage drop across terminals of one phase at 100 A dc current	mvolt				
2.32	Maximum transient pressure in circuit breaker due to making or breaking of short circuit current	Bar				
2.33	Rated operating sequence					
2.34	Mechanical performance:					
2.34.1	Maximum total break time (trip initiation to final arc extinction)	msec				
2.34.2	Total length of the arc	mm				
2.34.3	Opening time: - without current - with 100% rated breaking current	msec msec				
2.34.4	Maximum time interval between closure of a first and last phase of three phase circuit breaker	msec				
2.34.5	Maximum time interval between closure of interrupters of one phase.	msec				

SCHEDULE CB(II)

RATED VALUES AND TECHNICAL SPECIFICATION OF CIRCUIT BREAKER

ITEM	DESCRIPTION		Technical Specification for Systems With Following Nominal Voltages:			
			400 kV	230 kV	132 kV	63/66 kV
2.34.6	Maximum time interval between opening of first and last phase of three phase circuit breaker	msec				
2.34.7	Maximum time interval between opening of interrupters of one phase	msec				
2.34.8	Maximum of different make time between chambers of one pole	msec				
2.34.9	maximum of different break time between chambers of one pole	msec				
2.34.10	Making time - without current - with 100% rated current	msec mec				
2.34.11	Closing time (minimum time from extinction of main arc to contact make during autoreclosing duty)	msec				
2.35	Preinsertion closing resistors					
2.35.1	Resistance	Ω				
2.35.2	Insertion time	msec				
2.36	Switch synch	(Yes/No)				
2.36.1	Manufacturer					
2.36.2	Type and designation					
2.37	Reclosing dead time	msec				
2.38	Reclosing dead time setting range	cycle				
2.39	Max. current on breaking asynchronous system	kA				
2.40	Max. recovery voltage on breaking asynchronous system	kV				
2.41	Is the breaker restrike free?	Yes/No				

SCHEDULE CB(II)

RATED VALUES AND TECHNICAL SPECIFICATION OF CIRCUIT BREAKER

ITEM	DESCRIPTION		Technical Specification for Systems With Following Nominal Voltages:			
			400 kV	230 kV	132 kV	63/66 kV
3	**General features**					
3.1	Number of breaks in series per pole					
3.2	Type of devices, if any used to obtain uniform voltage distribution between break units.					
3.3	Value of voltage control capacitor connected across a break units	PF				
3.4	Type of main contact					
3.5	Type of arcing contact					
3.6	Type of Arc-Control contact					
3.7	Whether contacts are silver plate?	Yes/No				
3.7.1	Thickness of silver layer					
3.8	Minimum creepage distance to ground	mm				
3.9	Making mechanism:					
3.9.1	Type & designation					
3.9.2	Rated voltage of closing coil	dc volt				
3.9.3	Maximum and minimum voltage of pick up of closing coil	%				

SCHEDULE CB(II)

RATED VALUES AND TECHNICAL SPECIFICATION OF CIRCUIT BREAKER

ITEM	DESCRIPTION		Technical Specification for Systems With Following Nominal Voltages:			
			400 kV	230 kV	132 kV	63/66 kV
3.9.4	Power at rated voltage of closing (for three poles)	watts				
3.10	Tripping mechanism:					
3.10.1	Type & type designation					
3.10.2	Rated voltage of tripping coil	dc Volt				
3.10.3	Maximum and minimum voltage of pick up of tripping coil	%				
3.10.4	Power at rated voltage of tripping coil (for three poles)	watts				
3.11	Number of trip coil phase:					
3.11.1	Single phase mechanism					
3.11.2	Three phase mechanism					
3.12	Number of current making units in series per phase:					
3.12.1	Units which both make and break short circuit current					
3.12.2	Units which make short circuit current only					
3.13	Heater ratings:					
3.13.1	Voltage	Volt				
3.13.2	Capacity and number of heaters per pole	watts				

SCHEDULE CB(II)

RATED VALUES AND TECHNICAL SPECIFICATION OF CIRCUIT BREAKER

ITEM	DESCRIPTION	Technical Specification for Systems With Following Nominal Voltages:			
		400 kV	230 kV	132 kV	63/66 kV
3.13.3	Type and capacity and number of heaters for local control panel				
3.14	Auxiliary contacts:				
3.14.1	Normally open contacts				
3.14.2	Normally closed contacts				
3.15	Color:				
3.15.1	Outside				
3.15.2	Insulators				
3.16	Number of opening the circuit breaker is capable of performancing without inspection, replacement of contacts or other main parts:				
3.16.1	At 50% rated current				
3.16.2	At 100% rated current				
3.16.3	At current corresponding to 50% breaking capacity				
3.16.4	At current corresponding to 100% breaking capacity				
3.17	Number of opening the circuit breaker is capable of performing without replacing / reconditioning the dielectric (SF6 gas):				

SCHEDULE CB(II)

RATED VALUES AND TECHNICAL SPECIFICATION OF CIRCUIT BREAKER

ITEM	DESCRIPTION		Technical Specification for Systems With Following Nominal Voltages:			
			400 kV	230 kV	132 kV	63/66 kV
3.17.1	At 50% rated current					
3.17.2	At 100% rated current					
3.17.3	At 50% breaking current					
3.17.4	At 100% breaking current					
3.18	Total weight of complete circuit breaker	kg				
3.19	Max. weight of heaviest part for shipment	kg				
3.20	Weight of each pole	kg				
3.21	Overall dimensions (H×W×L)	mm				
3.22	Time interval between 2 maintenances:					
3.22.1	Infrequent operation	hours				
3.22.2	Frequent operation	hours				
3.23	Max. restoring force for support design	N				
3.24	Dead tank or live tank design					
3.25	Quantity of SF6 gas required to fill one three phase circuit breaker at rated pressure and 20 ℃	kg				
3.26	Quantity of make up gas required per year for one three phase circuit breaker	%				
3.27	Normal operating pressure for SF6 gas	bar				

SCHEDULE CB(II)

RATED VALUES AND TECHNICAL SPECIFICATION OF CIRCUIT BREAKER

ITEM	DESCRIPTION		Technical Specification for Systems With Following Nominal Voltages:			
			400 kV	230 kV	132 kV	63/66 kV
3.28	Minimum operating pressure of SF6 gas	bar				
3.29	Maximum operating pressure of SF6 gas	bar				
3.30	Leakage rate of SF6 gas (% of total stored per year)	%				
3.31	Percentage degradation of gas after short circuit interruption at 100% rating	%				
3.32	Is SF6 stored as gas or liquid					
3.33	Supplier of gas					
3.34	Grade of gas					
3.35	Vacuum pump motors consumption	kW				
3.36	Compressor motors consumption	kW				
3.37	Time required to fill the circuit breaker with gas ready for normal operation at site condition, assuming that it is initially filled with air at atmospheric	Hours				
3.38	Time required to empty the circuit breaker of gas, assuming that it is initially in normal operating condition	Hours				
4	**Operating Mechanism (General)**					
4.1	Type of mechanism					

SCHEDULE CB(II)

RATED VALUES AND TECHNICAL SPECIFICATION OF CIRCUIT BREAKER

ITEM	DESCRIPTION		Technical Specification for Systems With Following Nominal Voltages:			
			400 kV	230 kV	132 kV	63/66 kV
4.2	Three phase high speed auto – reclosing?	Yes/No				
4.3	Is C.B suitable for application of single phase autoreclosing?	Yes/No				
4.4	Single phase high speed auto – reclosing?	Yes/No				
4.5	Number of trip coils					
4.6	Number of close coils					
4.7	Motor voltage					
4.8	Motor power demand	W				
4.9	Motor starting current	A				
4.10	Motor full load current	A				
4.11	Motor speed	rpm				
4.12	Heater voltage/power demand					
4.12.1	Anti condensation heaters	Volt/watts				
4.12.2	Space heaters	Volt/watts				
4.13	Closing control current	A				
4.14	Opening control current	A				
4.15	Rated control voltage:					
4.15.1	AC	V				

SCHEDULE CB(II)

RATED VALUES AND TECHNICAL SPECIFICATION OF CIRCUIT BREAKER

ITEM	DESCRIPTION		Technical Specification for Systems With Following Nominal Voltages:			
			400 kV	230 kV	132 kV	63/66 kV
4.15.2	DC	V				
4.16	Degree of protection (IP) of:					
4.16.1	Motor enclosure					
4.16.2	Enclosure of control box					
4.17	Type and rating for motor protective MCB(S)	A				
4.18	Separate terminal box provided?	Yes/No				
4.19	Maximum force the operating mechanism can produce	N				
5	**Hydraulic Operating Mechanism**					
5.1	Manufacture and type designation					
5.2	Operating pressure on H.P. oil system:					
5.2.1	Normal pressure	bar				
5.2.2	Minimum pressure	bar				
5.2.3	Lock out pressure	bar				
5.2.4	Low pressure alarm	bar				
5.3	Pressure at which motor operated pump is started	bar				
5.4	Total quantity of oil required to fill completely the hydraulic system ready for operation	lit				

SCHEDULE CB(II)
RATED VALUES AND TECHNICAL SPECIFICATION OF CIRCUIT BREAKER

ITEM	DESCRIPTION	Technical Specification for Systems With Following Nominal Voltages:			
		400 kV	230 kV	132 kV	63/66 kV
5.5	Grade of oil used in hydraulic system				
5.6	Number of energy storage accumulators per single phase circuit breaker				
5.7	Type of energy storage accumulator				
5.8	Type of gas used for energy storage				
5.9	Quantity of gas at normal temperature and pressure required in single accumulator m^3				
5.10	Number of close open operations stored per accumulator				
5.11	Volume of gas when accumulator fully charged m^3				
5.12	Pressure of gas when accumulator fully charged bar				
5.13	Volume of gas when accumulator fully charged m^3				
5.14	Pressure of gas when accumulator fully discharged bar				
5.15	Method of topping up gas volume in accumulator				
5.16	Pressure drop after following operations starting from normal pressure:				
5.16.1	C bar				
5.16.2	CO bar				
5.16.3	COC bar				

SCHEDULE CB(II)

RATED VALUES AND TECHNICAL SPECIFICATION OF CIRCUIT BREAKER

ITEM	DESCRIPTION		Technical Specification for Systems With Following Nominal Voltages:			
			400 kV	230 kV	132 kV	63/66 kV
5.16.4	OCO	bar				
5.17	Time required to fully charge hydraulic system to normal operating conditions after system has been drained for maintenance at site conditions	min				
5.18	Time required to restore normal operating pressure after one oco operation at site conditions	min				
5.19	Type and manufacturer of oil pump					
5.20	Output of oil pump	lit/sec				
5.21	Oil pump consumption	kW				
6	**Pneumatic operating mechanism**					
6.1	Manufacturer					
6.2	Type designation					
6.3	Air compressor					
6.3.1	Type					
6.3.2	Manufacturer					

SCHEDULE CB(II)

RATED VALUES AND TECHNICAL SPECIFICATION OF CIRCUIT BREAKER

ITEM	DESCRIPTION		Technical Specification for Systems With Following Nominal Voltages:			
			400 kV	230 kV	132 kV	63/66 kV
6.3.3	Capacity	Lit/min				
6.3.4	Rated pressure	bar				
6.4	Compressor consumption	kW				
6.5	Safety valve opens on local receiver at	bar				
6.6	Safety valve opens on central air reservoir at	bar				
6.7	Normal operating pressure	bar				
6.8	Compressor starts at	bar				
6.9	Compressor stops at	bar				
6.10	Tripping lock-out pressure	bar				
6.11	Alarm switch closes on local air receiver operation:					
6.11.1	For closing	bar				
6.11.2	For opening	bar				
6.11.3	For autoreclosing duty	bar				
6.12	Number of stored close-open operation in:					
6.12.1	Breaker local air receiver					
6.12.2	Central air receiver					

SCHEDULE CB(II)

RATED VALUES AND TECHNICAL SPECIFICATION OF CIRCUIT BREAKER

ITEM	DESCRIPTION		Technical Specification for Systems With Following Nominal Voltages:			
			400 kV	230 kV	132 kV	63/66 kV
7	**Spring operating mechanism**					
7.1	Manufacturer					
7.2	Type designation					
7.3	Continuous rating of motor	Watts				
7.4	Time required by motor to charge the spring completely (at site condition)	sec				
7.5	Type of spring					
8	**Insulator columns**					
8.1	Type and manufacturer's name and full designation					
8.2	Creepage distance, phase – to- ground	mm				
8.3	No. of units per column of support insulator					
8.4	Ultimate strength of columns:					
8.4.1	Cantilever	N				
8.4.2	Tension	N				
8.4.3	Torsion	N-m				
8.5	Washable in service?	Yes/No				
8.6	LIWL	kV_{peak}				

SCHEDULE CB(II)

RATED VALUES AND TECHNICAL SPECIFICATION OF CIRCUIT BREAKER

ITEM	DESCRIPTION		Technical Specification for Systems With Following Nominal Voltages:			
			400 kV	230 kV	132 kV	63/66 kV
8.7	SIWL	kV_{peak}				
8.8	One min. PFWL	kV_{peak}				
9	**Auxiliary contacts**					
9.1	No. of normally open contacts					
9.2	No. of normally close contacts					
9.3	No. of spare normally open contacts					
9.4	No. of spare normally close contacts					
9.5	No. of reversible contacts					
9.6	No. of adjustable contacts					
9.7	Voltage rating	V dc				
9.8	Continuous current rating	A dc				
9.9	Minimum current	A dc				
9.10	Minimum time	ms				