

ANNEXURE –I

Technical specification of Short Circuit Generator Master Circuit Breakers

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Clause No.	TECHNICAL SPECIFICATION
1.0	FOREWORD: Central Power Research Institute (herein after referred to as CPRI) intends to establish/augment the test facilities of the High Power Laboratory in Bangalore in order to meet the growing demand for high power testing by adding two nos. of 2500 MVA Short-circuit Generators (G2 and G3). The laboratory is already having one Short circuit generator of 2500MVA capacity working since 1990 (G1). The total available short-circuit power (7500MVA) shall be used to increase the testing capability of the Laboratory (by running the Generators in parallel) and to improve the efficiency of testing activities making use the Generators individually to supply power to perform tests simultaneously in different test bays i.e. mainly short-circuit tests on various power system equipment such as circuit-breakers, switches, disconnecting switches, fuses, transformers, cables, etc.. In view of this, laboratory requires new generators master circuit breakers intended for use for short-circuit tests (or other kind of tests) in the test bays. This specification covers the supply of two sets of three single-pole generators master circuit breakers (MBs) along with its main interrupting chamber (for each single pole) and two local control panels for each set. It also includes all the required accessories and subsystems to properly install and operate the Generators master circuit breakers, ready for operation in the High Power Laboratory of CPRI-Bangalore.
2.0 2.1 2.2	GENERAL: 2.1 The purpose of this specification is to give the ratings for design, manufacture, testing, installation and commissioning of the Short Circuit Generator master circuit breakers as well as of all its accessories required for their use in the High Power Laboratory of CPRI-Bangalore. 2.2 The Short Circuit Generators master circuit breakers shall be used both as protection and break the test current during the short circuit test.
3.0 3.1 3.2	SCOPE: 3.1 This Scope covers the supply of two sets of three single-pole Short Circuit generators master circuit breakers along with its all accessories and subsystems to be installed for ready operation at the High Power Laboratory, CPRI-Bangalore. 3.2 This specification defines the conditions that the Short Circuit Generators master circuit breakers must satisfy the design, manufacture, characteristics, ratings and qualification testing and approval to be implemented in order to establish their compliance with the requested requirements.

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3.3	The supply shall include but not limited to the following: • Two (2) sets of 3 single-pole generators master circuit breakers to be connected at the output terminals of short-circuit generators at a voltage not exceeding 17.5 kV, identified as MB2 and MB3 in fig. (1) of the Single Line Diagram of High Power Laboratory. • Each single-pole shall include a main interrupting chamber which may be connected in parallel to an opening resistor according to the manufacturer design, in order to limit any over-voltage due to the breaking of the current • Two (2) local control panels, one for each set of 3 single poles • Two (2) remote control panels, one for each set of 3 single poles • All the required accessories, wiring, control & monitoring system and subsystems needed to install and operate the generators master circuit breakers. If generators master circuit breaker is air blast type, the supply of complete compressor system, piping between Air compressor and Master circuit breakers and Air storage according to pressure and volume required for two sets ready for use, control system, but not limited to this satisfactory operation of generators master circuit breakers is in bidder's scope. • Synchronised operation with make switches and other equipment for satisfactory operation of short circuit laboratory while operating standalone and in parallel operation of Short Circuit Generators. • The installation and commissioning activities by a team of specialized workers from the Bidder. • Special tool and tackles for maintenance purposes • Mandatory spares
3.4	The Bidder shall be responsible for the following activities: • Design • Manufacturing • Factory tests, Routine tests and Type tests • Transportation to CPRI Bengaluru site, unloading, handling and storage at the site • Erection & installation • Site tests • Commissioning • Personnel training of the new master circuit breakers complete with all accessories and subsystems.
3.5	These activities will be performed in a dedicated period, according to CPRI, in order to avoid interferences with other works.

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4.0	CLIMATIC CONDITIONS: The Short Circuit Generator master circuit breakers and its accessories shall be designed for satisfactory operation under tropical climatic conditions prevailing in India. The climatic conditions prevalent at the site of the operation are as follows; a) Altitude above Mean Sea Level : 921m b) Maximum ambient temperature : 45°C c) Minimum ambient temperature : 10°C d) Average annual temperature : 24°C e) Average Humidity : 81% f) Special corrosion conditions : Nil g) Solar Radiation (DNI) : 4.5-5.0 kWh/Sq. m/Day h) Atmospheric UV radiation : High i) Pollution level : Moderate j) Snow fall : NIL k) Seismic Zone : Zone-II l) Wind Speed : Average 5.6 km/h The site location is situated in the CPRI campus located adjacent to Indian Institute of Science. The site can be approached a) By Train: Nearest Railway station: Yeshwanthpur b) By Air: Kempegowda International airport 33 km away from site. c) Nearest Sea Port: Chennai
5.0	REFERENCE STANDARDS: The Short Circuit generator master circuit breakers devoted to high power testing laboratories are special equipment. For the definition of the parameters, of the performances and for any other prescriptions given in this document, reference has to be made to the following IEC Standards. If a relevant IEC Publication does not exist, the Bidder shall adopt other internationally accepted standards and codes. The generator master breaker shall comply with the requirements of the latest edition of the following IEC Standards: [1] IEC 62271-1 : High-voltage switchgear and control gear - Common specifications [2] IEC 62271-100 : High-voltage switchgear and control gear - Alternating current circuit breakers [3] IEC 60529: Degrees of protection provided by enclosures (IP Code)

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	The relevant texts are those of the most recent editions of these standards. Reference standards are considered integral part of the present Technical Specification. The equipment has to be compliant with all Indian laws applicable. In the matter of conformity, the following order shall be binding: • The requirements of this specification • The latest versions of IEC Publication • To the latest versions of other national/international standards/codes as applicable to the relevant equipment or component or the material used in the manufacture of the same. • In the event a requirement is not covered by any of the above mentioned documents the same will be decided by mutual agreement between the CPRI and the Bidder.
6 6.1 6.2 6.3	SYSTEM PARTICULARS: The Short Circuit Generator Master circuit breakers intended to protect both the test laboratory and the test object against excessive duration of test current or in case of the occurrence of a fault on the power circuit of the station. Consequently, they shall be capable of operating to protect the test laboratory under different test conditions and to limit the test duration if the apparatus under test does not succeed in clearing the test current and also for other equipment any switching devices e.g. transformer, reactors, arc test, cables, busducts etc. The Master circuit breakers shall be installed on the first floor (+9.3 meters above the ground level) of the short-circuit generator building and its location between the downstream of the generator outputs and upstream of the make switches as shown in the Fig (1). The control panels and monitoring system shall be installed in the control room of short-circuit generator building accordingly the wiring system to be connected. If the supplied Master breaker is airblast type, the subsystem i.e. air compressor to be installed on the basement (-6 meters approx. from ground level) of the short-circuit generator building accordingly the complete system shall be designed including piping work between compressor and master circuit breakers. The supply and wiring of the various control devices and links of the master circuit breakers: • Suitable system for simultaneous tripping of three master circuit breakers (emergency tripping), located in the generator control room and in test control room and wiring of the related links as well as their connection to the terminal box associated with the control units of the master circuit breakers.

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6.4 6.5	- Wiring and connection of the control links transmitting the tripping orders issued from the protection devices of the short circuit generators (or) the test programming units located in the test control room (or) test cell protection devices located in the test control room. The Short Circuit generator master circuit breaker tripping controls shall be made available in the Generator control room: - Suitable system for opening and closing of the master circuit breaker (one per apparatus) located in the generator control room and wiring of the related links as well as their connection to the control units of the master circuit breakers. - Display in the generator control room of the following master circuit breaker signals – closed position, open position, quenching air under pressure, control air under pressure, quenching air available, control air available, suitable indications to identify the healthiness of Master circuit breakers as well as wiring of the related links. For running two phase and three phase tests, it is necessary to actuate each circuit breaker along with each make switch of Short Circuit Generator system separately.																
7.0	MAIN TECHNICAL DATA: The rated voltage of the Master circuit breakers to be supplied shall be equal to the rated open circuit voltage of the short circuit generators i.e. 14.0kV. The following table gives the main technical data of master circuit breakers. Table 1: Main technical data of Short circuit Generator master circuit breaker <table data-bbox="357 1368 1410 2033"> <tr> <th data-bbox="357 1368 995 1429">Characteristics</th><th data-bbox="995 1368 1410 1429">Requirements</th></tr> <tr> <td data-bbox="357 1429 995 1480">Number of units</td><td data-bbox="995 1429 1410 1480">2 sets of 3 single-pole</td></tr> <tr> <td data-bbox="357 1480 995 1532">Class</td><td data-bbox="995 1480 1410 1532">Indoor</td></tr> <tr> <td data-bbox="357 1532 995 1583">Rated voltage</td><td data-bbox="995 1532 1410 1583">14 kV</td></tr> <tr> <td data-bbox="357 1583 995 1635">System Rated voltage</td><td data-bbox="995 1583 1410 1635">17.5 kV</td></tr> <tr> <td data-bbox="357 1635 995 1812">Rated short-duration power-frequency withstand voltage Common value Across the isolating distance</td><td data-bbox="995 1635 1410 1812">38 kV 45 kV</td></tr> <tr> <td data-bbox="357 1812 995 1955">Rated lightning impulse withstand voltage Common value Across the isolating distance</td><td data-bbox="995 1812 1410 1955">75 kV 85 kV</td></tr> <tr> <td data-bbox="357 1955 995 2033">Rated Frequency</td><td data-bbox="995 1955 1410 2033">50/60 Hz The generator master circuit breakers</td></tr> </table>	Characteristics	Requirements	Number of units	2 sets of 3 single-pole	Class	Indoor	Rated voltage	14 kV	System Rated voltage	17.5 kV	Rated short-duration power-frequency withstand voltage Common value Across the isolating distance	38 kV 45 kV	Rated lightning impulse withstand voltage Common value Across the isolating distance	75 kV 85 kV	Rated Frequency	50/60 Hz The generator master circuit breakers
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		shall also be able to operate at any frequency between 16 2/3Hz and 60Hz. The Bidder shall set down the corresponding guaranteed performances.
	Rated normal current	to be defined by the Bidder
	Rated short-circuit breaking current I_R RMS value Peak value Rated short circuit current duration DC time constant Number of breaking operation during lifetime	120 kArms 360 kApeak 1.0 s 120 ms 5000
	Fault short-circuit breaking current (exceptional conditions) RMS value Peak value DC time constant Fault short-circuit current duration	≥ 165 kArms ≥ 430 kApeak 120 ms 0.5 s
	First pole-to-clear factor	1.5
	Rated operating sequence	CO - 60s – CO
	Rated operating time: Opening time Opening time discrepancy between poles Scattering (repeatability of opening time) Minimum arcing time Maximum break time (opening time plus arcing time) Closing time and uncertainty	< 10 ms < 1 ms ± 0.5 ms < 1 ms < 20 ms to be defined by the Bidder
	Frequency of mechanical operations	class M2
	Rated Transient Recovery Voltage for terminals faults Frequency Amplitude factor	≥ 60 kHz ^{**} 1.9 p.u.
	Rated making current Characteristic of electrical endurance (Minimum required value)	To be defined by the Bidder $I_Z \geq 10000$ kA

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	Specific minimum values of the cumulative current broken	to be defined by the Bidder
	Centre-line distance between phases	4 to 6 meters
	Auxiliary and control circuits: Rated supply voltage and rated supply frequency Number and type of spare auxiliary switches Rated operating mechanism pressure (if any) Arc chamber pressure (if any)	230V(1-Φ)/415V(3-Φ) 50 Hz or 220V DC ^(*) to be agreed with the CPRI to be defined by the Bidder to be defined by the Bidder
	Opening resistor (if any)	to be defined by the Bidder
	Auxiliary circuit breaker for the opening resistor (if any)	to be defined by the Bidder
	Master circuit breaker Sub-system	to be defined by the Bidder
	Note: ^(*)Other than 220V DC supply, the source along with the batteries shall be supplied by the Bidder meeting the operational requirements. ** The circuit breakers shall be designed to match the test circuit inherent transient frequency of 60kHz and an amplitude factor of 1.9. However, if the maximum transient frequency for which the circuit breakers are designed is lower than 60kHz, the bidder shall provide for suitable capacitors to reduce the inherent transient frequency of. The inherent transient frequency shall not be lower than 30kHz.	
8.0 8.1	GENERAL REQUIREMENTS: Generators Master Circuit breakers Service: In the high-power laboratory where the generator master circuit breakers will operate, high-power equipment will be tested against very high peak and short-time currents. As a consequence, in normal service conditions the generator master circuit breakers shall be subjected to very high thermal, dielectric and mechanical stresses. The generator master circuit breakers included in the scope of these technical specifications are special switching devices normally used to maintain and break a test current at specified intervals of time in order to perform a short-circuit test. In addition, they have the purpose of providing protection to the short-circuit generators either in standalone and parallel operation and to the equipment under test, by breaking the fault current after a minimum delay in case of:	

Clause No.	TECHNICAL SPECIFICATION
	• a short-circuit fault occurring in the system • a misoperation of the circuit breaker under test (i.e. if it fails in opening the test current) In order to prevent damages to the test object and to other components in the test circuit, the master breaker shall be able to cut the test or fault short-circuit current with a short opening time, which shall not exceed the values prescribed in clause 7. A typical service of generator master circuit breakers during a short circuit test sequence foresees: (i) the application of the rated voltage up to the terminals of the laboratory making switch (ii) the closing of the three or two-phase test current by the laboratory making switch (iii) the circulation of the test current (iv) the current breaking by the generator master breaker (v) the appearance of a transient recovery voltage (TRV). 8.2 Performances: The requirements of IEC 62271-100 with respect to routine tests, type tests, service, operation and breaking of laboratory currents shall apply to the specified generator master circuit breakers, as far as they are relevant to their rating. 8.3 Type of operation: The rated operating sequence of the generator master circuit breakers is defined as follows: CO – 60s – CO At the rated operating sequence and at the rated frequency the generator master breaker shall be capable of breaking any current up to the ‘fault short-circuit breaking current’ with a power frequency recovery voltage corresponding to the rated voltage and a transient recovery voltage equal to the rated one (make reference to clause 7). The generator master circuit breakers will be installed in a high power test facility which will be operated with the followings basic duty cycles: a) Six (6) totally asymmetrical short circuits at the rated short-circuit current I_R (see clause 8.18), each one lasting 0.15 s, in a period of 30 min. The interval between two consecutive short-circuit can be 3 min. At the end of this test cycle, a pause of 30 min shall be followed.

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	b) One (1) totally asymmetrical short-circuit at the rated short-circuit current, lasting 1 s, repeatable every 30 minutes.						
9.0	SPECIAL REQUIEMNTS:						
9.1	Breaking of the laboratory transformers magnetizing current: The master circuit breakers shall be able to break the steady state and transient laboratory transformers magnetizing current, included in a range between 10 and 250 A. The switching overvoltage shall not exceed 2.5 p.u. of the phase-voltage peak.						
9.2	Breaking of low inductive current: The generators master circuit breakers shall be able to break low inductive current between 250 A and 4 kA (possible value of the normal rated current). The switching over voltage shall not exceed 2.5 p.u. of the phase-voltage peak.						
9.3	Breaking of capacitive current: The generators master circuit breakers shall be able to break capacitive current between 5 A and 1 kA. The switching overvoltage shall not exceed 2.5 p.u. of the phase-voltage peak. The generators master circuit breakers shall be free from re-striking.						
9.4	Maximum breaking time: In any operating condition the total breaking time (opening time plus arcing time) shall be as low as possible and not be higher than 20 ms.						
9.5	Uncertainty of the opening time: The duration of the opening operation shall not show an uncertainty of exceeding 1 ms. In addition, the duration of the opening operation shall have a scattering (repeatability of opening time) of ± 0.5 ms.						
9.6	Specific creepage distance: The specific creepage distance for generators master circuit breakers must be at least the value specified in the table here below; <table><tr><th>Installation</th><th>Specific creepage distance</th><th>USCD</th></tr><tr><td>Indoor</td><td>20 mm/kV</td><td>34.7 mm/kV</td></tr></table>	Installation	Specific creepage distance	USCD	Indoor	20 mm/kV	34.7 mm/kV
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Clause No.	TECHNICAL SPECIFICATION
10.0	REQUIRED DESIGN AND FEATURES:
10.1	General: The generator master circuit breakers shall be designed for indoor installation, with free-standing design. They shall be designed to perform both 50 Hz and 60 Hz tests. All master circuit breakers with control unit and accessories to be supplied shall be identical and shall be such that one unit could be replaced by any other. It shall be possible to know the operating position of the circuit breakers by means of a reliable position indicating device whose information will be remotely transmitted to the station control room. Reliability of the indicating device shall be proved to guarantee that the actual positions of the circuit breakers are displayed so as to ensure safety of operating personnel and equipment.
10.2	Size constraints: The generator master circuit breakers shall be installed in the HPL Generators Building and connected to the short-circuit generators terminals. Each single-pole of the generator master circuit breakers will be installed in a dedicated cell with the purpose of physically segregating each phase of the short-circuit generators. With reference to the present specifications, which refer to the case of one single-pole per each phase, the cell width is limited to about 3 m, while the available length for each pole is about 3.5 m.
10.3	Operating Mechanism: The operating mechanism shall be complete of all requested components. Generator master circuit breakers shall be capable to operate according with high reliability and declared performances over an extended life time, according to the requirements of clause 12. If the mechanism is operated by air pressure, the Bidder shall supply subsystem i.e. compressor system and storage cylinders as per the pressure and volume required. In order to reduce the contact wear, it is advisable to operate synchronized switching. However, since a failure of the synchronous control system should not be excluded, the circuit breakers shall be designed in such a way that they can fulfil all the switching operations at the short circuit breaking currents stated in clause 7 without any synchronised control mechanism.

Clause No.	TECHNICAL SPECIFICATION
10.4	Auxiliary and control panels: The generator master circuit breakers shall be supplied complete with all auxiliaries and controls necessary for proper operation in accordance with the intended use. Conceptually, the following functional subsystems can be identified: - the local auxiliary electrical panel that provides the auxiliary power supply to the operating mechanism of the generator master circuit breakers and acts as an interface to the control unit for synchronised operations; it includes auxiliary switches and associated relays, control switches, control cable terminations and other auxiliary equipment. - the control unit that manages the synchronised opening operations of the generator master circuit breakers, receives the start order from the Laboratory Test Sequencer, monitors the status and manages the alarms. The control system shall be composed of a separate unit for each three-phase generator master breaker and shall be able to operate the three poles jointly or separately. The control system shall be able to set a delay of operation from the reception of the trigger signal by the control system of the Laboratory. The Bidder shall provide information on the block diagram of the generator master breakers auxiliary and control systems, expected interfaces with the Laboratory control system and suggested installation conditions of the auxiliary and control panels. In particular, the Bidder shall define which kind of control signal is foreseen as opening order for a synchronised opening operation. The control system shall be immune to the interference given by the high current flowing in the power circuit and in the surrounding equipment. The Bidder shall declare in his offer the immunity level of the control system.
10.5	Operation mode: The operating mechanism shall allow the following modes: - Local operation: Local electrical operation by push-buttons placed on local auxiliary electrical panel. - Remote operation: Electrical operation from control unit, the Laboratory control system and and test sequencer from test control room. The selection of any one of the above position shall exclude the possibility of operation from the other position.

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10.6	Auxiliary contacts: Sufficient nos. of N/O and N/C auxiliary electrical contacts shall be provided in order to use for interlocking circuits and for status indications at the remote and supervisory control centres and any other requirements. Each generator master breaker pole shall be equipped with at least the following auxiliary contacts of high reliability so as to ensure the exact status of the generator master circuit breakers: • 4 contacts NC in open position • 4 contacts NC in closed position • 4 contacts NO in open position • 4 contacts NO in closed position The signal for “Master breaker closed” shall be given only after complete closing, which means that the rated current can run through the master breaker, while the signal for “Master breaker open” shall be given only after the complete opening when the isolating distance is sufficient to withstand with success the required dielectric test.
10.7	Type of materials used for no current parts of generator master breakers: The non-current carrying metallic parts of generator master circuit breakers can be either made of hot dip galvanized steel or stainless steel. Cast iron can be used only in places where applied forces are not relevant. Cast iron shall also be hot dip galvanized.
10.8	Type of materials used for assembly components of generator master breakers: All bolts, nuts and washers which are used in current carrying parts of the generator master circuit breakers shall either be of stainless steel or bronze. All bolts, nuts and washers which are used in the non-current parts of the generator master circuit breakers shall be hot dip galvanized steel or stainless steel.
10.9	Operating mechanism housing: The housing of the operating mechanism shall be of hot-dip galvanized steel. As the generator master circuit breakers is intended for indoor installation, the minimum degree of protection of the housing shall be IP21, refer IEC 60529 standard. The housing of the operating mechanism, as well as the local control panel, shall be equipped with anti-condensation heater controlled by thermostat (230V, 50Hz supplied – to be agreed with the CPRI) if necessary.

Clause No.	TECHNICAL SPECIFICATION
10.10	When applicable, the power of the resistor has to be indicated by Bidder. Marking and plates: Marking and plates shall comply with relevant IEC standards and with all applicable Indian standards.
11.0 11.1 11.2 11.3 11.4 11.5 11.6 11.7 11.8 11.9	CONSTRUCTIONAL REQUIREMENTS: The constructional features of the various parts making up the master circuit breakers shall comply with the special operating conditions of the circuit breakers as stated in above sub clauses. Main pieces such as contacts require particularly reliable features. In general, the master circuit breakers shall be mechanically reliable and have low maintenance requirements so that test operation without interruption and a steady utilization of the testing station could be guaranteed. If master circuit breaker is air blast type, compressed air and electronic control units shall include all the items necessary to ensure convenient operation of the circuit breakers in accordance with the above design requirements. The mentioned items shall be designed, assembled and connected accordingly and shall limit maintenance requirements of the units. Electric and pneumatic connections shall be suitably sized and joined to the units and it shall operate under local climatic conditions. All non-current carrying metal parts of the circuit breakers shall be provided with two reliable earthing terminals for connection to an earthing conductor. The electronic control units will be earthed to the special electronic earthing circuit of the laboratory. The circuit breaker terminals shall be so designed and positioned as to allow easy and reliable connection with the external circuit. The bidder shall provide the necessary insulation level between the various parts of the breakers, their operating mechanisms and the main circuits in order to prevent unintentional frame connections. The circuit breakers shall be equipped with a tripping operation counter.
12.0 12.1	MAINTENANCE REQUIREMENTS: The generator master circuit breakers shall be fit for frequent mechanical operation on no-load conditions. Therefore a performance corresponding to M2 class with respect to mechanical endurance and a design lifetime of 30 years is required.

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12.2 12.3 12.4	In addition, the master circuit breakers shall perform repeated breaking operations at any current up to the rated and fault short-circuit breaking current, before maintenance is required. Specific minimum values of the cumulative current broken without maintenance shall be specified by the Bidder and this value shall be more than 10000 kA, which means a minimum of 100 current breaking operations at a current of not less than 100kA at system rated voltage. Emphasis is placed on the need for reliability of design in order to give long continuous service with low maintenance costs. Tender submissions shall include evidence of mechanism reliability and low contacts wear in service. The Bidder shall declare in his offer the generator master circuit breakers maintenance intervals, specifying also the parts that have to be maintained and replaced. In particular the manufacturer must clarify for: • mechanical operations, how many inspections and revisions (if any) are necessary within the 10000 operation (M2 class) (periodic revision) • electrical operations, the: – list of inspections and revisions of the parts involved in the breaking process after the specified cumulative current broken is reached (periodic revision); – list of inspections and revisions of the parts of the circuit breaker elements not involved in the breaking process (major revision). The Bidder shall clarify if and when the (periodic) maintenance can be performed by CPRI's maintenance personnel (under proper training phase, to be included in the supply) and if and when the (major) maintenance must be performed by the Bidder personnel (in this case the Bidder shall clarify if the maintenance will be performed either at CPRI or at Manufacturer site). Any special tool and tackles for maintenance purposes shall be included in the scope of supply.
13.0	INSPECTION AND TESTS: The Bidder shall plan the testing requirements of this specification as given below; a) The tests that are feasible at the Manufacturer works shall be conducted in the presence of CPRI representative/s or authorised CPRI representative. The tests that are not feasible at Manufacturer works shall be conducted at any of the STL member Laboratory and witnessed by CPRI representative/s or authorised CPRI representative. b) The test charges shall be borne by the Bidder and same shall be furnished separately in the price bid.

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13.1	Inspection during manufacturing: The Bidder shall propose a comprehensive inspection program during manufacture of the generator master circuit breakers and obtain the approval from CPRI. CPRI representatives shall be allowed to inspect the production process in the factory.																		
13.2	Type Tests: Short Circuit Generator master circuit breakers (MBs) shall have been type tested according to a specific test program to be communicated to the CPRI for approval, based on the technical feasibility and standards where applicable, to verify the quality and performances of the product. In principle the following type of tests shall have been performed, for which reference to the corresponding clause of latest IEC 62271-100 is given hereinafter, as far as applicable. <table data-bbox="359 1010 1013 1664"> <tr> <th data-bbox="359 1010 459 1059">No.</th><th data-bbox="459 1010 1013 1059">TESTS</th></tr> <tr> <td data-bbox="359 1059 459 1108">1</td><td data-bbox="459 1059 1013 1108">Dielectric tests</td></tr> <tr> <td data-bbox="359 1108 459 1200">2</td><td data-bbox="459 1108 1013 1200">Measurement of the resistance of the main circuit</td></tr> <tr> <td data-bbox="359 1200 459 1292">3</td><td data-bbox="459 1200 1013 1292">Short-time withstand current and peak withstand current tests</td></tr> <tr> <td data-bbox="359 1292 459 1384">4</td><td data-bbox="459 1292 1013 1384">Verification of the degree of protection, where ever applicable</td></tr> <tr> <td data-bbox="359 1384 459 1433">5</td><td data-bbox="459 1384 1013 1433">Tightness tests, if applicable</td></tr> <tr> <td data-bbox="359 1433 459 1525">6</td><td data-bbox="459 1433 1013 1525">Additional tests on auxiliary and control circuits</td></tr> <tr> <td data-bbox="359 1525 459 1574">7</td><td data-bbox="459 1525 1013 1574">Mechanical tests</td></tr> <tr> <td data-bbox="359 1574 459 1664">8</td><td data-bbox="459 1574 1013 1664">Short-circuit and Out-of-phase breaking current tests</td></tr> </table> It is understood that, for those tests for which no specific requirements have been defined in clauses 7 and 9, the Bidder shall define and prove the relevant rated characteristics generally in accordance with IEC 62271-100 prescriptions, where ever applicable. Type test repetition is not required provided that the Bidder can submit valid type test certificates, not older than 10 years. Otherwise type test will be performed at Bidder exclusive cost.	No.	TESTS	1	Dielectric tests	2	Measurement of the resistance of the main circuit	3	Short-time withstand current and peak withstand current tests	4	Verification of the degree of protection, where ever applicable	5	Tightness tests, if applicable	6	Additional tests on auxiliary and control circuits	7	Mechanical tests	8	Short-circuit and Out-of-phase breaking current tests
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8	Short-circuit and Out-of-phase breaking current tests																		

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13.2.1 13.2.2 13.2.3 13.2.4 13.2.5	The requirements for conducting above type tests as given below; Dielectric tests The dielectric test shall be carried out as per procedure defined in IEC 62271-100. The test voltage shall be in accordance with those specified in Clause no. 7.0 of the technical specifications of MBs. Measurement of the resistance of the main circuit The Measurement of the resistance of the main circuit shall be carried out as per procedure defined in IEC 62271-100. Short-time withstand current and peak withstand current tests The short time withstand current and peak withstand current test shall be performed as per the procedure defined in IEC 62271-100, taking in to account the special requirement of this specification. The test circuit shall be such that the return conductor will be at a distance corresponding to the value provided between two phases of the station (i.e. between 4-6m). The following tests shall be performed: – 1 fully asymmetrical current test with r.m.s test current value of 165kA, the peak current being not less than 430kA for duration of 0.5 second. – 1 test with an r.m.s test current value of 120kA, the peak current being not less than 300kA; the short circuit duration shall be 1.0 second. After the test, circuit breaker shall not show any mechanical and di-electric deterioration and shall be capable of operating normally and particularly, any breaking tests as stated in clause no. 7.0 of the technical specifications of MBs could be performed. The resistance of the main circuit of MB after the tests, shall not exceed 20% of the before test value. The MB shall withstand rated power frequency high voltage test for 1 minute duration as per the values given in clause no. 7.0 of the technical specifications of MBs, across open contacts and live parts to ground with MB closed. Verification of the degree of protection Verification of the degree of protection shall be carried out as per procedure defined in IEC 62271-100 where ever applicable for IP XX rating as declared by Bidder. Tightness tests Tightness tests shall be carried out as per procedure defined in IEC 62271-100

Clause No.	TECHNICAL SPECIFICATION
13.2.6	where ever applicable. Additional tests on auxiliary and control circuits Additional tests on auxiliary and control circuits shall be carried out as per procedure defined in IEC 62271-100.
	13.2.7 Mechanical Tests The mechanical test shall be consists of 2000 operating cycles without voltage on or current in the main circuit. The tests shall be carried out as per the procedure defined in IEC 62271-100 without any maintenance. However, the closing time and opening time shall be measured each 200 CO operations when the technical tests are performed. Ten CO operations shall be carried out on each of the other five units in order to check the accuracy and the reliability of the opening time and closing time of each unit of the other five units in order to check the accuracy and reliability of the opening time and closing time of each unit. The maintenance schedule and list of renewable parts shall be defined by the Bidder for confirming the MBs to comply M2class (10,000 operations). 13.2.8 Short-circuit and Out-of-phase breaking current tests One Mater Circuit Breaker (on which Mechanical Tests are completed) shall be submitted to test to prove its breaking capacity, taking in to account the special requirement of this specification. The test circuit shall be such that the return conductor will be at a distance corresponding to the provided between two phases of the station (i.e. between 4-6m). Taking into account the particular use and special in nature of these circuit-breakers, the conventional Circuit Breakers test procedure as per IEC cannot be strictly applied. The general arrangements of the station will be such that the current limitation devices will always be connected downstream of the circuit-breakers which will be directly connected to the short-circuit generator terminals. Consequently, the test conditions shall match as far as possible the actual operating conditions on site, particularly with regards to the transient recovery voltage. Breaking test required by the present specifications shall be performed using the

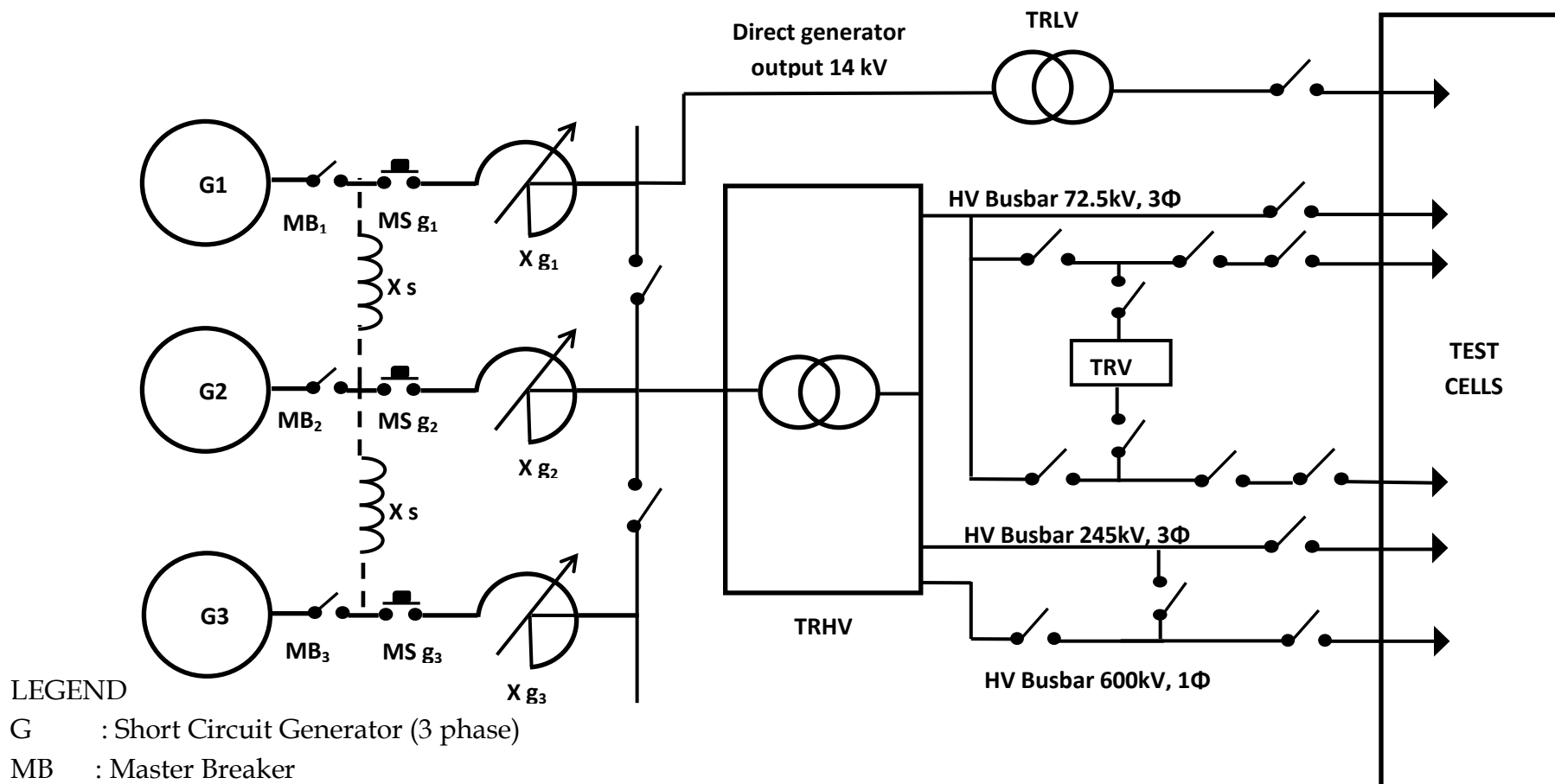
Clause No.	TECHNICAL SPECIFICATION
	synchronized breaking procedure, and the contacts shall not be changed until the test sequence is completed. According to the requirements of this specification the following tests shall be carries out: a) 03 no. of breaking tests at 10% of the rated short circuit breaking current (12kArms) b) 03 no. of breaking tests at 30% of the rated short circuit breaking current (36kArms) c) 03 no. of breaking tests at 60% of the rated short circuit breaking current (72kArms) d) 10 no. of breaking tests at 100% of the rated short circuit breaking current (120kArms) e) 03 no. of Asymmetrical breaking tests with the DC component (as declared by the manufacturer based on the opening time and protection tripping time according to IEC 62271-100) shall be performed (120kArms). f) 03 no. of out of phase breaking current tests (at 30kArms) as per the procedure defined in IEC 62271-100 shall be performed at voltage factor of 2.5. In addition, one breaking test at 100% of the exceptional short circuit breaking current (165kArms) and one more exceptional short circuit breaking current (165kArms) test with a maximum arcing time (>10ms) shall be carried out to check the behaviour of the circuit breaker in case of failure of synchronized breaking system. The parameters of the transient recovery voltage being in accordance with those stated in sub-clause no. 7.0. The exact test conditions shall be discussed with and agreed by CPRI. No negative tolerance on the above said a test current is allowed. However, there is no limit on positive tolerance. After this test sequence, to meet the requirement of electrical endurance characteristic of $I_{\Sigma} \geq 10000$ kA and particularly the main contacts shall not show any excessive arcing. The condition of MB after the above tests shall be as per IEC 62271-100. MBs shall be tested for Breaking of the laboratory transformers magnetizing current and Breaking of low inductive current tests according to clause no. 9.1 and 9.2 respectively of this technical specification. The no. of tests for each current value given in clause no. 13.4.2 shall be 10. A tolerance of $\pm 10\%$ is allowed on the test currents given in 13.4.2. MBs shall be designed for capacitive current switching tests according to clause no. 9.3 and 13.4.2 of this technical specification. No type test report/certificate is

Clause No.	TECHNICAL SPECIFICATION													
13.3	required for these tests.													
	Routine Tests:													
	Generator master circuit breakers shall be subjected to routine tests according to a specific program to be agreed with the CPRI at manufacturer’s work, based on the technical feasibility and standards where applicable, to verify the quality and performances of the product.													
	In principle the following routine of tests shall be performed, for which reference to the corresponding clause of IEC 62271-100 is given hereinafter, as far as applicable.													
	<table><tr><th>No.</th><th>TESTS</th></tr><tr><td>1</td><td>Dielectric test on the main circuit</td></tr><tr><td>2</td><td>Dielectric test on the auxiliary and control circuits</td></tr><tr><td>3</td><td>Measurement of the resistance of the main circuit</td></tr><tr><td>4</td><td>Tightness Test, if applicable</td></tr><tr><td>5</td><td>Design and visual checks</td></tr><tr><td>6</td><td>Mechanical operation tests</td></tr></table>	No.	TESTS	1	Dielectric test on the main circuit	2	Dielectric test on the auxiliary and control circuits	3	Measurement of the resistance of the main circuit	4	Tightness Test, if applicable	5	Design and visual checks	6
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6	Mechanical operation tests													
13.4	During mechanical operating tests, satisfactory operation of the indicating devices shall be checked.													
	Additional tests:													
13.4.1	The execution of the additional tests is subjected to CPRI decision. Alternatively the Bidder may demonstrate the capability of his product by appropriate certifications.													
	Short circuit cycle test:													
	In addition to its rated operated sequence (which shall be tested according to IEC 62271-100), the “short circuit cycle test” foresees the application of the worst laboratory basic duty cycle to be withstood by the generator master circuit breakers.													
	For the generator master circuit breakers here specified, the worst duty cycle is the one described in clause 8.3:													
	0.15s ON - O - 3min OFF - C - 0.15s ON - O - 3min OFF - C - 0.15s ON - O - 3min OFF - C - 0.15s ON - O - 3min OFF - C - 0.15s ON - O - 3min OFF - C - 0.15s ON - O													

Clause No.	TECHNICAL SPECIFICATION
13.4.2	Where, 'C' operation is in no-load condition (zero current). Test procedure and evaluation of results shall comply with the relevant prescriptions of IEC 62271-100 (where applicable). Low inductive and capacitive switching tests The generator master circuit breakers shall be subjected to the following tests: • Magnetizing current and low inductive current switching tests with the followings values: 10 - 50 - 100 - 200 - 500 - 1000 - 2000 A • Capacitive switching tests with the followings values: 5 - 10 - 100 - 200 - 500 - 1000 A Test procedure and evaluation of results shall comply with the relevant prescriptions of IEC 62271-100 (where applicable).
14	INSTALLATION AND FINAL ACCEPTANCE: 14.1 The generator master circuit breakers shall be installed in CPRI HPL in Bangalore and tested for final acceptance. The Bidder shall install all master circuit breakers and to check the correct operation of the generator master circuit breakers. CPRI will then perform mechanical and electrical tests on the installed generator master circuit breakers in the presence of Bidder, aimed to the final acceptance of the supply. The specific test program covering current interruption up to rated/fault short circuit breaking current is to be agreed between Bidder and CPRI based on the technical feasibility and following IEC 62271-1 and IEC 62271-100 where applicable, with the aim to verify the fulfilment of the generator master circuit breakers to the parameters of clause 7, as declared by the Bidder, and to verify the control system operation and performance under the real operating conditions. No damage shall result from these tests. 14.2 They will be commissioned after satisfying all above tests and providing their compliance with all the requirements of this specification. 14.3 Equipment could be energized only after the personnel performing the tests have certified that said equipment is ready for energizing and after approval by CPRI. 14.4 The bidder shall then provide all the necessary documents, updated, to allow the operation and maintenance teams to work on the equipment after completion of the personnel training programme.

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14.5	CPRI shall be entitled to reject any of the equipment if it does not fulfil duty requirements and tests as specified in this document.
15	SPARE PARTS and MAINTENANCE: The bidder shall have to propose and quote for mandatory spares, which are mandatory to be procured for first ten years normal operation. Mandatory spares quote shall be included in the main equipment cost for bid evaluation purpose. The bidder shall have to propose and quote for recommended spares with a minimum validity of one year. Recommended spares quote shall not be included in the main equipment cost for bid evaluation purpose. The bidder shall supply all the special tools and tackles necessary for both routine & main maintenance and mounting or dismounting operations as regards removable equipment. The bidder shall indicate the maintenance schedule proposed during the guarantee period and service life of the various items of equipment offered, when operated and maintained in accordance with instructions of the manufacturers.
16.0	WARRANTY: The Bidder will guarantee, for the duration indicated in the tender documents from the date of the commissioning, all the making switches and accessories, with reference to materials quality and declared performances. In case of damages resulting from the Bidder supply and activities, the Bidder will substitute at its expenses the faulty parts and all the parts not compliant with declared performances.
17.0	PERSONNEL TRAINING: During erection and acceptance tests at site, the bidder shall have to organize a training programme for CPRI's maintenance and operation teams. Bidder shall plan the erection period in compliance with the general schedule. The personnel constituting his own starting up team shall be sufficient and shall have the right qualification level to implement this training programme which will last for 3 days during erection and commissioning. The content of the suggested programme shall be submitted in the Bid.
18.0	DOCUMENTATION: The information to be submitted with the offer shall include:

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	• Technical pamphlets and brochures of the offered generator master circuit breakers which will help the technical evaluation process. • Outline drawing showing overall dimensions of the generator master circuit breakers, drawing indicating terminal markings as well as any information, sketches and data necessary for a complete description of the proposal. • Mechanical and electrical endurance data. • Any type test certificates for the type and special test specified in this hereby specification. • List of spare parts, maintenance program. • Any special tool for maintenance purposes. All the information required by IEC 62271-100 clause 9.102 (“Information to be given with tenders”) shall be included in the offer. The following documents shall be provided along with the supply: • General drawings, electrical schemes, installation drawings. • Operation manual and Maintenance manual: the manuals shall contain specific diagrams with complete instructions relevant to storage, handling, construction, commissioning, troubleshooting, servicing. • The curve of generator master circuit breakers capabilities in terms of made currents / cumulated current (electrical endurance) before any maintenance is requested. • Reports of in-production inspections. • Reports of routine/acceptance tests performed on generator master circuit breakers. All documents shall be issued in English and provided both on paper and on digital support.

Fig (1) : High Power Laboratory**LEGEND**

G : Short Circuit Generator (3 phase)

MB : Master Breaker

MS : Make Switch

X : Adjustable reactors

X s : Synchronizing reactors

TRHV: Step up transformer

TRLV : 300kA high current transformer

TRV :TRV adjustment elements