Compact Substation Technical Specification

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1. General Provisions

1.1 Purpose

This document defines the minimum technical requirements for the compact substation package of the Project. The compact substation shall generally include the medium-voltage switching section or RMU, power transformer, low-voltage switchgear, auxiliary service equipment, enclosure or housing, internal wiring, earthing system, ventilation, lighting, space heating, cable termination facilities, and all accessories required for safe, reliable, and continuous operation under the specified site conditions. This document shall be read together with the applicable Single Line Diagram, Material Requisition, data sheets, cable schedule, and other project documents. In case of any conflict between this document and other project documents, the order of precedence stated in the Material Requisition, contract, or purchase documents shall apply.

1.2 Scope of Document

This Technical Specification defines the minimum functional, electrical, mechanical, environmental, constructional, inspection, testing, and documentation requirements for the compact substation. Equipment ratings, quantities, feeder arrangement, transformer rating, switchgear configuration, protection functions, metering requirements, and terminal points shall be as specified in the applicable Single Line Diagram, Material Requisition, and project data sheets. The Vendor shall review all project documents and shall ensure that the offered compact substation is fully compatible with the project design, site conditions, cable interfaces, installation arrangement, operation philosophy, and applicable standards.

1.3 Project Description

The Project consists of grid-connected solar photovoltaic power plants. The compact substations are intended to collect the low-voltage AC output from PV inverters, step up the voltage through the power transformer, and interface with the medium-voltage collection system through the MV/RMU section. The compact substation shall be suitable for outdoor installation in a solar power plant environment, including high ambient temperature, direct solar radiation, dust, sand, wind, and site-specific environmental conditions.

1.4 Scope of Supply

Unless otherwise specified in the Material Requisition or other project documents, the compact substation package shall include the following as a minimum:

- Compact substation enclosure or housing with separate compartments as required for MV/RMU, transformer, LV switchgear, and auxiliary/control equipment.
- Medium-voltage RMU or switchgear section, including switching, protection, earthing, indication, interlocking, cable termination facilities, and required accessories according to the approved Single Line Diagram.

- Power transformer complete with standard accessories, protection devices, fittings, oil containment or drainage provisions, and monitoring devices.
- Low-voltage switchgear complete with incoming and outgoing feeders, busbars, circuit breakers, metering, protection, surge protection, auxiliary circuits, internal wiring, and terminal blocks as required.
- Auxiliary AC supply arrangement for internal loads of the compact substation, including lighting, heating, ventilation, sockets, control supply, communication/control equipment, and other internal consumers.
- Internal earthing and bonding system of the compact substation.
- Cable entry, gland plate, cable support, termination space, and sealing arrangement for MV, LV, auxiliary, control, and communication cables.
- Nameplates, warning labels, mimic diagrams, operating instructions, and safety signs.
- Factory tests, routine tests, inspection documents, drawings, manuals, and test certificates.

1.5 Scope Boundary and Interface Points

The terminal points of the compact substation shall be defined in the relevant Material Requisition, Single Line Diagram, and project interface documents. Unless otherwise specified, the scope boundaries and interface points shall generally include MV cable termination points at the RMU or switchgear cable boxes, LV AC cable termination points at the LV switchgear incoming and outgoing terminals, and auxiliary/control/communication terminal points at the relevant terminal blocks or communication interface panel. Earthing interface points shall be provided on the compact substation main earth bar or external earthing pads for connection to the plant earthing grid. The plant earthing grid and external earthing conductors are outside the compact substation package, unless otherwise specified in project documents. The Vendor shall provide sufficient space, mechanical support, bending radius, gland plates, non-magnetic cable entry plates where required, and termination facilities suitable for the specified MV and LV cables.

1.6 Exclusions

Unless explicitly stated in the Material Requisition or other project documents, the following items are excluded from the compact substation package:

- External MV, LV, auxiliary, control, and communication cables.
- Civil works, foundation, trench, duct bank, and external cable support system.
- External earthing grid outside the compact substation.
- Site installation works.
- External SCADA system, plant controller, and communication network outside the defined terminal points.

1.7 General Responsibility of Vendor

The Vendor shall be responsible for the complete engineering, coordination, manufacturing, assembly, internal integration, factory testing, packing, and documentation of the compact substation

package within the defined scope. The Vendor shall ensure full compatibility between the MV/RMU section, transformer, LV switchgear, auxiliary systems, enclosure, internal wiring, earthing, ventilation, and all other supplied components. Any deviation from this Technical Specification, Single Line Diagram, Material Requisition, or applicable standards shall be clearly identified by the Vendor in the deviation list for review and approval before manufacturing.

1.8 Order of Precedence

In case of discrepancy between project documents, the following order of precedence shall generally apply unless otherwise specified in the contract or Material Requisition:

- Contract or Purchase Order.
- Material Requisition.
- Approved Single Line Diagram.
- Project data sheets.
- This Technical Specification.
- Approved Vendor drawings and documents.
- Applicable standards and codes.

The Vendor shall notify the Purchaser of any conflict, ambiguity, or missing information before proceeding with detailed design or manufacturing.

2 Codes and Standards

2.1 General

The compact substation and all associated equipment shall be designed, manufactured, assembled, tested, inspected, packed, transported, installed, and commissioned in accordance with the latest applicable editions of IEC standards and other referenced international standards, unless otherwise specified in the project documents.

The standards listed in this section define the minimum requirements. Compliance with these standards shall not relieve the Vendor from providing a complete, safe, reliable, and fit-for-purpose compact substation suitable for the specified project conditions.

In case of conflict between the requirements of this Technical Specification and the applicable standards, the more stringent requirement shall apply, subject to Purchaser review and approval.

Equivalent international standards may be proposed by the Vendor, provided that the Vendor clearly identifies the equivalent standard, demonstrates technical equivalency, and obtains approval before implementation.

The Vendor shall comply with all applicable statutory, safety, environmental, transportation, and installation regulations relevant to the project location and the supplied equipment.

2.2 Applicable Standards

The following standards shall apply as minimum requirements, where relevant to the supplied equipment.

IEC 60076 Series	Power Transformers
IEC 60296	Electrical Application Fluids — Mineral Insulating Oil for Electrical Equipment
IEC 60137	Insulating Bushings for AC Voltages Above 1000 V
IEC 62271-1	High-voltage switchgear and controlgear — Part 1: General specifications for AC switchgear and controlgear
IEC 62271-100	Switchgear and Controlgear — Part 100: AC Circuit Breakers
IEC 62271-102	High-voltage switchgear and controlgear — Part 102: AC disconnect switches Disconnectors and earthing switches
IEC 62271-103	High-voltage switchgear and controlgear – Switches for rated voltages above 1 kV and up to and including 52 kV.
IEC 62271-105	High-voltage switchgear and controlgear – Alternating-current switch-fuse combinations.
IEC 62271-200	High-voltage switchgear and controlgear — Part 200: AC metal-enclosed switchgear and controlgear rated for voltages above 1 kV and not exceeding 52 kV
IEC 62271-202	High-voltage switchgear and controlgear - Part 202: AC prefabricated substations for rated voltages above 1 kV and up to and including 52 kV
IEC 62271-206	High-voltage switchgear and controlgear — Part 206: Voltage presence indication systems for rated voltages above 1 kV and up to 52 kV
IEC 60502-4	Power cables with extruded insulation and their accessories for rated voltages from 1 kV (Um = 1,2 kV) up to 30 kV (Um = 36 kV) - Part 4: Test requirements on accessories for cables with rated voltages from 6 kV (Um = 7,2 kV) up to 30 kV (Um = 36 kV)
IEC 61936-1	Power installations exceeding 1 kV AC.
IEC 61000 Series	Electromagnetic compatibility.
IEC 60865-1	Short-circuit currents – Calculation of effects.
IEC 61643 Series	Low-voltage surge protective devices.
IEC 60376	Specification of technical grade sulfur hexafluoride (SF6) for use in electrical equipment.
IEC 60480	Specifications for the re-use of sulfur hexafluoride (SF6) and its mixtures in electrical equipment.
IEC 60099-4	Surge Arresters – Part 4: Metal-Oxide Surge Arresters Without Gaps for AC System
IEC 61439-1	Low-Voltage Switchgear and Controlgear Assemblies – Part 1: General Rules
IEC 61439-2	Low-Voltage Switchgear and Controlgear Assemblies – Part 2: Power Switchgear and Controlgear Assemblies (PSC Assemblies)
IEC 60947 Series	Low-Voltage Switchgear and Controlgear
IEC 60364 Series	Low-Voltage Electrical Installations

IEC 60255 Series	Measuring relays and protection equipment.
IEC 62052 Series	Electricity metering equipment – General requirements, tests, and test conditions.
IEC 62053 Series	Electricity metering equipment – Particular requirements.
IEC 60529	Degrees of Protection Provided by Enclosures (IP Code)
IEC 62262	Degrees of Protection Provided by Enclosures for Electrical Equipment Against External Mechanical Impacts (IK Code)
ISO 12944 Series	Paints and varnishes – Corrosion protection of steel structures by protective paint systems.
EN 50522	Earthing of Power Installations Exceeding 1 kV AC
ISO 780	Packaging – Distribution Packaging – Graphical Symbols for Handling and Storage of Packages

2.3 Certification and Test Reports

The Vendor shall provide valid type test reports, routine test reports, certificates of conformity, and relevant factory test documents for the compact substation and its main components. As a minimum, the following documents shall be submitted for review:

- Type test report or certificate for the prefabricated compact substation according to IEC 62271-202, where applicable.
- Type test reports and routine test reports for the MV/RMU section according to the relevant parts of IEC 62271.
- Type test reports and routine test reports for the power transformer according to IEC 60076.
- Type test reports and routine test reports for the LV switchgear according to IEC 61439-1 and IEC 61439-2.
- Certificates and datasheets for major components including circuit breakers, disconnectors, earthing switches, protection relays, meters, surge arresters, bushings, current transformers, voltage transformers, auxiliary transformers, and other key equipment.

If any type test report is not available for the exact offered configuration, the Vendor shall clearly state the difference between the tested configuration and the offered equipment and shall justify the applicability of the submitted test report.

3 Site and Service Condition

3.1 General

The compact substation shall be suitable for continuous outdoor operation under the site and service conditions specified in this section and in the project documents. All equipment, components, materials, coatings, gaskets, seals, insulation systems, ventilation systems, auxiliary systems, and accessories shall be selected and designed for reliable operation under the specified environmental conditions. The Vendor shall consider the combined effect of high ambient temperature, direct solar radiation, dust, sand, wind, altitude, pollution, and outdoor installation on the design, derating,

temperature rise, insulation level, ventilation, enclosure protection, and long-term performance of the compact substation.

3.2 Installation Conditions

- Installation location: Outdoor solar PV power plant.
- Installation type: Fixed outdoor compact substation installed on concrete foundation or steel support structure, as defined in the project civil and installation documents.
- Operating condition: Continuous operation.
- Service life: Minimum 25 years under the specified site conditions, subject to proper operation and maintenance.
- System frequency: 50 Hz.
- MV system voltage: As specified in the Single Line Diagram and Material Requisition.
- LV system voltage: As specified in the Single Line Diagram and Material Requisition.
- Earthing system: The compact substation shall be provided with a complete internal earthing and bonding system, including main earth bar, compartment earth bars where required, bonding conductors, equipment earthing connections, door bonding, cable screen/armour earthing facilities, and external earthing connection points.

3.3 Environmental Conditions

The compact substation shall be designed for the following environmental conditions as minimum requirements, unless otherwise specified in project documents.

- Minimum ambient temperature: -25°C.
- Maximum ambient temperature: +60°C.
- Maximum daily average temperature: +50°C.
- Maximum monthly average temperature: +40°C, unless otherwise specified.
- Annual average temperature: +30°C, unless otherwise specified.
- Relative humidity: 0% to 95%, non-condensing.
- Altitude: Up to 2000 m above sea level.
- Solar radiation: Up to 1200 W/m².
- Installation environment: Outdoor, dusty, sandy, and exposed to direct sunlight.
- Pollution level: Heavy pollution, suitable for outdoor PV plant environment.
- Maximum wind speed: 34 m/s, unless otherwise specified in project documents.
- Snow depth: 200 mm, unless otherwise specified in project documents.
- Seismic horizontal acceleration: 0.3 g.
- Seismic vertical acceleration: 0.15 g.

3.4 Design Considerations for Site Conditions

All electrical equipment shall be properly rated or derated for the specified ambient temperature and altitude. The transformer, MV/RMU section, LV switchgear, busbars, circuit breakers, auxiliary transformer, internal wiring, ventilation system, and enclosure shall be designed so that the

temperature rise of each component remains within the limits of the applicable IEC standards under the specified operating and environmental conditions. The enclosure, paint system, seals, gaskets, locks, hinges, louvers, filters, cable entry plates, and all external accessories shall be suitable for outdoor installation, UV exposure, dust, sand, high temperature, and long-term corrosion resistance. Ventilation and cooling systems shall be designed to maintain acceptable internal temperatures for all compartments under maximum operating conditions. The design shall prevent direct ingress of dust, sand, rainwater, insects, and foreign objects.

The compact substation shall be designed to prevent accumulation of water inside the enclosure. Adequate drainage, sealing, roof slope, door sealing, cable entry sealing, and condensation control shall be provided. Anti-condensation heaters or space heaters shall be provided where required to avoid condensation inside MV, LV, control, and auxiliary compartments. All external metallic parts shall be corrosion protected. The corrosion protection system shall be suitable for the specified outdoor environment and minimum service life. The Vendor shall verify that the proposed design is suitable for transportation, lifting, handling, storage, installation, and operation under the project conditions.

3.5 Storage and Transportation Conditions

The compact substation and its components shall be suitable for normal road and/or sea transportation, as applicable to the project. The equipment shall be designed and protected to withstand transportation, handling, lifting, temporary storage, vibration, humidity, dust, and mechanical stresses without damage or performance degradation. All sensitive components, including meters, relays, electronic devices, protection devices, communication devices, and auxiliary equipment, shall be properly protected during transportation and storage. The Vendor shall provide handling, lifting, storage, and preservation instructions as part of the documentation package.

4 General Technical Requirements for Compact Substation

4.1 General Arrangement

The compact substation shall be a complete outdoor prefabricated substation suitable for solar PV power plant application. The compact substation shall generally consist of separate compartments or sections for the medium-voltage/RMU equipment, power transformer, low-voltage switchgear, auxiliary/control equipment, and internal service equipment, as required by the final arrangement. The arrangement shall provide safe access for operation, inspection, testing, maintenance, cable termination, replacement of major components, and future troubleshooting. The final internal layout, dimensions, equipment arrangement, access doors, ventilation openings, cable entry locations, lifting points, and maintenance clearances shall be proposed by the Vendor and submitted for review and approval. The compact substation shall be designed as a fully integrated package. The Vendor shall ensure proper coordination between the MV/RMU section, transformer, LV switchgear, auxiliary systems, internal wiring, earthing, ventilation, enclosure, cable termination facilities, and all related accessories. The compact substation shall be suitable for continuous operation at rated load under the specified site and service conditions without exceeding the temperature rise limits of the applicable IEC standards.

4.2 Enclosure and Housing

The enclosure or housing shall be suitable for outdoor installation and shall provide adequate mechanical strength, environmental protection, corrosion resistance, ventilation, accessibility, and safety for the installed equipment. The enclosure may be containerized or compact kiosk type, subject to project requirements, transportation limitations, installation conditions, and Purchaser approval.

The enclosure shall be divided into separate compartments as required to ensure operational safety, equipment segregation, fire separation where applicable, ventilation efficiency, and ease of maintenance. The enclosure structure shall be designed to withstand transportation, lifting, handling, installation, wind load, seismic forces, equipment weight, thermal effects, and normal operation without permanent deformation or damage. All doors, panels, covers, locks, hinges, louvers, lifting points, fixing points, cable entry plates, and external accessories shall be suitable for outdoor service and long-term operation under the specified environmental conditions. Doors shall be outward-opening, lockable, mechanically robust, and provided with door stoppers or limiters. Door opening angle shall be sufficient for safe operation and maintenance. All doors and removable panels shall be provided with suitable sealing to prevent ingress of dust, sand, rainwater, insects, and foreign objects. The design shall prevent water accumulation on the roof, inside the enclosure, around cable entry points, and in equipment compartments. Adequate drainage and sealing shall be provided. The enclosure shall be provided with lifting facilities suitable for safe lifting and handling of the complete unit or major transport sections. Lifting points shall be clearly marked.

4.3 Degree of Protection

The compact substation enclosure and compartments shall have a degree of protection suitable for outdoor installation in dusty and sandy environments. Unless otherwise specified, the minimum degree of protection for MV, LV, auxiliary, control, and accessible electrical compartments shall be IP54 according to IEC 60529. The transformer compartment may be naturally ventilated or provided with mesh/louvered doors or panels, provided that the design ensures adequate cooling, operational safety, protection against accidental contact, and prevention of ingress of harmful objects. Any reduction of IP rating due to ventilation openings, louvers, filters, cable entries, doors, or access panels shall not be acceptable. Ventilation openings shall be designed to prevent direct ingress of rainwater, dust, sand, insects, and foreign objects. Filters shall be provided where required and shall be accessible for cleaning or replacement.

4.4 Corrosion Protection and Painting

All enclosure structures, supports, doors, panels, frames, louvers, cable entry plates, and exposed metallic parts shall be protected against corrosion. The corrosion protection and painting system shall be suitable for outdoor installation, direct solar radiation, high temperature, dust, sand, and the specified service life. Unless otherwise specified, corrosion protection shall be suitable for a minimum corrosivity category of C4 according to ISO 12944. The coating system shall have proper surface preparation, primer, intermediate coat where required, and final coat suitable for outdoor exposure. The final color shall be as specified in the project documents. If not specified, the Vendor

shall propose a standard outdoor color for approval. Painted surfaces shall be uniform, smooth, free from visible defects, blistering, peeling, rust, sharp edges, poor adhesion, and mechanical damage. All cut edges, welds, corners, bolted connections, and repaired areas shall receive suitable corrosion protection equivalent to the main coating system.

4.5 Earthing and Bonding

The compact substation shall be provided with a complete internal earthing and bonding system. A main earth bar shall be installed inside the compact substation. The main earth bar shall be easily accessible and suitable for connection to the external plant earthing grid. All metallic non-current-carrying parts shall be bonded to the internal earthing system, including enclosure frame, doors, removable panels, MV/RMU section, transformer tank, LV switchgear, auxiliary panels, cable supports, gland plates, ventilation equipment, and other metallic parts. All doors and hinged panels shall be bonded to the enclosure by flexible copper bonding conductors. Facilities shall be provided for earthing of MV cable screens, MV cable armour where applicable, LV cable armour where applicable, surge arresters, instrument transformer secondary circuits, and other equipment requiring earthing. External earthing pads or connection points shall be provided on the compact substation enclosure for connection to the plant earthing grid. Earthing connection points shall be clearly marked and shall be accessible for installation and inspection. The continuity of the internal earthing and bonding system shall be verified during factory inspection and testing. The external plant earthing grid and external earthing conductors are outside the compact substation package, unless otherwise specified in project documents.

4.6 Cable Entry and Termination Arrangement

The compact substation shall be designed with suitable cable entry, cable support, bending radius, termination space, gland plates, and sealing arrangement for MV, LV, auxiliary, control, and communication cables. Cable entry shall preferably be from the bottom, unless otherwise specified in project documents or required by the final approved arrangement. The Vendor shall verify the suitability of all cable entry and termination arrangements based on the specified cable sizes, cable types, bending radius, number of cables, armour/screen earthing requirements, and installation conditions. For single-core AC cables, gland plates and cable entry plates shall be made of non-magnetic material where required to avoid circulating currents, heating, and magnetic losses. All cable entries shall be sealed after cable installation to maintain the required degree of protection and to prevent ingress of dust, sand, water, insects, and rodents. Adequate space shall be provided for cable pulling, glanding, termination, phase identification, cable support, and maintenance. Cable clamps, cleats, supports, and fixing accessories shall be suitable for the specified cable type, short-circuit forces, and installation arrangement. Sharp edges around cable entry openings shall be removed, and suitable protection shall be provided to avoid cable damage.

4.7 Internal Wiring and Auxiliary Circuits

All internal wiring shall be properly sized, insulated, routed, protected, terminated, and identified according to applicable IEC standards and approved drawings. Secondary and auxiliary wiring shall

be copper conductor type, flame-retardant, and suitable for the maximum internal temperature of the relevant compartment. Power cables, control cables, communication cables, and measurement circuits shall be segregated as far as practicable to minimize interference, improve maintainability, and ensure safety.

Communication and signal cables shall be shielded where required. Cable shields shall be properly terminated and earthed according to the approved design. All wires shall be terminated through terminal blocks. Direct loose wiring connections shall not be acceptable. Terminal blocks shall be clearly marked and shall provide sufficient spare terminals for future use. Internal wiring shall be arranged in cable ducts, trays, conduits, or equivalent supports. Wiring shall be neat, secure, accessible, and protected against mechanical damage, heat, sharp edges, and vibration.

4.8 Ventilation, Cooling and Anti-Condensation

The compact substation shall be provided with natural or forced ventilation as required to ensure safe and reliable operation of all equipment under maximum load and specified ambient conditions. The ventilation and cooling design shall ensure that the transformer, MV/RMU section, LV switchgear, auxiliary equipment, control devices, meters, relays, and internal wiring remain within their allowable temperature limits. Fans, filters, louvers, heat exchangers, thermostats, temperature sensors, and ventilation accessories shall be provided where required by the design. Ventilation openings shall be protected against ingress of dust, sand, rainwater, insects, and foreign objects. Filters, where used, shall be easily accessible for inspection, cleaning, and replacement. Anti-condensation heaters or space heaters shall be provided in MV, LV, control, and auxiliary compartments where required. Heater circuits shall be protected and controlled by thermostat or humidity controller as applicable. Failure of forced ventilation, abnormal temperature, or relevant auxiliary system failure shall generate alarm contacts where required by the control and monitoring philosophy.

4.9 Lighting, Socket Outlets and Internal Services

Internal lighting shall be provided in compartments where operation, inspection, or maintenance access is required. Lighting shall be suitable for the compartment environment and shall be arranged to provide adequate visibility for operation and maintenance. Maintenance socket outlets shall be provided where required and shall be protected by suitable circuit protection devices. Auxiliary circuits for lighting, heating, ventilation, socket outlets, control supply, and monitoring equipment shall be supplied from the compact substation auxiliary supply system. All auxiliary circuits shall be clearly identified in the wiring diagrams and shall be protected against short-circuit and overload.

4.10 Accessibility, Operation and Maintenance

The compact substation shall be designed for safe and convenient access to all equipment requiring operation, inspection, testing, maintenance, adjustment, or replacement. Operating handles, indicators, meters, relays, test points, terminal blocks, protection devices, and auxiliary devices shall be located in accessible positions. Adequate clearance shall be provided for opening doors, removing covers, withdrawing or replacing equipment, cable termination, testing, and maintenance. Equipment

requiring routine inspection or maintenance shall not be installed in inaccessible or unsafe locations. The arrangement shall minimize the need for dismantling unrelated equipment during maintenance or replacement of major components.

4.11 Safety Requirements

The compact substation shall be designed to ensure personnel safety during operation, inspection, testing, maintenance, and cable termination. All live parts shall be properly enclosed, insulated, segregated, or protected against accidental contact. Mechanical and electrical interlocks shall be provided where required to prevent unsafe operation. Warning labels, danger signs, operating instructions, phase identification, and safety notices shall be provided at appropriate locations. Compartments shall be arranged to reduce the risk of accidental contact with live parts during normal operation. The Vendor shall consider internal arc safety requirements for the MV/RMU section according to the applicable IEC standard and the requirements specified in the SLD or Material Requisition.

4.12 Fire Safety and Oil Containment

The transformer compartment shall be designed considering fire safety, oil leakage control, ventilation, drainage, and safe access. For oil-immersed transformers, suitable oil containment, oil drainage, or oil collection provisions shall be provided as required by the final design and applicable regulations. Oil drain valves, sampling valves, pressure relief devices, oil level indicators, temperature indicators, and other transformer accessories shall be accessible for inspection and maintenance. Materials used inside the compact substation shall be selected to reduce fire risk and shall be suitable for the intended electrical and environmental conditions. Space for portable fire extinguishers may be provided where specified in the project documents.

5 Medium Voltage / RMU Requirements

5.1 General

The compact substation shall include a medium-voltage switching section or RMU as required by the applicable Single Line Diagram and Material Requisition. The MV/RMU section shall be suitable for connection to the project medium-voltage collection system and shall provide safe switching, isolation, earthing, cable termination, indication, interlocking, protection, and operation facilities as required by the project design. The MV/RMU section shall be based on SF6 gas-insulated RMU technology, unless otherwise specified in the Material Requisition or approved as a deviation by the Purchaser. The final MV/RMU configuration, number of feeders, feeder functions, protection arrangement, metering requirements, cable termination arrangement, and auxiliary/control interfaces shall be in accordance with the approved Single Line Diagram, Material Requisition, and project documents. The MV/RMU section shall be designed, manufactured, assembled, and tested in accordance with the relevant parts of IEC 62271 series.

5.2 Rated Electrical Characteristics

The rated voltage of the MV/RMU section shall be suitable for the project medium-voltage system. For a 20 kV system, the equipment rated voltage shall not be less than 24 kV, unless otherwise specified in project documents.

The rated frequency shall be 50 Hz. The rated normal current of busbars, switches, circuit breakers, disconnectors, earthing switches, cable terminals, and all current-carrying parts shall be suitable for the continuous operating current specified in the Single Line Diagram, Material Requisition, and approved design documents. The rated short-time withstand current and duration shall be as specified in the Single Line Diagram, Material Requisition, or grid connection study. The MV/RMU section shall withstand the specified short-circuit current without mechanical, thermal, or insulation damage. The rated peak withstand current shall be coordinated with the rated short-time withstand current according to applicable IEC standards. The insulation level, power frequency withstand voltage, lightning impulse withstand voltage, clearances, creepage distances, and insulation coordination shall be suitable for the rated voltage, altitude, pollution level, and site conditions.

5.3 Construction Requirements

The MV/RMU section shall be metal-enclosed, factory assembled, type-tested, and suitable for installation inside the compact substation enclosure. The RMU shall be SF6 gas-insulated type, factory assembled, type-tested, metal-enclosed, and suitable for installation inside the compact substation enclosure. Air-insulated RMU, solid-insulated RMU, or any alternative insulation technology shall not be accepted unless specifically approved by the Purchaser as a technical deviation before contract award. The SF6 gas compartment shall be hermetically sealed or sealed pressure system type, suitable for long-term operation with minimum maintenance under the specified site conditions. The SF6 gas, gas compartment, pressure monitoring, gas filling, leakage rate, handling, and maintenance requirements shall comply with the applicable IEC standards and manufacturer recommendations. The RMU shall be provided with gas pressure or gas density indication, where applicable, and any low-gas alarm or lockout function required by the manufacturer’s standard design shall be included. The Vendor shall clearly state the SF6 gas quantity, rated filling pressure, minimum operating pressure, expected leakage rate, gas monitoring arrangement, and maintenance requirements in the technical offer.

All MV compartments shall be designed to prevent accidental contact with live parts during normal operation, inspection, and maintenance. The MV/RMU section shall be arranged to allow safe access for cable termination, operation, inspection, testing, maintenance, and replacement of components. The design shall provide adequate segregation between MV live parts, control circuits, cable compartments, operating mechanisms, and earthing systems. All MV equipment shall be suitable for outdoor compact substation application, considering internal temperature, ventilation, dust, humidity, altitude, and operational conditions.

5.4 Functional Requirements

The MV/RMU section shall provide the switching and protection functions required by the approved Single Line Diagram. Depending on the approved design, the MV/RMU section may include load break switches, switch-disconnectors, circuit breakers, fuse-switch combinations, disconnectors, earthing switches, voltage transformers, current transformers, protection relays, voltage presence indicators, surge arresters, and cable termination facilities.

The RMU shall be provided with clearly visible position indicators for switches, disconnectors, circuit breakers, and earthing switches. The operating mechanism shall be reliable, mechanically robust, and suitable for manual operation. Motorized operation shall be provided where specified in the project documents. All operating handles, push buttons, indicators, mimic diagrams, labels, and interlocking devices shall be located in accessible and safe positions.

5.5 Interlocking and Safety

The MV/RMU section shall be provided with mechanical and/or electrical interlocks to prevent unsafe operation. As a minimum, the interlocking system shall prevent closing of an earthing switch when the associated circuit is energized, prevent energizing of a feeder while the associated earthing switch is closed, and prevent access to MV cable compartments unless the associated circuit is safely isolated and earthed. Cable compartment doors or covers shall be interlocked or provided with suitable safety provisions according to the applicable IEC standard and the approved RMU design.

Earthing switches shall have made capacity suitable for the specified fault level where required by the applicable IEC standard. Padlocking facilities shall be provided for operating mechanisms where required for safe operation and maintenance. Clear warning labels and operating instructions shall be provided on the MV/RMU section.

5.6 Cable Termination Arrangement

The MV/RMU section shall be suitable for termination of the project MV cables as specified in the Material Requisition, cable schedule, and approved design documents. The Vendor shall verify the cable termination arrangement based on the specified cable type, conductor material, insulation type, cross-sectional area, armour or screen type, cable outside diameter, bending radius, and termination accessories. Sufficient space shall be provided for cable entry, cable bending, cable termination, screen/armour earthing, cable clamping, phase identification, testing, and maintenance.

MV cable compartments shall be designed for bottom cable entry unless otherwise specified in project documents. Cable supports, clamps, cleats, gland plates, and termination accessories shall be suitable for the specified MV cable arrangement and short-circuit forces. Facilities shall be provided for proper earthing of MV cable screens and armour, where applicable. For single-core AC cables, non-magnetic gland plates and cable entry plates shall be used where required.

5.7 Earthing Requirements

The MV/RMU section shall be connected to the compact substation internal earthing system. All metallic non-current-carrying parts of the MV/RMU section shall be bonded to the internal earth bar.

Earthing switches, cable screens, cable armour, surge arresters, instrument transformer secondary circuits, and all components requiring earthing shall be connected to the earthing system. The MV/RMU earth bar shall be accessible for inspection and connection. The continuity of earthing and bonding connections shall be verified during factory testing.

5.8 Protection, Metering and Indication

Protection, metering, measurement, and indication devices associated with the MV/RMU section shall be provided as specified in the Single Line Diagram, Material Requisition, and project documents. Protection relays, if required, shall be suitable for the protection functions specified in the approved design. Current transformers and voltage transformers, if required, shall have suitable ratio, burden, accuracy class, insulation level, and short-time withstand capability according to the approved design and applicable IEC standards. Voltage presence indicating systems shall be provided where required and shall comply with applicable IEC requirements. Auxiliary contacts shall be provided for switch status, circuit breaker status, earthing switch status, trip indication, alarm indication, and other signals required for monitoring or control.

5.9 Internal Arc and Fault Safety

The MV/RMU section shall be designed considering internal arc safety according to the applicable IEC standard and the project requirements. Internal arc classification, if required, shall be as specified in the Material Requisition or project documents. The design shall ensure safe pressure relief and arc gas exhaust without endangering personnel or damaging adjacent equipment, as far as practicable within the compact substation arrangement. The Vendor shall clearly state the internal arc classification of the offered MV/RMU section and provide relevant type test reports, where applicable.

5.10 Testing and Inspection

The MV/RMU section shall be subject to routine tests in accordance with the applicable IEC standards. Routine tests shall include, as applicable, power frequency withstand voltage test, main circuit resistance measurement, mechanical operation test, interlock function test, auxiliary and control circuit test, wiring check, earthing continuity test, and functional checks. Type test reports shall be submitted for the offered MV/RMU type or for an equivalent design acceptable to the Purchaser. Factory inspection and testing shall be performed before shipment. The Vendor shall submit test procedures and test reports for review.

6 Power Transformer Requirements

6.1 General

The compact substation shall include one power transformer with rated capacity of 3300 kVA suitable for solar PV inverter step-up application and continuous outdoor operation under the specified site and service conditions. The transformer shall be oil-immersed type, outdoor duty, suitable for installation inside the compact substation transformer compartment. The transformer shall be designed, manufactured, assembled, tested, and supplied in accordance with IEC 60076 series and other applicable standards.

The transformer shall be generally equivalent to the proven transformer design used in similar 3.3 MVA compact substations for utility-scale solar PV applications. Any deviation from the specified transformer rating, voltage ratio, vector group, cooling method, impedance, insulation level, or construction philosophy shall be clearly stated by the Vendor and shall be subject to Purchaser approval before contract award. The transformer shall be suitable for operation with PV inverter output characteristics, including frequent load variation, daily loading cycles, harmonics within the limits defined by inverter/grid requirements, and operation under high ambient temperature. The transformer shall be integrated with the compact substation arrangement and shall be fully coordinated with the MV/RMU section, LV switchgear, internal busbar or cable connections, earthing system, ventilation system, oil containment arrangement, and enclosure design.

6.2 Main Electrical Characteristics

The main transformer characteristics shall be as follows, unless otherwise specified in the Material Requisition or approved project documents.

- Rated capacity: 3300 kVA at the specified ambient condition.
- Rated frequency: 50 Hz.
- Number of phases: Three-phase.
- Transformer type: Oil-immersed power transformer.
- Cooling method: ONAN.
- Rated primary voltage: 20 kV.
- Rated secondary voltage: 0.8 kV.
- Vector group: Dy11.
- Tap changer: Off-circuit tap changer.
- Tap range: ±2 × 2.5%.
- Short-circuit impedance: 7%, with tolerance according to IEC 60076 unless otherwise specified.
- Winding material: Aluminum/Aluminum, unless otherwise specified or approved by the Purchaser.
- Transformer oil: New, unused, PCB-free mineral insulating oil complying with IEC 60296.
- Insulation level: Suitable for 20 kV system and 0.8 kV LV system according to IEC 60076 and project requirements.

The transformer shall be capable of continuous operation at 3300 kVA under the specified site conditions without exceeding the temperature rise limits of IEC 60076. The Vendor shall confirm that the offered transformer rating is valid at the specified ambient temperature and altitude without

unacceptable derating. The transformer shall be designed to withstand mechanical and thermal stresses caused by short-circuit conditions in accordance with IEC 60076-5.

Transformer losses, sound level, temperature rise, insulation level, guaranteed no-load loss, load loss, oil quantity, total weight, dimensions, and accessories shall be clearly stated by the Vendor in the technical offer and submitted for approval.

6.3 Insulation and Temperature Rise

The insulation level of MV and LV windings shall be suitable for the rated voltage, system earthing arrangement, altitude, pollution level, and overvoltage conditions. Power frequency withstand voltage, lightning impulse withstand voltage, clearances, and creepage distances shall comply with IEC 60076 and applicable insulation coordination requirements. The transformer temperature rise shall comply with IEC 60076-2 under the specified service conditions. The insulation system shall be suitable for the maximum operating temperature and expected service life of the transformer.

6.4 Tap Changer

The transformer shall be provided with off-circuit tap changer, unless otherwise specified in the project documents The tap range shall be ±2 × 2.5%, unless otherwise approved in the project documents. The tap changer shall be accessible for operation when the transformer is de-energized and shall be provided with clear position indication and mechanical locking facility.

6.5 Winding, Core and Tank

The transformer core shall be manufactured from high-quality grain-oriented silicon steel or equivalent material suitable for low loss and reliable long-term operation. The transformer windings shall be aluminum/aluminum, unless otherwise approved by the Purchaser. The transformer tank shall be mechanically robust, oil-tight, corrosion protected, and suitable for transportation, lifting, installation, and operation inside the compact substation. The tank, cover, radiators, conservator where applicable, valves, fittings, bushings, and accessories shall be designed to avoid oil leakage under normal operation, transportation, and site conditions. All gaskets, seals, and sealing materials shall be compatible with transformer oil and suitable for the specified ambient temperature and service life.

6.6 Cooling System

The transformer cooling method shall be ONAN, unless otherwise approved by the Purchaser. For naturally cooled oil-immersed transformers, the cooling system shall generally be ONAN, unless otherwise specified. The transformer compartment ventilation shall be coordinated with transformer heat dissipation requirements to ensure that the transformer can operate continuously under the specified ambient temperature and loading conditions. The Vendor shall verify the adequacy of transformer cooling considering enclosure arrangement, ventilation openings, solar radiation, ambient temperature, transformer losses, and compact substation layout.

6.7 Transformer Oil

Transformer oil shall be new, unused, PCB-free mineral insulating oil complying with IEC 60296, unless otherwise specified.

The Vendor shall provide transformer oil test reports as part of the factory test documentation. Oil filling, oil sampling, oil drainage, oil level monitoring, and oil maintenance provisions shall be provided as required by the transformer design.

6.8 Bushings and Connections

MV and LV bushings or connection interfaces shall be suitable for the rated voltage, rated current, insulation level, cable or busbar arrangement, and compact substation layout. The arrangement of MV and LV terminals shall allow safe and convenient connection, inspection, maintenance, and replacement. The LV connection between transformer and LV switchgear shall be designed for the rated current and short-circuit forces. The connection may be by busbar, flexible copper connection, or suitably rated cable connection, subject to approved design. All transformer terminals and connections shall be properly insulated, supported, protected, and identified.

6.9 Accessories and Protection Devices

The transformer shall be supplied complete with all standard accessories and protection devices required for safe and reliable operation. As a minimum, the transformer shall be provided with oil level indicator, oil temperature indicator, pressure relief device, oil drain valve, oil sampling valve, filling facility, earthing terminals, lifting lugs, jacking pads or pulling facilities where applicable, rating plate, and required terminal marking. Gas relay, winding temperature indicator, contact thermometer, pressure relay, Buchholz relay, sudden pressure relay, or other protection devices shall be provided where applicable according to transformer design and project requirements. Alarm and trip contacts for transformer protection devices shall be wired to terminal blocks for connection to the control, alarm, or monitoring system as required by the approved design.

6.10 Earthing

The transformer tank and all associated metallic parts shall be connected to the compact substation internal earthing system. At least two earthing terminals shall be provided on the transformer tank, unless otherwise specified by the manufacturer’s standard design. Transformer neutral earthing, if applicable, shall be provided according to the Single Line Diagram and project earthing philosophy. All earthing points shall be clearly marked and accessible for inspection.

6.11 Oil Containment and Drainage

For oil-immersed transformers, the compact substation shall include suitable oil leakage control, oil containment, or oil drainage provisions as required by the final design and applicable regulations.

The design shall prevent transformer oil leakage from spreading to LV, MV, auxiliary, or control compartments. Oil drain and sampling points shall be accessible for maintenance.

The Vendor shall state the transformer oil volume and proposed oil containment or drainage arrangement in the technical offer.

6.12 Testing and Inspection

The transformer shall be subject to routine tests in accordance with IEC 60076. Routine tests shall include, as applicable, winding resistance measurement, voltage ratio measurement, vector group verification, impedance voltage and load loss measurement, no-load loss and current measurement, dielectric routine tests, insulation resistance measurement, oil tests, functional checks of accessories, and leak test. Type test reports shall be submitted where required by the Material Requisition or project documents.

The Vendor shall submit transformer test procedures and factory test reports for review. The transformer shall not be shipped before completion of required routine tests and release for shipment according to the approved inspection procedure.

7 Low-voltage Switchgear Requirements

7.1 General

The compact substation shall include a low-voltage switchgear section suitable for connection between the PV inverters and the 0.8 kV side of the 3300 kVA transformer. The low-voltage switchgear shall be factory assembled, type-tested, and designed in accordance with IEC 61439-1, IEC 61439-2, IEC 60947 series, and other applicable standards. The low-voltage switchgear shall be suitable for continuous operation under the specified site and service conditions, including high ambient temperature, internal heat dissipation, dust, humidity, and compact substation installation arrangement. The LV switchgear arrangement, number of feeders, feeder ratings, protection devices, metering, auxiliary circuits, cable termination arrangement, and monitoring requirements shall be in accordance with the approved Single Line Diagram, Material Requisition, and project documents.

The Vendor shall ensure full coordination between the LV switchgear, transformer LV terminals, inverter AC output cables, auxiliary transformer, internal wiring, earthing system, ventilation system, and compact substation enclosure.

7.2 Rated Electrical Characteristics

The rated operational voltage of the LV switchgear shall be suitable for the 0.8 kV AC system. The rated insulation voltage of LV switchgear, busbars, circuit breakers, auxiliary circuits, and accessories shall be suitable for the 0.8 kV system and applicable IEC requirements. The rated frequency shall be 50 Hz.

The main LV busbar and main incoming/outgoing transformer connection shall be rated for continuous operation at the full output current of the 3300 kVA transformer at 0.8 kV. Unless otherwise specified, the main low-voltage circuit breaker shall be air circuit breaker type, rated 3200 A minimum, with 4000 A frame size.

The short-circuit withstand rating of the LV switchgear, busbars, main circuit breaker, outgoing feeders, and current-carrying parts shall be suitable for the calculated short-circuit level of the transformer and the project design. As a minimum, the LV switchgear short-circuit rating shall not be less than 50 kA, unless otherwise approved by the Purchaser. The rated peak withstand current shall be coordinated with the rated short-time withstand current according to applicable IEC standards.

All current-carrying components shall be selected with sufficient margin considering ambient temperature, enclosure temperature, grouping, ventilation, and continuous loading.

7.3 Construction Requirements

The LV switchgear shall be metal-enclosed, factory assembled, and installed in a dedicated compartment of the compact substation. The LV switchgear shall be designed for safe access, operation, inspection, cable termination, testing, and maintenance. The form of internal separation shall comply with IEC 61439-2 and shall be suitable for the required level of operational safety and maintainability.

Busbars shall be rigidly supported and designed to withstand thermal and dynamic effects of the specified short-circuit current. Busbar joints shall be properly tightened, protected against loosening, and accessible for inspection where practicable. All live parts shall be shrouded, insulated, segregated, or otherwise protected against accidental contact during normal operation and maintenance.

The LV compartment shall be provided with suitable ventilation, temperature control, and internal layout to avoid excessive temperature rise. The LV switchgear doors and covers shall be lockable and provided with warning labels.

7.4 Main Circuit Breaker

The main low-voltage circuit breaker shall be air circuit breaker type, withdrawable or fixed type as proposed by the Vendor and approved by the Purchaser. The main ACB shall be rated 3200 A minimum, with 4000 A frame size, suitable for 0.8 kV AC operation. The breaking capacity, making capacity, short-time withstand current, rated insulation voltage, and rated operational voltage of the ACB shall be suitable for the LV system and the calculated fault level.

The ACB shall be provided with an electronic trip unit suitable for overload, short-circuit, instantaneous, and earth-fault protection functions as required by the approved design. The ACB shall have clear open/closed/trip indication, manual operating mechanism, trip-free mechanism,

mechanical ON/OFF indication, padlocking facility, auxiliary contacts, and alarm contacts as required. The ACB trip settings shall be adjustable and shall be coordinated with transformer protection, outgoing feeder protection, and upstream/downstream protection philosophy.

The Vendor shall provide time-current characteristic curves and setting ranges for the proposed ACB.

7.5 Outgoing Feeders

Outgoing feeder quantity, rating, cable size, protection device type, and terminal arrangement shall be as specified in the Single Line Diagram, Material Requisition, and cable schedule. Outgoing feeders connected to PV inverters shall generally be equipped with molded case circuit breakers or equivalent approved protection devices suitable for the inverter AC output circuits.

The LV outgoing feeder terminals shall be suitable for termination of three-core aluminum power cables, including 3×240 mm² aluminum cables, unless otherwise specified in the project cable schedule. MCCBs shall be suitable for 0.8 kV AC operation, with adequate breaking capacity, thermal-magnetic or electronic trip unit as required, clear ON/OFF/trip indication, and auxiliary/alarm contacts where required. Each outgoing feeder shall be clearly identified with feeder number, destination, rating, and phase marking.

Adequate cable termination space shall be provided for each outgoing feeder considering the specified 3-core aluminum cable size, bending radius, lug size, cable outside diameter, and installation method. Feeder terminals shall be suitable for aluminum cable termination. Suitable aluminum or bi-metallic lugs, terminal adapters, washers, contact grease, and termination accessories shall be provided where required to ensure proper electrical and mechanical connection. The MCCB terminal arrangement shall allow safe and practical termination of the specified 3×240 mm² aluminum cables without excessive bending, mechanical stress, overheating, or reduction of electrical clearance.

7.6 Surge Protection

The LV switchgear shall be provided with surge protection devices suitable for the 0.8 kV AC system and PV plant application. The SPD type, voltage rating, discharge current rating, protection level, and installation arrangement shall be suitable for the system voltage, earthing arrangement, lightning protection concept, and applicable IEC standards. Unless otherwise specified, the SPD shall be Type I+II or equivalent approved arrangement suitable for the project LV system.

SPD units shall be provided with fault indication and remote alarm contacts where required. SPD protection devices, fuses, or disconnectors shall be provided according to the SPD manufacturer’s recommendation and applicable standards.

7.7 Metering, Measurement and Indication

The LV switchgear shall include metering, measurement, and indication devices as required by the approved Single Line Diagram and project documents. Meters shall be suitable for the 0.8 kV system

and shall measure required electrical parameters such as voltage, current, frequency, power, power factor, energy, and other parameters required for operation and monitoring.

Current transformers shall be provided where required for metering, protection, or monitoring. CT ratio, class, burden, and short-time rating shall be suitable for the approved design. Voltage indication and phase presence indication shall be provided where required. Metering and monitoring devices shall provide communication interface where specified in project documents.

7.8 Auxiliary Transformer and Auxiliary Circuits

The compact substation shall be provided with a dedicated auxiliary transformer for supplying the internal auxiliary loads of the compact substation. The auxiliary transformer shall be dry-type, three-phase, suitable for installation inside the compact substation, and supplied from the 0.8 kV LV switchgear through a suitable protection device. The auxiliary transformer secondary voltage shall be 400/230 V AC, unless otherwise approved by the Purchaser. The rated capacity of the auxiliary transformer shall be determined by the Vendor based on the total internal auxiliary load of the compact substation, including lighting, ventilation, heaters, socket outlets, control supply, protection and metering devices, communication equipment, UPS input supply, and other internal consumers. The Vendor shall submit the auxiliary load calculation and selected auxiliary transformer rating for review and approval. The selected rating shall include adequate design margin for continuous operation under the specified site conditions. The auxiliary transformer shall be provided with suitable primary and secondary protection devices. Auxiliary circuits shall be protected by suitable MCBs, fuses, or MCCBs as applicable. All auxiliary circuits shall be clearly identified in the wiring diagrams and terminal blocks.

7.9 Cable Entry and Termination

The LV switchgear shall be designed for bottom cable entry, unless otherwise specified in project documents. Cable entry plates, gland plates, cable clamps, cleats, supports, and termination facilities shall be suitable for the specified LV cables, including three-core aluminium inverter output cables. The LV outgoing feeder cable termination arrangement shall be suitable for 3×240 mm² aluminium cables connected to the MCCB feeders, unless otherwise specified in the project cable schedule.

Adequate space shall be provided for cable pulling, bending, glanding, termination, phase identification, cable support, and maintenance. Cable termination points shall be accessible from safe working positions. The Vendor shall verify the suitability of MCCB terminals, cable lugs, gland plates, cable cleats, bending space, and compartment dimensions for the specified cable size and cable construction. For single-core AC cables, where used in any part of the compact substation, cable entry plates and gland plates shall be non-magnetic where required to avoid induced heating and circulating current effects. All cable entries shall be sealed after installation to maintain the required degree of protection and to prevent ingress of dust, sand, water, insects, and rodents.

7.10 Internal Wiring and Terminal Blocks

Internal LV wiring and auxiliary/control wiring shall be properly sized, insulated, protected, identified, and routed. Secondary wiring shall be copper conductor type, flame-retardant, and suitable for the maximum internal temperature.

Power, control, measurement, and communication circuits shall be segregated as far as practicable. All control and auxiliary wires shall be terminated through terminal blocks. Terminal blocks shall be clearly numbered and shall correspond to the approved wiring diagrams. A minimum of 20% spare terminals shall be provided in each terminal block group, unless otherwise approved. Wiring shall be arranged neatly in cable ducts, trays, conduits, or equivalent supports and shall be protected against mechanical damage, sharp edges, heat, and vibration.

7.11 Earthing and Bonding

The LV switchgear frame, doors, panels, busbar supports, cable gland plates, cable armour earthing points, SPD earthing connections, auxiliary transformer enclosure, and all metallic non-current-carrying parts shall be bonded to the compact substation internal earthing system.

The LV switchgear shall include an earth bar with sufficient cross-sectional area for equipment earthing, cable armour/screen earthing, SPD earthing, and connection to the main earth bar of the compact substation. All earthing points shall be clearly marked and accessible for inspection. Continuity of earthing and bonding connections shall be verified during factory testing.

7.12 Protection Coordination

The Vendor shall provide protection device data, trip curves, setting ranges, and coordination information for the main ACB, outgoing MCCBs, auxiliary circuit protection devices, SPD protective devices, and other relevant protection devices. Protection devices shall be selected and coordinated to provide safe and selective operation as far as practicable. The final protection settings shall be submitted for review and approval before commissioning.

7.13 Testing and Inspection

The LV switchgear shall be subject to routine tests according to IEC 61439-1 and IEC 61439-2. Routine tests shall include, as applicable, visual inspection, verification of wiring, mechanical operation test, dielectric test, insulation resistance test, continuity of protective circuits, functional test of protection and control circuits, verification of clearances and creepage distances, and checking of nameplates and markings. Type test reports or design verification documents according to IEC 61439 shall be submitted for review. Factory inspection and testing shall be performed before shipment. The Vendor shall submit test procedures and test reports for review.

8 Protection, Metering, Control and Communication Requirements

8.1 General

The compact substation shall be provided with all protection, metering, control, indication, alarm, and communication facilities required for safe, reliable, and coordinated operation of the MV/RMU section, power transformer, LV switchgear, auxiliary systems, and internal service equipment.

The final protection functions, metering points, control philosophy, communication interfaces, signal list, and monitoring requirements shall be in accordance with the approved Single Line Diagram, Material Requisition, project control philosophy, and approved Vendor documents.

All protection, metering, control, and communication devices shall be suitable for operation under the specified site conditions and inside the compact substation environment. The Vendor shall ensure compatibility between protection devices, metering devices, auxiliary supply, CTs, VTs, terminal blocks, communication devices, and the plant monitoring or SCADA interface.

8.2 Protection Requirements

Protection devices shall be provided for MV, transformer, LV, auxiliary, and internal service circuits as required by the approved design. Protection functions shall be selected and coordinated to protect equipment against overload, short-circuit, earth fault, overtemperature, abnormal operating conditions, and other relevant faults. The transformer shall be provided with protection and alarm devices suitable for its design, including oil temperature, oil level, pressure relief, gas relay or equivalent protection where applicable, and other standard transformer protective devices. The LV main circuit breaker and outgoing feeder protection devices shall be coordinated with the transformer rating, inverter output circuits, auxiliary circuits, and downstream/upstream protection philosophy.

Protection relays, trip units, auxiliary relays, and alarm devices shall be suitable for the relevant circuit voltage, current, fault level, operating duty, and environmental conditions. Protection settings, setting ranges, time-current curves, relay configuration, and coordination information shall be submitted by the Vendor for review and approval before commissioning.

8.3 Metering and Measurement

Metering and measurement devices shall be provided as required for operation, monitoring, testing, and maintenance of the compact substation.

As a minimum, the LV switchgear shall be provided with measurement of main electrical parameters required for operation, including voltage, current, frequency, power, power factor, and energy, unless otherwise specified in project documents. MV metering or measurement, where required, shall be provided according to the approved Single Line Diagram and project documents. Meters shall be suitable for the relevant system voltage, CT/VT ratios, accuracy class, communication protocol, and installation environment. Current transformers and voltage transformers used for metering or

protection shall have suitable ratio, accuracy class, burden, insulation level, and short-time withstand capability. Metering devices shall be accessible for inspection, testing, parameter setting, and maintenance.

8.4 Control and Indication

The compact substation shall be provided with local control and indication facilities required for safe operation and maintenance. Local indication shall be provided for switch status, circuit breaker status, earthing switch status, trip status, alarm status, protection relay status, meter readings, transformer alarm/trip signals, auxiliary supply status, ventilation status, heater status, and other relevant operating conditions as required by the approved design.

Control switches, push buttons, selector switches, indication lamps, meters, relays, and human-machine interface devices, where provided, shall be clearly labelled and located in accessible positions. Remote control facilities shall be provided only where specified in the project documents. If remote control is provided, local/remote selection and necessary interlocking shall be included. All control and indication circuits shall be shown in the schematic and wiring diagrams.

8.5 Alarm and Trip Signals

All essential alarm and trip signals of the compact substation shall be wired to terminal blocks or communication interface as required by the project monitoring system. The following signals shall be provided as applicable to the final approved design:

- MV/RMU switch or circuit breaker status.
- MV/RMU earthing switch status.
- MV/RMU protection trip or fault indication, where applicable.
- Transformer oil temperature alarm and trip.
- Transformer oil level alarm, where applicable.
- Transformer pressure relief or gas relay alarm/trip, where applicable.
- LV main ACB open/closed/trip status.
- LV outgoing feeder trip indication, where required.
- SPD fault indication.
- Auxiliary supply healthy/failure indication.
- Ventilation or fan failure alarm, where applicable.
- High temperature alarm inside LV, MV, control, or auxiliary compartments, where applicable.
- Heater or thermostat status, where applicable.
- Door open indication, where required.
- UPS fault, low battery, battery fault, bypass status, and AC input failure alarms.

The final signal list shall be submitted by the Vendor for review and approval.

8.6 Communication Interface

Communication interface shall be provided as required for connection of the compact substation to the plant monitoring, control, or SCADA system. Communication protocol, communication media, port type, network arrangement, addressing, and data mapping shall be as specified in project documents or proposed by the Vendor for approval. Where digital communication is required, the Vendor shall provide communication-capable meters, relays, monitoring devices, gateways, switches, or communication modules as required by the approved design. Common communication protocols such as Modbus RTU, Modbus TCP/IP, IEC 60870-5-104, or IEC 61850 may be used where applicable and subject to project requirements and approval. Communication devices shall be suitable for industrial environment and shall be powered from the compact substation auxiliary supply system.

Fiber optic or Ethernet interface shall be provided where specified in the project documents. The Vendor shall provide a complete communication architecture, signal list, data point list, register map, protocol description, and interface drawings for review.

8.7 Auxiliary Power Supply and UPS

Auxiliary power supply shall be provided for protection, metering, control, indication, communication, lighting, ventilation, heating, socket outlets, and other internal consumers of the compact substation. The compact substation shall be provided with UPS for supplying critical control, monitoring, communication, alarm, and protection-related auxiliary loads where uninterrupted supply is required.

The UPS shall be industrial type, suitable for installation inside the compact substation environment, and suitable for continuous operation under the specified site conditions. The UPS capacity and backup time shall be determined by the Vendor based on the connected critical loads and required operation philosophy, and shall be submitted for review and approval. As a minimum, the UPS shall supply the communication equipment, monitoring equipment, essential alarm circuits, and other critical auxiliary loads required to maintain monitoring and alarm availability during loss of auxiliary AC supply. The UPS input/output voltage, capacity, backup time, battery type, battery autonomy calculation, bypass arrangement, alarms, maintenance requirements, and interface signals shall be clearly stated in the Vendor technical offer. UPS fault, battery fault, low battery, bypass status, and AC input failure alarms shall be provided as applicable and wired to terminal blocks or communication interface for monitoring.

Auxiliary circuits shall be protected by suitable circuit protection devices and shall be clearly identified

8.8 Terminal Blocks and Wiring Interface

All external control, alarm, trip, monitoring, and communication signals shall be terminated on clearly identified terminal blocks or interface ports. Terminal blocks shall be arranged in accessible

locations and shall be suitable for the required wire size, voltage level, current rating, and circuit type. Control, protection, metering, communication, and auxiliary circuits shall be segregated as far as practicable. A minimum of 20% spare terminals shall be provided for each terminal block group, unless otherwise approved. All terminals, wires, cables, devices, and circuits shall be clearly numbered and shall correspond to the approved wiring diagrams. The Vendor shall provide terminal block diagrams, interconnection diagrams, cable schedules, and signal lists for all external interfaces.

8.9 Control and Communication Panel Arrangement

Control, metering, communication, and auxiliary devices may be installed in the LV compartment, auxiliary/control compartment, or dedicated control/communication panel, subject to the approved layout. The arrangement shall provide sufficient space for installation, wiring, maintenance, testing, ventilation, and future access. Electronic devices, communication equipment, relays, meters, gateways, switches, and terminal blocks shall be protected against dust, heat, vibration, humidity, and electromagnetic interference. Adequate segregation shall be maintained between power circuits and sensitive control or communication circuits.

8.10 Electromagnetic Compatibility

Protection, metering, control, and communication circuits shall be designed to minimize electromagnetic interference.

Shielded cables shall be used for communication, analog, and sensitive signal circuits where required. Cable shields shall be properly terminated and earthed according to the approved design. Power cables and control or communication cables shall be routed separately as far as practicable. All control and communication equipment shall be suitable for the electromagnetic environment of the compact substation.

8.11 Documentation and Testing

The Vendor shall submit protection, metering, control, alarm, and communication documents for review. As a minimum, the following documents shall be submitted:

- Protection relay datasheets and setting ranges.
- Meter datasheets and communication details.
- CT and VT datasheets, where applicable.
- AC and DC auxiliary supply diagrams, where applicable.
- Control schematic diagrams.
- Wiring diagrams.
- Terminal block diagrams.
- Signal list and alarm list.
- Communication architecture diagram.
- Communication protocol details and data point list.
- Factory test procedures and test reports.

Functional tests shall be performed during factory inspection to verify protection, metering, control, alarm, indication, communication, auxiliary supply, interlocking, and terminal wiring functions as applicable.

9 Marking, Nameplates and Labels

9.1 General

All equipment, compartments, devices, terminals, cables, busbars, operating mechanisms, warning signs, and safety labels shall be clearly and permanently marked. Marking, nameplates, labels, and warning signs shall be suitable for outdoor installation, high ambient temperature, dust, sand, UV exposure, humidity, and the specified service life. All markings shall be durable, legible, securely fixed, and resistant to fading, corrosion, peeling, and mechanical damage. All labels, nameplates, operating instructions, warning signs, manuals, and documentation supplied with the compact substation shall be in English, unless otherwise specified in project documents.

9.2 Equipment Nameplates

Each major item of equipment shall be provided with a permanent nameplate.

As a minimum, nameplates shall be provided for the compact substation enclosure, MV/RMU section, power transformer, LV switchgear, auxiliary transformer, meters, protection relays, circuit breakers, surge protection devices, communication/control panels, and other major components. Nameplates shall include all relevant technical information required by applicable IEC standards and manufacturer practice. As a minimum, the compact substation nameplate shall include manufacturer name, equipment type, serial number, year of manufacture, project name or project reference, rated voltage, rated frequency, rated current where applicable, short-circuit rating where applicable, degree of protection, total weight, and applicable standard. The transformer nameplate shall include all information required by IEC 60076.

The MV/RMU and LV switchgear nameplates shall include all information required by the applicable IEC standards. Nameplates shall be made of stainless steel, anodized aluminium, engraved plastic, or other durable material suitable for the specified outdoor environment and subject to Purchaser approval.

9.3 Warning and Safety Labels

Warning labels and safety signs shall be provided at all locations where personnel may be exposed to electrical, mechanical, thermal, operational, or maintenance hazards. As a minimum, warning labels shall be provided on MV compartments, LV compartments, transformer compartment, cable compartments, live terminals, earthing switches, circuit breakers, surge protection devices, auxiliary supply panels, and other hazardous locations.

Danger labels shall be provided for high-voltage equipment, live parts, back-feed risk, stored energy, hot surfaces, automatic operation, and other relevant hazards. Operating instructions shall be provided near MV/RMU operating mechanisms, earthing switches, circuit breakers, and other devices requiring defined operating sequence. Labels shall not obstruct inspection windows, meters, indicators, operating handles, ventilation openings, or access to equipment.

9.4 Device and Circuit Identification

All circuit breakers, switches, disconnectors, earthing switches, fuses, relays, meters, terminal blocks, auxiliary devices, control switches, indication lamps, and communication devices shall be identified with unique tags. Device tags shall correspond to the approved Single Line Diagram, schematic diagrams, wiring diagrams, terminal block diagrams, and equipment list. Each feeder shall be clearly identified with feeder number, function, destination, voltage level, and rating where applicable. All terminal blocks and terminals shall be numbered and shall correspond to the approved wiring diagrams. All internal wires and external interface terminals shall be identified by durable wire markers or equivalent approved method.

9.5 Phase Identification

All MV and LV phases shall be clearly identified. Busbars, cable termination points, terminals, and phase conductors shall be marked according to the phase sequence used in the project.

Phase marking shall be consistent throughout the compact substation and shall correspond to the approved drawings. Phase identification shall be durable and visible during installation, inspection, testing, and maintenance.

9.6 Cable Identification

Cable termination points shall be clearly marked to identify cable origin, destination, phase, feeder number, and circuit function. Cable tags or markers shall be provided for internal cables and wiring. External cable identification shall be coordinated with the project cable schedule and termination documents. Cable screen, cable armour, and earthing connections shall be clearly identified where applicable.

9.7 Operating Mimic and Instruction Plates

The MV/RMU section shall be provided with a clear mimic diagram showing the switching arrangement, feeder designation, switch positions, earthing switch positions, and operating sequence where applicable. LV switchgear shall be provided with feeder identification and operating labels for main and outgoing circuit breakers. Operating instruction plates shall be provided where required for safe operation of MV switches, earthing switches, circuit breakers, interlocks, and auxiliary systems. The mimic diagram and operating labels shall match the approved Single Line Diagram and final Vendor drawings.

9.8 Label Material and Installation

Labels and nameplates shall be permanently fixed by screws, rivets, adhesive suitable for outdoor service, or equivalent durable fixing method. Adhesive-only labels shall not be used for critical safety labels or main equipment nameplates unless the adhesive system is proven suitable for the specified outdoor service conditions. Labels installed on removable covers or doors shall not create ambiguity after removal and reinstallation. All labels and nameplates shall be installed in visible and accessible locations. The Vendor shall submit a label and nameplate schedule or sample layout for review when required.

10 Inspection and Testing Requirements

10.1 General

The compact substation and all major components shall be inspected and tested before shipment to verify compliance with this Technical Specification, applicable IEC standards, approved drawings, approved datasheets, and project requirements. Inspection and testing shall cover the complete compact substation package, including MV/RMU section, power transformer, LV switchgear, auxiliary systems, protection and control circuits, communication interfaces, internal wiring, earthing system, enclosure, ventilation system, marking, and accessories.

All tests shall be performed using calibrated test instruments. Calibration certificates shall be valid and available for review. The Vendor shall submit inspection and test procedures for review before conducting factory tests. The compact substation shall not be released for shipment until all required routine tests, functional tests, inspections, and documentation checks have been completed and accepted.

10.2 Type Tests

Type test reports shall be submitted for the compact substation and major equipment where required by applicable IEC standards and project documents. As a minimum, type test reports or equivalent design verification documents shall be submitted for the following equipment:

- Compact substation or prefabricated substation according to IEC 62271-202, where applicable.
- MV/RMU section according to the relevant parts of IEC 62271 series.
- Power transformer according to IEC 60076 series.
- LV switchgear according to IEC 61439-1 and IEC 61439-2.
- Main LV circuit breaker and MCCBs according to the relevant parts of IEC 60947 series.
- Surge protection devices according to applicable IEC standards.
- Protection relays, meters, CTs, VTs, auxiliary transformer, and other major components according to their applicable standards.

If the submitted type test report is not for the exact offered configuration, the Vendor shall clearly identify the differences and justify the applicability of the submitted report.

10.3 Routine Tests

Routine tests shall be carried out on each supplied compact substation and its major components according to the applicable IEC standards and approved test procedures. Routine tests shall include, as applicable, visual inspection, dimensional check, verification of nameplates and labels, verification of equipment arrangement, verification of clearances and creepage distances, mechanical operation tests, electrical continuity checks, wiring checks, insulation resistance tests, dielectric tests, earthing continuity tests, functional tests, and verification of auxiliary circuits. Routine test reports shall be submitted as part of the final documentation package.

10.4 MV/RMU Tests

The MV/RMU section shall be tested according to the relevant parts of IEC 62271 series. As a minimum, the following tests and checks shall be performed as applicable:

- Visual and dimensional inspection.
- Verification of rating and nameplate data.
- Power frequency withstand voltage test.
- Measurement of main circuit resistance.
- Mechanical operation test of switches, circuit breakers, disconnectors, and earthing switches.
- Verification of interlocking system.
- Verification of position indicators.
- Functional test of auxiliary contacts, alarms, trip circuits, and control circuits.
- Verification of voltage presence indicating system, where applicable.
- Gas pressure or density check for SF6 gas-insulated RMU.
- SF6 gas leakage check or verification according to manufacturer standard and applicable IEC requirements.
- Earthing continuity test.
- Cable compartment and termination arrangement check.

10.5 Transformer Tests

The power transformer shall be tested according to IEC 60076 series. As a minimum, the following routine tests shall be performed:

- Measurement of winding resistance.
- Voltage ratio measurement and vector group verification.
- Measurement of impedance voltage and load loss.
- Measurement of no-load loss and no-load current.
- Dielectric routine tests.
- Insulation resistance measurement.

- Oil test.
- Leak test.
- Functional check of transformer accessories and protection devices.
- Verification of alarm and trip contacts.
- Verification of nameplate data, terminal marking, and earthing points.

The Vendor shall provide transformer routine test reports and oil test reports before shipment.

10.6 LV Switchgear Tests

The LV switchgear shall be inspected and tested according to IEC 61439-1 and IEC 61439-2. As a minimum, the following tests and checks shall be performed:

- Visual and dimensional inspection.
- Verification of assembly arrangement against approved drawings.
- Verification of busbar rating, support, clearance, and creepage distance.
- Verification of circuit breaker ratings and settings.
- Mechanical operation test of ACB, MCCBs, switches, and auxiliary devices.
- Verification of wiring and terminal blocks.
- Dielectric test.
- Insulation resistance test.
- Continuity test of protective circuits.
- Functional test of protection, metering, indication, alarm, and control circuits.
- Verification of SPD installation and indication.
- Verification of cable entry, gland plate, termination space, and cable support arrangement.
- Verification of nameplates, labels, phase marking, and feeder identification.

10.7 Auxiliary, Control and Communication Tests

Auxiliary, control, metering, protection, and communication circuits shall be functionally tested before shipment. As a minimum, the following checks shall be performed as applicable:

- Auxiliary supply circuit test.
- Lighting circuit test.
- Socket outlet circuit test.
- Space heater and thermostat test.
- Ventilation fan and temperature control test.
- Temperature and humidity controller test.
- Alarm and trip signal test.
- Metering device functional test.
- Protection relay or trip unit functional check.
- Communication interface check.
- Terminal block and wiring continuity check.
- Verification of signal list against approved drawings.

- UPS functional test, including input failure simulation, battery operation, bypass indication, and alarm verification.

10.8 Enclosure and Mechanical Inspection

The compact substation enclosure shall be inspected before shipment. As a minimum, the following checks shall be performed:

- Visual inspection of enclosure structure.
- Dimensional check.
- Verification of compartment arrangement.
- Verification of doors, locks, hinges, stoppers, covers, and removable panels.
- Verification of lifting points and fixing points.
- Verification of ventilation openings, louvers, filters, and sealing.
- Verification of cable entry openings and gland plates.
- Verification of corrosion protection and painting.
- Verification of IP protection measures.
- Verification of drainage, oil containment, and sealing arrangement.
- Verification of internal lighting, socket outlets, and auxiliary services.
- Verification of warning labels, nameplates, and operating instructions.

10.9 Factory Acceptance Test

Factory Acceptance Test shall be performed on the complete compact substation package before shipment. The FAT shall verify correct assembly, internal integration, functional operation, interlocking, protection, metering, control, alarm, communication, auxiliary circuits, earthing continuity, marking, and compliance with approved drawings. The Vendor shall submit FAT procedure for review before the test. The FAT report shall include test results, measured values, observations, punch list items if any, corrective actions, and final acceptance status.

10.10 Test Reports and Certificates

The Vendor shall provide complete inspection and test documentation as part of the final documentation package. As a minimum, the following documents shall be submitted:

- Type test reports or design verification documents.
- Routine test reports.
- Factory Acceptance Test report.
- Transformer test reports.
- Transformer oil test report.
- MV/RMU test report.
- LV switchgear test report.
- Protection, metering, control, and communication test reports.
- SF6 gas certificate and gas leakage test record, where applicable.

- Calibration certificates for test instruments used during FAT.
- Certificates of conformity for major components.
- Inspection release note, where applicable.

10.11 non-conformities

Any non-conformity, failed test, missing document, damaged component, or deviation from approved documents shall be recorded and reported by the Vendor. Corrective actions shall be completed and verified before shipment, unless otherwise approved by the Purchaser. No equipment shall be shipped with unresolved critical non-conformities.

11 Documentation Requirements

11.1 General

The Vendor shall submit all technical documents required for review, approval, manufacturing, inspection, testing, installation, commissioning, operation, and maintenance of the compact substation. All documents shall be prepared in English, unless otherwise specified in project documents. Documents shall be clear, complete, consistent, and suitable for engineering review and site use. All submitted documents shall include project name, document title, document number, revision number, date, Vendor name, and equipment identification. The Vendor shall ensure consistency between all submitted documents, including drawings, datasheets, calculations, test procedures, test reports, manuals, and certificates. Any change in design, component selection, rating, layout, wiring, terminal arrangement, or interface after document approval shall be re-submitted for review and approval.

11.2 Documents to Be Submitted for Review

As a minimum, the following documents shall be submitted for review and approval before manufacturing, where applicable:

- Compact substation general arrangement drawing.
- Compact substation dimensional drawing.
- Foundation and fixing arrangement drawing.
- Lifting and transportation drawing.
- Internal layout drawing.
- MV/RMU arrangement drawing.
- Transformer arrangement drawing.
- LV switchgear arrangement drawing.
- Auxiliary/control/communication panel arrangement drawing.
- Single Line Diagram, if Vendor revision or detailed version is required.
- MV/RMU schematic diagrams.
- LV switchgear schematic diagrams.
- Auxiliary AC supply diagram.

- Control and protection schematic diagrams.
- Metering and monitoring diagrams.
- Communication architecture diagram.
- Wiring diagrams.
- Terminal block diagrams.
- Interconnection diagrams.
- Cable entry and cable termination arrangement drawings.
- Earthing and bonding arrangement drawing.
- Ventilation and cooling arrangement drawing.
- Oil containment or oil drainage arrangement drawing, where applicable.
- Nameplate and label schedule.
- Equipment datasheets.
- Main component list.
- Protection device datasheets.
- Meter datasheets.
- CT and VT datasheets, where applicable.
- Transformer datasheet.
- MV/RMU datasheet.
- LV switchgear datasheet.
- Auxiliary transformer datasheet
- Auxiliary load calculation.
- UPS datasheet.
- Surge protection device datasheet.
- Battery or backup supply datasheet.
- Technical deviation list.

11.3 Calculations and Studies

The Vendor shall submit the required calculations and technical justifications to demonstrate suitability of the compact substation design. As a minimum, the following calculations or technical confirmations shall be submitted where applicable:

- Transformer loading and temperature rise confirmation.
- Transformer loss and efficiency data.
- Transformer short-circuit withstand confirmation.
- LV busbar sizing and short-circuit withstand calculation.
- MV/RMU short-circuit rating confirmation.
- LV switchgear short-circuit withstand confirmation.
- Protection coordination information.
- Cable termination suitability confirmation for specified MV and LV cables.
- Ventilation and heat dissipation calculation or confirmation.
- Enclosure temperature rise assessment.
- Earthing continuity and bonding arrangement confirmation.
- Auxiliary load calculation and auxiliary transformer sizing calculation.

- UPS sizing and battery autonomy calculation.
- Seismic or structural strength confirmation, where applicable.
- Lifting and transportation strength confirmation, where applicable.
- Corrosion protection and painting system technical data.

11.4 Inspection and Test Documents

- The Vendor shall submit inspection and test documents before factory inspection and after completion of tests. As a minimum, the following documents shall be submitted:
- Inspection and Test Plan, where required by project documents.
- Factory Acceptance Test procedure.
- MV/RMU test procedure.
- Transformer test procedure.
- LV switchgear test procedure.
- Auxiliary, control, metering, and communication test procedure.
- Routine test reports.
- Factory Acceptance Test report.
- Transformer routine test report.
- Transformer oil test report.
- MV/RMU routine test report.
- LV switchgear routine test report.
- Protection and control functional test report.
- Communication test report, where applicable.
- SF6 gas certificate and leakage test record, where applicable.
- Calibration certificates for test instruments used during FAT.
- Certificates of conformity for major components.

11.5 Final As-Built Documents

The Vendor shall submit final as-built documents after completion of manufacturing, inspection, and testing. As a minimum, the final documentation package shall include:

- Final approved general arrangement drawings.
- Final approved dimensional drawings.
- Final approved foundation and fixing drawings.
- Final approved internal layout drawings.
- Final approved MV/RMU drawings.
- Final approved transformer documents.
- Final approved LV switchgear drawings.
- Final approved schematic diagrams.
- Final approved wiring diagrams.
- Final approved terminal block diagrams.
- Final approved interconnection diagrams.
- Final approved communication architecture and signal list.

- Final approved cable termination drawings.
- Final approved earthing and bonding drawings.
- Final equipment datasheets.
- Final component list.
- Final protection settings and setting ranges.
- Final test reports.
- Certificates of conformity.
- Operation and maintenance manuals.
- Installation and commissioning instructions.
- Packing list.
- Spare parts recommendation list.

11.6 Operation and Maintenance Manuals

The Vendor shall provide complete operation and maintenance manuals for the compact substation and its major components. The manuals shall include, as a minimum:

- General description of the compact substation.
- Safety instructions.
- Operating instructions.
- Switching instructions.
- Interlocking description.
- Maintenance instructions.
- Inspection intervals.
- Troubleshooting guide.
- Transformer maintenance requirements.
- MV/RMU maintenance requirements.
- LV switchgear maintenance requirements.
- Auxiliary system maintenance requirements.
- Protection and metering device manuals.
- Communication device manuals, where applicable.
- Recommended spare parts.
- Lubrication requirements, where applicable.
- SF6 gas handling and maintenance instructions, where applicable.

11.7 Document Review

Review or approval of Vendor documents by the Purchaser shall not relieve the Vendor from responsibility for correctness, completeness, performance, safety, compliance with standards, and suitability of the supplied compact substation. The Vendor shall incorporate Purchaser comments and re-submit revised documents until approval is obtained. Manufacturing shall not proceed before approval of critical documents, unless otherwise agreed in writing. The Vendor shall clearly identify all deviations, assumptions, missing information, and interface requirements in the submitted documents.