

**Ministry of Climate Change, Environment and Energy
Republic of Maldives**

ASSURE PROJECT
Design Supply and Installation of Microgrid Modifications and
Expansions for Integration of Solar Photovoltaic Systems in 20
Islands across Maldives

VOLUME-II

PART 1

TECHNICAL SPECIFICATIONS

Technical Specifications provided herein are applicable for all Lots of the bid document for Design Supply and Installation of Microgrid Modifications and Expansions for Integration of Solar Photovoltaic Systems under ASSURE Project

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AP - 001

TECHNICAL SPECIFICATION FOR LOW VOLTAGE SWITCHGEAR PANELS (LVDB) AND EXTENSIONS

1.0 SCOPE

This specification covers the general requirements of the design, manufacture, testing, supply and delivery of communication enabled, arc resistant LV metal clad switchgear panels (LVDB) having fully insulated secondary circuit with necessary measuring, control & protection equipment as per single line diagrams (SLD) of the designs provided in bid documents and approved modifications based on Contractor's proposals during detailed design stage.

The applicable provisions of the specification shall also apply for modification / extension of existing LV switchgear panels as indicated in Section 16 of the specification. The panels are to be installed for operation and control of microgrid distribution systems of the Islands at electrical powerhouses.

Whilst this specification provides applicable technical requirements and guidelines, the Contractor / Supplier shall be fully responsible for detailed design of the the panels to meet their intended functionalities and performance.

During the implementation stage, the Supplier / Contractor is required to submit complete design diagrams including details of secondary control, protection, metering and communication circuits for approval.

The offered equipment shall be suitable for operating in system and service conditions provided in sections 2.0 and 3.0 respectively.

2.0 SYSTEM PARAMETERS

Parameter	LV System	11kV System
Nominal Voltage	0.415 / 0.240 kV	11 kV
Highest System Voltage	0.44 / 0.255 kV	12 kV
Number of Phases	3PN	3
Frequency	50 Hz	50Hz
Neutral Earthing	Solidly Earthed	Solidly earth
3 Phase Short Circuit Levels	Upto 65 kA / 1s	Upto 20 kA / 1s
Impulse Withstand Voltage	6 kV	75 kV (peak)
Power Freq. Withstand Voltage 1 min	2.5 kV	28 kV

3.0 SERVICE CONDITIONS

Parameter	Value
Climate	Typical tropical coast line
Atmosphere	Saliferous, corrosive and dusty

Parameter	Value
Max. Ambient Temperature	35 °C
Max. Daily average ambient temp.	29 °C
Min Ambient Temp	24 °C
Maximum Humidity	90 %
Maximum altitude above M.S.I.	Average 2 m
Average days of rainfall	145 days/ yr
Maximum wind speed	gusts up to 100 km/hr

4.0 APPLICABLE STANDARDS

The equipment and the components supplied shall be in accordance with the latest editions of the Standards specified below and amendments thereof.

Standard	Title
IEC 61439-1 & 2	Low voltage switchgear and control gear assemblies.
IEC 60947	Low voltage switchgear and control gear.
IEC 62271-102	A.C disconnectors and earthing switches
IEC 61869 - 201	Instrument transformer
IEC 60255	Electrical Relays
IEC 60529	Degrees of protection provided by enclosures
IEC TR 61641	Enclosed low-voltage switchgear and control gear assemblies - Guide for testing under conditions of arcing due to internal fault
ANSI/IEEE C37.20	Guide for Testing Switchgear Rated up to 52kV for Internal Arcing Faults

5.0 BASIC FEATURES

5.1 Design

The LV switchgear panels shall be of metal clad and extensible type suitable for indoor application. It consists of a combination of different types of incomer and outgoing panels with a common busbar for control and protection of microgrid distribution systems in the Islands. The general technical parameters of panels shall comply with requirements indicated below;

- | | |
|--|---|
| a) Type | - Indoor |
| b) Rated operating voltage | - 415 V AC |
| c) Rated frequency | - 50 Hz |
| d) Rated insulation level | |
| i) Impulse withstand voltage (peak) | - upto 8 kV |
| ii) Rated insulation voltage | - 1000 V |
| e) Rated current for main distribution busbar | - As per bus rating of existing LVDB, upto 8000 A |
| f) Rated short-time withstand current | - Upto 65 kA / 1 Sec |
| g) Arc fault - prospective short-circuit current | - Upto 65 kA |
| h) Temp. rise | - within specified limit (IEC 61439) |
| h) Internal Separation | - Form 4 |
| h) Ingress Protection (IP) | - IP44 or higher |
| i) Control Voltage | - 24 VDC |
| k) Auxiliary Voltage | - 230 VAC |
| l) Material group (as per IEC 61439-1) | - IIIa |
| m) Degree of pollution | - Category III (costal area / indoor) |

5.2 Equipment and Materials

5.2.1 Air Circuit Breakers (ACB)

- i) The circuit breakers shall be of standard design and construction conforming to IEC 60947. The interrupting medium of the circuit breaker shall be of Air.
- ii) The ACB'S must be draw out type and provided with motor operating mechanism.
- ii) The control mechanism of the circuit breakers shall be of spring assisted trip free type with remote / local control selector switch and manual operational facility.
- iii) The circuit breaker shall have a mechanical counter to register the number of circuit breaker operations.
- iv) Characteristics of the Circuit Breakers shall be as follows;

a)	Number of poles	- 3 pole
b)	Type	- Indoor, Withdrawable
c)	Rated voltage	- 415 V
d)	Rated frequency	- 50 Hz
e)	Rated insulation level	
	i) Impulse withstand voltage (peak)	- 8 kV
	ii) Rated insulation voltage	- 1000 V
f)	Rated normal current	- As per schedules
g)	Rated short circuit breaking current (rms)	- 65 kA
h)	Rated short circuit making current	- 100 kA _{pk}
i)	Tripping supply voltage	- 24 VDC
i)	Mechanical life (No. of operations)	- 15,000 (for I _u < 2500 A)
k)	Electrical life (No. of operations)	- 10,000 (for I _u < 2500 A)
- v) The ACBs shall be standard models from the following manufactures or equivalent ; ABB, Siemens, Schneider, Terasaki or other internationally reputed manufacturer approved by FENAKA.

5.2.2 Molded Case Circuit Breaker (MCCB)

- i) The MCCBs shall be of standard design and construction conforming to IEC 60947-2.
- ii) MCCBs shall be provided with **thermal-magnetic trip unit for ratings upto 630 A** and **electronic (microprocessor controlled) trip unit for ratings above 630 A**.
- iii) The MCCBs with thermal-magnetic tripping shall have adjustable thermal magnetic tripping settings (Upto 800 A). The thermal setting adjustment (I_r adjustment) shall be available upto 0.63 I_n (63% x rated current).
- iv) Both line up and line down power flow must be possible without decreasing MCCBs performances or functionality.
- v) Characteristics of the MCCBs shall be as follows;

a)	Number of poles	- 3 pole
b)	Type	- Indoor, Fixed
c)	Rated voltage	- 415 V
d)	Rated frequency	- 50 Hz
e)	Rated insulation level	

- i) Impulse withstand voltage - 8 kV
 - ii) Rated insulation voltage - 800 V
 - f) Rated normal current (A) - as per schedules
 - g) Rated short circuit breaking current (rms) - 65 kA
 - h) Mechanical life (No. of operations) - > 15,000
 - i) Electrical life (No. of operations) - > 3,000
- vi) The MCCBs shall be standard models from the following manufactures or equivalent ; ABB, Siemens, Schneider, Terasaki or other internationally reputed manufacturer approved by FENAKA.

5.2.2 Busbars

- i) The LV main busbar shall be made of electrical grade high conductivity, hard drawn copper Tin plated bus bar with continuous current up to 8000 A (or as per existing LVDB main busbar rating), without exceeding the maximum temperature rise specified in the IEC Standard 61439.
- ii) All LV live parts shall be air insulated.

5.2.3 Current Transformers

- i) Current transformers shall conform to IEC 61869-201 and comply with the following.

		Measuring	Metering	Protection
a)	Class	3.0	0.5	5P
b)	Burden	To match the measuring, metering and protection equipment		
c)	Accuracy limit factor	-	-	10
d)	Frequency	50 Hz	50 Hz.	50 Hz.
e)	C.T. ratios	As per design requirements		

- ii) Type Test Certificates Conforming to IEC 61869-201 shall be furnished with the offer.

5.2.4 Energy Metering Instruments

- i) The energy metering facilities with Export and Import measurements shall be provided in incoming and outgoing feeder panels as indicated in 5.4.
- ii) The programmable poly phase metering equipment shall conform to IEC - Static (Electronic) Three Phase Meters, Accuracy Class 0.5. The metering equipment shall be of the flush mounting type.
- iii) The meters shall be calibrated by the supplier taking into consideration that the errors of current and voltage transformers tested separately.
- iv) Necessary software package and the handheld programming unit (1 for each Island) shall be supplied with the LVDB panels.
- v) Volt free switching contact pulse output shall be available to send the energy measurements to the SCADA system. RS232 bus interface shall be available additionally for remote meter reading facility.

5.2.5 Cable Terminations

- i) ACB and MCCB terminals shall be suitable for terminating specified number and size of cables as indicated in schedules. (Upto to 6 x 630 mm², armored (single core) cables for ACB). Necessity terminal block extensions shall be provided if exiting terminals are not adequate to terminate specified number / size of cables.
- ii) Facilities for connecting prods for cable testing and cable fault locating shall also be provided.
- iii) Stainless Steel, clamps, bolts and nuts must be provided to connect the incoming / outgoing feeder cables.

5.2.6 Protection Relays

- i) The programmable type self-powered numerical protection relays, conforming to IEC 60255, shall be used.
- ii) It shall be possible to select the required type of overcurrent and earth fault protection of IDMT characteristics. Appropriate settings shall be determined during the design stage as per specific requirements in respective Islands and submitted for approval of the Employer
- iii) Necessary software package and the handheld programming unit (1 for each Island) shall be supplied with the numerical protection relays to set the protection relays as required.
- iv) The numerical relay units shall be suitable for use in the tropical climatic conditions as given under the Clause 3.0 Service Conditions.
- v) Relays should have memory and recording Features to provide event log, trip log and oscillographic disturbance records. Relays shall be fixed on the front door with trip indicators and alarms.
- vi) The numerical relay unit shall have provision for incorporating SCADA system.
- vii) The relays shall be standard models from the following manufactures or equivalent ; ABB, Siemens, Schneider, Terasaki or other internationally reputed manufacturer approved by FENAKA.

5.2.7 Earthing

- i) The copper earthing conductor shall be provided along the entire length of the panel. The cross-sectional area of earthing conductor shall be such that the current density shall not exceed 200 A/mm² under the specified earth fault conditions.
- ii) It shall be possible to earth the cable with facility for padlocking, and mechanical interlocking shall be provided to prevent earthing the busbar.
- iii) All metallic parts of the functional units intended to be earthed shall be bonded to the earthing conductor of the panel.

5.2.8 Indications

The front panel shall display the mimic diagram of the main circuit with the position indicators for the ACB. The voltage indicators shall be situated on the front panels. Multifunction Power Meter shall be fixed on the front door for each feeder cubicle, displaying at least Voltage, Current and Power.

The position indicators of ACB shall be visible through the front cover and indicating lights shall be wired to auxiliary contact of the VCB to indicate the status of VCB.

The voltage indicators shall be situated on the front door, one for each module, and indicate the voltage condition of each incoming/outgoing cable. Identification of the phases is achieved with labels L1, L2 and L3 on the front of the voltage indicators. The voltage indicator shall satisfy the requirements of IEC61243.

5.2.9 Auxiliary Circuits

- i) Control and auxiliary devices shall be segregated by earthed metallic partitions from the main circuit.
- ii) Terminal and other auxiliary apparatus requiring attention while the equipment is in service, shall be accessible without exposing to high voltage conductors.
- iii) Auxiliary switches and auxiliary circuits shall be capable of carrying a current of at least 10A at 24 V.d.c. continuously.
- viii) PVC insulated flexible copper wire 2.5 sqmm shall be used for control wiring. For the purpose of identification, the control wiring shall be provided with numbered tags to distinguish the different circuits, and shall be terminated using suitable terminations.

5.2.10 Construction of Panels

The panels shall be of free-standing type with bottom cable entry facility. The panel shall be manufactured using high quality electrogalvanized MS plates, treated and powder coated upto 80 micron or higher. The surface colour shall match the existing panel.

The thickness of the metal sheets shall be at least 1.5 mm, and other plates shall be 1mm. The thickness of the main frame shall not be less than 2 mm.

The panels shall be dust and vermin proof type and cable entries shall be sealed using suitable filler material upon installation.

The panel dimensions shall meet or be similar to minimum dimensions for existing LVDB panel size (2100 X 660 X 900 mm) to match and retrofit (if required) with the existing panels. However, in case of space restrictions in existing powerhouse buildings the specified panels dimensions may be changed subject to compliance with technical requirements as per applicable standards and prior approval of FENAKA.

All cables and wiring shall be complete with all necessary terminal plates, cable glands for cable entry, wiring trunkings for small wiring and multi core cables. Wiring trunkings shall be adequate sizes for accommodating incoming and outgoing cables for present and future requirements.

All equipment, control, measuring and monitoring devices, relays, battery chargers, and meters shall be from reputable international brands acceptable to Employer. Drawings and technical specification must be provided with the bid documents.

The switchboard panel shall be suitable for mounting on a concrete floor or plinth and necessary foundation or fixing bolts and rails shall also be provided.

Labeling shall be provided with each panel, and each circuit. Cabling from CTs shall terminate at the panel on isolating links of the shorting disconnecting type. Shorting Links shall also be provided.

External effects of internal arc shall be limited by a suitable design to prevent any danger to operator. Test evidence in accordance with relevant IEC to verify the design is required.

The design including dimensions shall be compatible with existing LVDB used in the Islands. The contractor is required to prepare and submit suitable design accordingly. Drawings and technical specification must be submitted for approval of FENAKA during design stage.

5.2.10 Internal Arc protection measures

Panels shall provide personnel protection for authorized personnel at the front, back and sides of the panels against internal arcs as per arc classification B of IEC/TR 61641 with the following features implemented in panel design.

- i. Safe secondary terminals
- ii. Barrired terminal boards
- iii. Line side connection automatic shutters
- iv. Segregation between compartments
- v. Bus compartment segregated from cable compartment and breaker/instrument compartments
- vi. Breaker/instrument compartments separated from one another
- vii. Cable compartments segregated between vertical sections

Any available test certificates of panels with similar design complying with IEC/TR 61641 shall be furnished.

5.2.10 Interlocking

The following interlocks shall be provided:

- i) Any compartments shall be interlocked such that the air circuit breaker (ACB) must be open before the compartment cover/door can be opened.
- ii) The cubicle door shall be interlocked with the air circuit breaker (ACB) to prevent opening of the door with the circuit breaker in the Service/ON position and prevent the insertion of a circuit breaker into the service position with the door open.
- iii) In addition, any other interlocking arrangements deemed necessary for safety of operators and equipment shall be provided

5.4 Types of LV Switchgear Panels

The panels shall be provided with following components / devices and any additional devices as required complying with the specifications and applicable standards, according to approved

design to ensure full functionality. The Contractor shall submit complete design details during design stage for review and approval.

5.4.1 LV Switchgear Incomer and outgoing Panels / Transformer Panel

- 1 No ACB, 3Pole, with motorized with shunt trip release, rating as given in schedules
- 1 Set Busbar, rating, 8000A, Copper, Tin plated
- 1 No Breaker ON/OFF control with push button, with indicating lights
- 3 Nos Analog Amp meter (0-5000A) for R, Y, B
- 1 Lot Live busbar and cable indications
- 1 No voltmeter c/w selector switch, Analog
- 1 No Digital multifunction power meter
- 1 No Digital Energy Meter, kWh & kVarh, class 0.5 s, Export and Import measurements
- 1 No x Over current protection relay
- 1 No x earth fault protection relay
- 1 Lot Protection and metering CTs, sets of relays, fuses and sensors as per approved design
- 1 Lot control cables Cu/PVC 2.5 sqmm
- 1 Set Surge Protection Device (SPD) at cable entry (load side)
- Indications / alarms / displays as per approved design
- Other accessories / fittings / devices as required
- A schematic mimic representing the system being controlled

Internal separation of the panel shall be Form 4 as per IEC 61439-1.

5.4.2 BESS Panel

BESS switchgear panel shall be provided with synchronizing facility with following components / devices and any additional devices as required according to approved design to ensure full functionality;

- 1 No ACB, 3Pole, 5000 A, motorized with shunt trip release
- 1 Set Busbar, rating, 8000A, Copper, Tin plated
- 1 No Breaker ON/OFF control with push button, with indicating lights
- 3 Nos Analog Amp meter (0-5000A) for R, Y, B
- 1 No x Frequency Meter (0-55Hz), Analog
- 1 Lot Live busbar and cable indications
- 1 No BMS controller / indication panel
- 1 No voltmeter c/w selector switch, Analog
- 1 No x Power Meter PM1000 or equivalent
- 1 No Digital Energy Meter, kWh & kVarh, class 0.5 s, Export and Import measurements
- 1 No x Over current protection relay
- 1 No x earth fault protection relay
- 1 No Sync Relay
- 1 Lot Protection and metering CTs, sets of relays, fuses and sensors as per approved design
- 1 Lot control cables Cu/PVC 2.5 sqmm
- 1 Set Surge Protection Device (SPD) at cable entry (BESS side)
- Indications / alarms / displays as per approved design
- Other accessories / fittings / devices as required
- A schematic mimic representing the system being controlled

Internal separation of the panel shall be Form 4 as per IEC 61439-1.

5.4.3 MCCB Panel

MCCB panel should be provided in the LVDB to connect LV outgoing feeders and PV incomer connections. The MCCBs shall provide both overcurrent and earth fault protection for the LV incomer / outgoing feeders (bi-directional).

Individual MCCBs shall be provided in separate compartments in the panel. Panel shall be provided with following components / devices and any additional devices as required according to approved design to ensure full functionality;

- XX Nos MCCB, 3 pole with shunt release, ratings as specified in schedules (ratings and quantity as specified in schedules)
- XX Nos Earth Leakage Relay
- XX Nos Ammeter with selector switch
- X Nos Digital Energy Meter, kWh & kVarh, class 0.5 s, Export and Import measurements
- 01 Lot Nos 4 Pole Terminal Block
- 01 Lot Protection and Measuring CTs.
- 1 Lot control cables Cu/PVC 2.5 sqmm
- Other accessories / fittings / devices as required
- Display indicating LV feeder number and MCCB ratings

Note - XX shall be as defined in schedules.

Internal separation of the panel shall be Form 4 as per IEC 61439-1.

6.0 SCADA COMPATIBILITY

The supplier / contractor shall make all necessary provisions in design and manufacture of LVDB for interfacing and integrating switchgear panels with central SCADA system located in Male and hybrid Plant Control and Monitoring (PCMS) / Energy management System (EMS) system to be established in respective Islands (by a third party), allowing for efficient data exchange, monitoring, and control as required.

The central SCADA system is already established to remotely monitor energy production and other parameters of islands power systems in real-time which already covers some of the Islands included in the scope of works.

The PCMS / EMS will be established in all Islands to provide interactive control and monitoring for PV power plants, the Battery Energy Storage Systems (BESS), diesel generators and auxiliaries in order to improve efficiency of diesel usage, maximize PV energy usage and to improve system stability of power distribution systems in respective Islands. PCMS / EMS shall communicate with and provide data to the SCADA system.

The PCMS / EMS communications protocol shall be Modbus TCP over an Ethernet network with a minimum data transfer rate of 100 Mbit/s.

The ACB switchgear panels in LVDB to be supplied by the Contractor shall be fully SCADA enabled and following requirements shall be met.

1. The SCADA provision in ACB switchgear panels shall include but not limited to measurement data and controls such as voltage, ampere, cos pi, frequency, energy, CB open / close, relay data and settings, warnings /alarms etc. This shall be in accordance with the data, monitoring and control requirements of the existing SCADA and PCMS / EMS systems described above and expected future upgrades. The Contractor during design stage is required to submit

proposed input / output schedule for SCADA provision in Panels including the details of devices / datapoints covered and signal type (SC/DC, SP/DP, DV) etc. for review and approval of Fenaka.

2. The required devices in switchgear panels including ACBs, Relays, Energy Meters, Controllers, auxiliary contracts etc shall be provided with communication interfaces for integration with SCADA / PCMS / EMS systems for provision of data exchange, monitoring, and control functionality.
3. All necessary equipment and material in communication circuits including auxiliary relays, cables, terminal blocks, test switches, isolation devices, auxiliary relays, wiring and labeling shall be provided.
4. Communication Protocol: shall be compatible with SCADA, PCMS/EMS systems described above.
5. Human-Machine Interface: The switchgear panels should have a human-machine interface (HMI) that can display data from the SCADA system and allow operators to manually control the panel as necessary.
7. Security: The switchgear panels should be equipped with appropriate security measures complying with ISO/IEC 27002 standard to prevent unauthorized access to the panel or the SCADA system.

7.0 OTHER REQUIREMENTS

7.1 Manufacturing Experience

The manufacturer shall have at least 05 years' experience in manufacturing and supply of offered type of LV switchgear panels and manufacturer shall furnish documentary evidence with the offer to prove his manufacturing experience.

7.2 Tools

All special tools and accessories required for installation, operation and maintenance of equipment shall be clearly indicated in the offer and shall be supplied with panels. This includes manual operating handles and lifting trolley for removing and transporting the ACBs and handheld programming units where applicable.

7.3 Spares

Mandatory Spare parts : The Contractor is required to supply mandatory spare parts and tools for 5 year trouble-free operation of the LVDB. This should include all necessary spare parts required for ACBs, MCCBs, primary and secondary circuits, indications etc. that may need to be replaced during 5 year operation under normal operating conditions and specified service conditions, as per manufacturer recommendations. The bidder is required to submit a list of spare parts that would be supplied accordingly for each LVDB in respective Islands, in the technical proposal.

Recommended Spare Parts : In addition to mandatory spare parts the bidder is required to provide list of recommended spare parts for 10 year trouble free operation of LVDB under normal operating conditions and specified service conditions, in Schedule No 6 (Section 4). Bidders are responsible to ensure availability of spare parts listed for minimum 10 year period. Bidders shall

note that the price of recommended spare parts quoted in this Schedule will not be added to Bid Price and not considered in price evaluation.

7.4 Name Plates

Name Plates shall include the following information:-

- a) Manufacturer's name and trademark.
- b) Serial number or type designation.
- c) Applicable rated values.
- d) Number and year of the relevant standard.
- e) Country and year of manufacture
- f) Project Name
- g) Property of FENAKA

The name / description of each panel and mimic diagram shall be provided. The removable parts, if any, shall have a separate name plate with the relevant information.

7.5 Labeling

All equipment, devices, control positions, indicator positions, control/indicator identification, terminals, small wiring of instrumentation and protection of the panel shall be identifiable by clear markings and labeling in English Language with relevant colour code, if any. The labels shall be made out of durable materials and prints permanently edged.

7.6 Packing and Delivery

All equipment shall be suitably packed for transportation and installation strictly according to the manufacturer's recommendations. Packing shall be suitable for transportation under restricted volumes and rough conditions for local transportation between Male and respective Islands.

Preferably panels may be supplied as separate cubicles for assembly and integration at the powerhouse in consideration of sea transportation from Male to respective Islands, where heavy duty lifting facilities may not be available.

8.0 TESTS

8.1 Routine Tests

The following Routine tests as per IEC 61439 part 1 & 2 shall be carried out on each distribution panel and the routine test reports shall be made available to the Employer.

- i) Visual Inspection
- ii) Verification of Electrical Continuity
- iii) Insulation Resistance Test
- iv) Verification of Wiring and Connections
- v) Functional Test
- vi) Verification of Protective Measures

8.2 Type Tests

a) Switchgear Panels

Certified copies of the type test carried out in accordance with clause 6 of the IEC 61439 as indicated below shall be furnished with the offer.

- i) Temperature Rise Test
- ii) Short-Circuit Withstand Strength Test
- iii) Dielectric Tests
- iv) Mechanical Operation Test
- v) Verification of Degree of Protection
- vi) Clearances and Creepage Distances Test

Any certificates / reports available on internal arc classification of the offered or similar design panel as per IEC/TR 61641 should also be provided.

b) Circuit Breaker (ACB/MCCB)

Certified copies of the Certificates of type tests carried out in accordance with the relevant IEC standard indicated below shall be furnished with the offer.

- i) Temperature Rise Test
- ii) Short-Circuit Withstand Test
- iii) Dielectric Tests
- iv) Mechanical Operation Test
- v) Endurance Test
- vi) Electric Arc Test
- vii) Electromagnetic Compatibility (EMC) Test
- viii) Verification of Temperature Limits

c) Instrument Transformers and Protection Relays

Certified copies of the certificates of type tests carried out in accordance with the following standards shall be furnished with the offer.

- Current Transformers conforming to IEC 61869.
- Protection Relays conforming to IEC 60255-1

The test certificates should clearly identify the equipment concerned, showing the manufacturer's identity, type/model and basic technical parameters. The type test certificates referred to, shall be issued within 5 years from the date of bid opening from a recognized independent testing authority accredited to ISO/IEC 17025:2005 for carrying out specified type tests and acceptable to the Employer.

8.3 Sample/Acceptance tests

The following Sample/Acceptance tests shall be witnessed by the inspection Engineer. Extra copies of these test certificates shall also be furnished with the equipment, prior to dispatch.

- i) Verification of Dimensions and Clearances
- i) Verification of Mechanical Operation
- ii) Verification of Electrical Continuity
- iii) Verification of Insulation Resistance
- iv) Verification of Dielectric Properties
- v) Verification of Protection Measures
- vi) Verification of Temperature Rise

9.0 INSPECTION AND TESTING

The selected Bidder shall make necessary arrangements for inspection by the Employer or his representative inspection of goods prior to dispatch and to carry out in his presence sample / acceptance tests indicated in clause 8.3.

The report of routine tests performed on each equipment shall be made available for the observation of the inspector.

10.0 QUALITY ASSURANCE

The manufacturer shall possess valid ISO 9001 Quality Assurance Certification for the process of design and manufacturer of LV Metal Enclosed Switchgear Panels for the plant where the offered Switchgear panels are manufactured. The Bidder shall furnish a copy of the ISO Certificate certified as true copy of the original by the Manufacturer, along with the offer.

11.0 WARRANTY

The Bidder shall warrant that all equipment supplied shall have no defect arising from design, materials or workmanship or from any act or omission of the supplier that may develop under normal use of the supplied equipment.

This Warranty shall remain valid for minimum 3 years form the date of installation.

12.0 TRAINING

The Supplier shall provide comprehensive training on the design, installation, operation and maintenance of the Panels to FENAKA staffs in each Island. Training should include both theoretical and hands-on on the job training. Training should be provided for up to 10 Nos FEANKA staffs in each Island.

Training shall cover both theoretical and practical aspects of design, operation and maintenance of the equipment. In addition training should include overall control, operation and management of the microgrid system through LVDB.

13.0 INFORMATION TO BE SUPPLIED BY THE BIDDER

13.1 Documentation be furnished with the offer.

- Catalogues/ Technical literature including technical data and drawings for panels.
- Technical literature including technical characteristics of associated equipment including breakers, switches, controllers, busbars, fuses, instruments and relays etc.
- Mechanical characteristics of panels and equipment including overall dimensions, weight, constructional features, interlocks, access covers and doors.
- Type test certificates
- List of mandatory Spare parts and tools for 5-year trouble-free operation as per Manufacturer's recommendation that will be supplied together with equipment.
- List of recommended spare parts for 10-year trouble free operation.
- Manufacturers ISO 9001 Certifications
- Completed schedule of guaranteed technical particulars
- Manufacturer experience records
- Training plan

13.2 Documentation to be submitted during detail design and implementation

(The following list shall be considered applicable for all implementation works in respective Islands and regardless of any specific equipment specification)

- Detail design diagrams, updated single line diagrams and reports
- Maps indicating proposed cable routes, location of joints and location of equipment
- Proposed layout drawings
- Foundation designs for equipment
- Layout drawings
- Powerhouse building modification / civil works drawings, BOQs and cost estimates.

- Method statements for works
- Details of earthing and terminations
- Soil resistivity measurements
- Site safety procedures
- Project documents (data sheets, specifications, drawings) for major systems and components including system description of the main systems
- Variation requests (if applicable).
- Updated BOQs and cost estimates for all works for each Island
- Commissioning Test protocols
- Details records of Quality assurance system
- Supply interruption schedules for approval
- Inspection and dispatch schedules for equipment / materials
- Routine and acceptance test reports
- Reports on integration of switchgear panels with SCADA/ PCMS / EMS
- Commissioning reports
- Any other as requested by the Employer.

13.3 Final Documentation to be submitted

(The following list shall be considered applicable for all implementation works in respective Islands and regardless of any specific equipment specification)

- All As-built drawings (civil, mechanical, electrical)
- Final cable route and equipment location maps
- Single line and Wiring diagrams
- Data sheets of installed components
- Warranties of installed components
- O&M manuals
- Mechanical completion documents
- o Data sheets and manuals of components and equipment
- o Model and Serial number of equipment.
- o Acceptance protocols
- o Calibration protocols
- Factory Acceptance Test Reports for all equipment
- Commissioning test reports
- Any other as requested by the Employer.

14.0 OPERATIONS MANUAL, TECHNICAL LITERATURE AND DRAWINGS

The selected Bidder shall supply along with the equipment five copies of operational/maintenance manuals for each type of panel ordered including all relevant drawings, technical literature, hand books, wiring diagrams in order to facilitate easy installation, faultless operation and maintenance. Routine test reports shall also be furnished with the equipment.

15.1 GUARANTEED TECHNICAL PARTICULARS

Schedule of Guaranteed Technical Particulars (GTP) for LVDB or extension of the same should be filled by the Bidder. Specimen GTP schedule for LVDB is provided at the end of the specification. Bidder may provide additional information in the GTP schedule as required.

15.2 SCHEDULE OF DEVIATIONS

Any non-compliances of the offered item in respect of the technical requirements provided in this specification shall be provided using Schedule of Deviations form provided in Section 4 of the bid documents. This form should be provided for each item of specification, indicating any deviations or 'no deviations' as applicable.

16.0 EXTENSION OF EXISTING SWITCHGER PANELS

Following are key technical considerations for extending existing low voltage switchgear panels;

- 16.1 **Compliance to Standards and Specifications** : Extension of existing low voltage switchgear panels (LVDB) shall be carried complying with the technical requirements provided in this specification and applicable standards.
- 16.2 **Design** : Prior to extension the Contractor is required to carry out detailed designs and submit design data for approval of FENAKA which include following ;
- Single line diagrams with details of proposed primary and secondary circuits
 - Specifications and technical catalogues of busbars, circuit breakers, equipment, and devices
 - Technical details of additional panels to be connected or existing panels to be modified
 - Proposed busbar jointing and busbar support details
 - Details of adaptor / transition panels (if any) proposed by the Contractor
 - Protection design and settings / calculations
 - Onsite test plan upon extension
 - Time schedules
- 16.3 **Space Availability** : It should be noted that availability of space in existing powerhouse buildings in the respective Islands is limited, hence proposed extensions shall be designed with due consideration of the space constraints.

Where feasible panels in existing LVDB may be upgraded / modified to suit specified requirements as indicated in the schedules. Any additional panels should be designed so that they utilize minimum space whilst complying with the technical requirements such as temperature rise limits and internal arc safety requirements as per specifications and applicable standards. In some instances where additional space may be essential for proposed extensions, provision is provided in the BOQs (provisional sum) for necessary civil works to carry out building modifications / additional cable trenches etc. In this case Contractor is required to submit details and layout drawings of proposed powerhouse building modifications (during design stage) for approval of FENAKA prior to commencement of any work.

- 16.4 **Service Interruptions** : It should be noted that existing LVDBs are in continuous service for provision of power supply to consumers and plants in the Islands, hence only minimum service interruptions can be permitted for LVDB extension works. The Contractor is required to pre-plan all works and supplies for extension so that it can be carried out within minimum service interruptions approved by FENAKA. The Contractor may need to make temporary arrangements to ensure continuity of DG supply to consumers if prolonged service interruptions are required.
- 16.5 **Site Acceptance, Testing and Commissioning** : Upon completion of works, the Contractor is required to carry out necessary inspections and testing prior to commissioning to conform that the extended panel conforms to the specified technical requirements provided in this specification and applicable standards. The Contractor is required to submit a tentative **Test Plan** in this respect for the approval of FENAKA indicating details of tests and acceptance criteria. These on-site acceptance tests shall be performed as recommended by the manufacturer which should generally include but not limited to the following ;
- Verification of the installation work including check mechanical installation, check electrical installation including all cables, terminations, labeling, check external controls and interfaces.
 - Insulation resistance tests,
 - Continuity tests,
 - Polarity tests
 - Earth loop impedance tests

- Functional tests verify correct operation of each item of switchgear
- Secondary injection tests
- Adjust all necessary settings for equipment including relay settings
- Interlocking testing
- Verify the operation of all (remote) trips, controls and output signals
- Safety tests

The Contractor shall arrange services of qualified test and commissioning engineers, supply test instruments, perform required tests and submit test reports for approval FENAKA.

The requirements with respect to specific types of panels included in the extension scope are as follows;

16.6 Transformer Panel :

- New transformer panels (if required) shall be provided as given in schedules.
- Where existing transformer panel/s are required to be upgraded as specified in schedules, the existing ACB needs to be replaced accordingly. The contractor shall also ensure upgrading of the existing panel as per new current capacity, including upgrading capacity of busbar links (branch busbars) to breakers, upgrading secondary circuits / devices including CTs / protection relays and relay settings as required.

16.7 BESS Panel :

- New panel as per specification shall be included in the extended panel.

16.8 MCCB Panel :

The schedules indicate requirement of new MCCB panels and upgrading of existing MCCB panels based on the information available at the time of preparation of this bid. However contractor during design stage may consider other options, particularly in case of space restrictions in powerhouse buildings and submit proposed design for review and approval by Fenaka.

- Generally, one MCCB panel with upto 10 Nos MCCB compartments are available in existing LVDBs. As indicated in schedules, the additional MCCBs are required for new PV feeders. In order to save space and cost of adding limited number of additional MCCBs following options shall be considered during design stage;
- **Option 1 :** If additional MCCBs indicated in schedules can be installed in the existing MCCB panel, new MCCB panel in extended LVDB is not required. In this case additional MCCBs can be installed in spare MCCB compartments or in compartments with existing unused MCCBs by replacing the existing MCCB with a new MCCB of specified rating.
- **Option 2 :** If the above option is not feasible due to higher number of new feeders, capacity of existing MCCB compartments etc., a new MCCB panel shall be introduced in the extended LVDB. In this case the new MCCB panel shall consist of MCCB compartments required for new feeders plus additional spare MCCB compartments which can be accommodated in the panel for future use, as indicated in schedules.

Note : In case of option 2, if critical space constraints exists, Contractor may propose alternate design options such as providing a separate standalone MCCB panel connected to main LVDB via cables.

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS
LOW VOLTAGE SWITCHGER PANEL (LVDB)
(This schedule shall be duly filled by the Bidder)

#	Particulars	Unit	offed
1.0	LV SWITCHGEAR PANELS		
1.1	Name & Address of Manufacturer	-	
1.2	Country of Origin	-	
1.3	Model / catalogue number	-	
1.4	Applicable Standard/s		
1.5	Rated operating voltage	V	
1.6	Rated Highest System Voltage	V	
1.7	Rated frequency	Hz	
1.8	Number of phases	-	
1.9	Rated current for main busbar	A	
1.10	Rated insulation level	-	
1.10.1	i) Impulse withstand voltage (peak)	kV	
1.10.2	ii) Rated insulation voltage	V	
1.11	Rated short-time withstand current / duration	kA / s	
1.12	Internal Arc Classification (IEC/TR 61641)		
1.13	Internal Separation	-	
1.14	Degree of Ingress Protection (IP)	-	
1.15	Degree of pollution Category		
1.16	Temperature rise (as per IEC 61439)	°C	
1.17	Particulars of Interlocking provided	-	
1.18	Earthing as per specifications (Y/N)		
1.19	SCADA provision (Y/N)		
1.20	Panel Construction		
1.20.1	Material		
1.20.2	Thickness	mm	
1.20.3	Surface Treatment	-	
1.20.4	Panel dimensions	mm	
1.21	Other particulars	-	
1.22	Manufacturing Experience	Yrs	
2.0	Air Circuit Breakers (ACB)		
2.1	Make / Model		
	Country of Origin		
2.2	Type (Fixed / withdrawable)		
2.3	Applicable standard/s		
2.4	Number of poles		
2.5	Rated current ratings of offered models	A	
2.6	Rated operating voltage	V	
2.7	Rated frequency	H	
2.8	Rated short circuit breaking current (rms)	kA	
2.9	Rated short circuit making current (pk)	kA	
2.10	Rated insulation level	-	
	i) Impulse withstand voltage (peak)	kV	
2.11	ii) Rated insulation voltage	V	
2.12	Method of closing	-	

#	Particulars	Unit	offed
2.13	Method of tripping	-	
2.14	CB is trip free type (Y/N)	-	
2.15	Motorized operating mechanism (Y/N)		
2.16	i) Mechanical life (No. of operations)	-	
	ii) Electrical life (No. of operations)	-	
2.17	Other details		
3.0	MCCBs		
3.1	Make / Model	-	
3.2	Country of Origin	-	
3.3	Applicable standard/s	-	
3.4	Type (thermal-magnetic / microprocessor)	-	
3.5	Type (Fixed / Withdrawable)	-	
3.6	Number of poles	-	
3.7	Rated current ratings of offered models	A	
3.8	Rated operating voltage	V	
3.9	Rated frequency	Hz	
3.10	Rated short circuit breaking current (rms)	kA	
3.11	Rated insulation level	-	
	i) Impulse withstand voltage (peak)	kV	
	ii) Rated insulation voltage	V	
3.12	The thermal setting adjustment range	%	
3.13	i) Mechanical life (No. of operations)	-	
	ii) Electrical life (No. of operations)	-	
3.14	Other Particulars	-	
4.0	Busbars		
4.1	Make / Model	-	
4.2	Country of Origin	-	
4.4	Applicable standard/s	-	
4.5	Material	-	
4.6	Cross Sectional Area / Dimensions	mm ²	
4.7	Type of insulation	-	
4.8	Clearance between busbars	-	
	i) Phase – Phase / Neutral	mm	
	ii) Phae - Earth	mm	
4.9	Continuous current carrying capacity	A	
4.10	Maximum Temperature rise at rated current	°C	
4.11	Mounting Arrangements		
5.0	Protection Relays		
5.1	Make / Model	-	
5.2	Country of Origin	-	
5.3	Applicable standard/s	-	
5.4	Type (Numerical/ Static)	-	
5.5	Self-powered (yes / no)	-	
5.6	Type : Programable (yes / no)	-	
5.7	Handheld programming unit provided for each Island ? (yes / no)	-	
5.8	Software provided (yes / no)	-	
5.9	SCADA provision (yes/no)		

#	Particulars	Unit	offed
6.0	Current Transformers		
6.1	Make / Models		
6.2	Country of Origin		
6.3	Applicable standard/s		
6.4	Rated voltage	V	
6.5	Rated frequency	Hz	
6.6	Rated short time rating / duration	kA / s	
6.7	Accuracy Class (Measuring /Metering/Protection)	-	
6.8	Accuracy limit factor	-	
6.9	Burden (measuring/metering/protection)	VA	
6.10	CT Ratios (measuring/metering/protection)	-	
7.0	Energy Metering Instruments		
7.1	Make / Model	-	
7.2	Country of Origin	-	
7.3	Applicable standard/s	-	
7.4	Accuracy class	-	
7.4	programmable type ? (Yes/No)	-	
7.5	Programming software provided? (yes / No)	-	
7.6	Handheld programing tool provided (yes / no)	-	
7.7	Calibration certificates provided? (yes / no)	-	
8.0	Type test certificates ? (yes / no)	-	
9.0	List of Mandatory Spare parts for each LVDB provided in technical proposal ? (yes / no)	-	
	Mandatory spare parts will be supplied accordingly ? (yes / no)	-	
10.0	Manufacturer's Quality Assurance Certifications provided (Yes / No)	-	
11.0	Training will be provided as per specification / training plan ? (yes / No)	-	
12.0	Confirmed period of technical support to be provided upon completion	Yrs	
13.0	Completed GTPs submitted ? (Yes / No)	-	
14.0	Schedule of Deviations from specifications Submitted ? (Yes / No)	-	
15.0	Warranty Period	Yrs	

We certify that the above data are true and correct.

SEAL AND SIGNATURE OF THE BIDDER/ Date

AP - 002

TECHNICAL SPECIFICATION FOR 0.6/1 (1.2) kV SINGLE AND MULTI CORE ARMORED POWER CABLES

1.0 SCOPE:

This specification covers design, engineering, manufacture, inspection and testing before supply and delivery at site of 0.6/1 (1.2) kV grade single and multi-core armored copper Conductor, Cross-linked polyethylene (XLPE) insulated, PVC sheathed power cables to IEC 60502-1 / BS 5467 for use with electricity distribution systems in Maldives.

1.1 The cables shall confirm in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation in a manner acceptable to the Employer, who will interpret the meanings of drawings and specification and shall have the power to reject any work or material which, in his judgment is not in accordance therewith.

1.2. Normally the offer should be as per Technical Specification without any deviation. But any deviation felt necessary to improve performance, efficiency and utility of equipment must be mentioned in the "Deviation Schedule" with reasons duly supported by documentary evidence and advantages of such deviation. Such deviation suggested may or may not be accepted. But deviation not mentioned in "Deviation Schedule" will not be considered afterwards.

1.3. The cables may be laid buried directly in ground or laid in ducts, cable trays and terminated for outdoor connection to a distribution transformer or to overhead LT lines, and indoor connection for indoor switchgear.

1.4 The equipment / materials supplied shall be rated to be used under system parameters and service conditions given and clause 2.0 and 3.0 respectively.

2.0 SYSTEM PARAMETERS

Parameter	Low Voltage System	11kV System
Nominal Voltage	0.415 / 0.240 kV	11 kV
Highest System Voltage	0.44 / 0.255 kV	12 kV
Number of Phases	3PN	3
Frequency	50 Hz	50Hz
Neutral Earthing	Solidly Earthed	Solidly earth
3 Phase Short Circuit Levels	Upto 65 kA / 1s	Upto 20 kA / 1s
Impulse Withstand Voltage	6 kV	75 kV (peak)
Power Freq. Withstand Voltage 1 min	2.5 kV	28 kV

3.0 SERVICE CONDITIONS

Parameter	Value
Climate	Typical tropical coast line
Atmosphere	Saliferous, corrosive and dusty

Parameter	Value
Max. Ambient Temperature	35 °C
Max. Daily average ambient temp.	29 °C
Min Ambient Temp	24 °C
Maximum Humidity	90 %
Maximum altitude above M.S.I.	Average 2 m
Average days of rainfall	145 days/ yr
Maximum wind speed	gusts up to 100 km/hr

4.0 STANDARDS:

The equipment and material supplied shall be in accordance with the latest editions of the Standards specified below and amendments thereof.

Standard	Title
IEC 60502-1	POWER CABLES WITH EXTRUDED INSULATION AND THEIR ACCESSORIES FOR RATED VOLTAGES Part 1: Cables for rated voltages of 1 kV (Um = 1,2 kV) and 3 kV (Um = 3,6 kV)
BS 5467	Electric cables. Thermosetting insulated, armoured cables of rated voltages of 600/1000 V and 1900/3 00 V for fixed installations. Specification
IEC 60228	Conductors for insulated electric cables
IEC 60811	Electric and optical fiber cables - Test methods for nonmetallic materials - Part 201: General tests - Measurement of insulation thickness, Part 203: General tests – Measurement of overall dimensions, Part 501: Mechanical tests - Tests for determining the mechanical properties of insulating and sheathing compounds Electric and optical fiber cables - Test methods for non-metallic materials
IEC 60724	Guide to the short-circuit temperature limits of electric cables with a rated voltage not exceeding 0,6/1,0 kV

Material conforming to other internationally accepted standards, which ensure equal or higher quality than the standards mentioned above, may be acceptable, subject to approval by the Employer at his discretion. In case the Bidders who wish to offer material conforming to the other standards, salient points of difference between the standards adopted and the specific standards shall be clearly brought out in relevant schedule. Two copies of such standards with authentic English Translations shall be furnished along with the offer.

5.0 TECHNICAL REQUIREMENTS:

5.1 MAIN FEATURES:

The power cables shall be of low voltage 0.6 / 1 (1.2) kV Grade, stranded compacted, high conductivity, copper conductor, XLPE insulated, Steel wire armored (multicore cables) / non-magnetic aluminum wire armored (single core cables), ST-2 type extruded PVC outer sheathed, conforming to relevant standards suitable for low voltage AC three phase, 50Hz, solidly earthed distribution system.

5.2 MATERIALS AND CONSTRUCTION:

5.2.1 CONDUCTOR:

The cable conductor shall be made from plain circular compacted stranded copper conductor

to IEC 60228 Class 2 having resistance within the limits specified in the standard.

5.2.2 INSULATION

The insulation shall be cross linked Polyethylene (XLPE) applied by extrusion process. The manufacturing process shall ensure that the insulation is free from voids. The insulation shall withstand mechanical and thermal stresses under steady state as well as transient operating conditions. The extrusion method shall give smooth surface of insulation. The insulation shall be so applied that it fits closely on the conductor, and it shall be easily possible to remove it without damaging the conductor. The insulation shall be resistant to chemicals like acids, alkalis, oils and ozone. The insulating material shall have excellent electrical properties with regard to resistivity, dielectric constant and loss factor and shall have high tensile strength and resistance to abrasion. This shall not deteriorate at elevated temperatures or when immersed in water. The insulation shall be so applied that it fits closely on the conductor, and it shall be possible to remove it without damaging the conductor.

The average thickness of insulation shall not be less than the nominal value as specified in 60502-1.

The insulation properties shall be stable under thermal conditions arising out of continuous operation at conductor temperature of 90°C rising momentarily to 250°C under short circuit conditions.

Insulation / insulation screen in individual cores of multi-core cables shall be provided with red, yellow, blue and black colors for core identification purpose.

5.2.3 FILLERS AND LAYING UP OF CORES

The cores shall be laid together with a suitable right hand lay. The interstices shall be filled with non-hygroscopic material. Further, the compounds used with fillers shall be such as to have no deleterious effect on other components of the cable and to be stable at cable temperatures.

5.2.4 INNER-SHEATH (COMMON COVERING) :

The laid up cores shall be provided with ST-2 inner sheath applied by extrusion process. It shall be ensured that the shape is as circular as possible. It shall be applied to fit closely on to the laid up cores and shall be possible to remove easily without causing any damage to the underlying insulated cores.

The thickness of the inner sheath shall be as per IEC 60502-1. No tolerance on the negative side shall be acceptable.

The inner covering shall be suitable to withstand the site conditions and the desired temperature. It shall be of adequate thickness, consistent quality and free from all defects.

5.2.5 ARMOUR

The multicore cables shall be provided with Galvanized Steel Wire armour (SWA).

Single core cables may be armored or unarmored as specified in the Bill of Quantities (BOQ). If specified as armored non-magnetic Aluminium / Aluminium Alloy wire armour (AWA) complying with IEC 60502-1 / BS 5467 shall be applied helically over the PVC bedding / inner covering and should withstand the designed short circuit current of the cable.

5.2.6 OUTER SHEATH

The outer sheath shall consist of extruded tough outer sheath of PVC compound insulation over the armouring. The PVC compound for the outer sheath shall conform to type ST-2. Suitable additives (to prevent attacks by rodents and termites) shall be provided. Common acids, alkalis, saline solutions etc.,

shall not have adverse effects on the PVC sheathing material used. Minimum thickness of outer sheath shall be as specified in IEC 60502-1 / BS 5467..

5.2.7 OTHER

All materials shall comply with the applicable provisions of the tests of the relevant Standards. No recycled PVC is permissible. Fillers shall be suitable for the operating temperature of the insulation & compatible with the insulation material. The Employer reserves the right to ask for documentary proof of the purchase of various materials to be used for the manufacture of cable and to check that the conductor is complying with quality control.

6.0 CURRENT RATING

The cables shall have continuous and short circuit current ratings and derating factors as per relevant IEC / BS Standards. The current ratings shall be based on maximum conductor temperature of 90 deg. C with ambient site condition specified for continuous operating at the rated current. The bidder shall provide tables of maximum current ratings for various cable laying arrangements under the system and service conditions specified in section 2.0 and 3.0.

7.0 SHORT CIRCUIT CURRENT WITHSTAND CAPACITY

The short circuit current carrying capacity of cables shall be as per specified values or above in the table below in accordance with calculations as per IEC 60724.

#	Nominal conductor area of multi-core cable (sq mm)	Short Circuit current for conductor (KA/ sec)
1	4C 35 sqmm	3.3
2	4C 70 sqmm	6.6
3	4C 95 sqmm	9
4	4C 120 sqmm	11.3
5	4C 150 sqmm	14.1
6	4C 240 sqmm	22.3
7	4C 300 sqmm	25
8	4C 400 sqmm	37.6

8.0 TESTS

8.1 ROUTINE TESTS

The following Routine tests as per IEC 60502-1 / BS 5467 shall be carried out on each manufactured cable length and the routine test reports shall be made available to the Employer.

- i) Conductor resistance test
- ii) Voltage tests.

Optional routine test if requested by Employer; Resistance test for armour

8.2 TYPE TESTS

Certified copies of the type test carried out in accordance with IEC 60502-1 as indicated below shall be furnished with the offer. The test certificates should clearly identify the equipment / material concerned, showing the manufacturer's identity, type/model and basic technical parameters. The type test certificates referred to, shall be issued within 5 years from the date of bid opening from a recognized independent testing authority accredited to ISO/IEC 17025:2005 for carrying out specified type tests and acceptable to the Employer.

A. Electrical Type Tests

- (a) Insulation resistance measurement at ambient temperature
- (b) Insulation resistance measurement at maximum conductor temperature in normal operation
- (c) Voltage test for 4 h

B. Non- Electrical Type Tests

- (a) Measurement of thickness of insulation (testing done for IEC defined sizes acceptable)
- (b) Measurement of thickness of non-metallic sheaths (testing done for IEC defined sizes acceptable)
- (c) Tests for determining the mechanical properties of insulation before and after Ageing
- (d) Tests for determining the mechanical properties of non-metallic sheaths before and after ageing
- (e) Additional ageing test on pieces of completed cables
- (f) Loss of mass test on PVC sheaths of type ST2
- (g) Pressure test at high temperature on insulations and non-metallic sheaths
- (h) Test for resistance of PVC insulation and sheaths to cracking (heat shocktest)
- (i) Hot set test for EPR, HEPR and XLPE insulations and elastomeric sheaths
- (j) Water absorption test on insulation
- (k) Flame spread test on single cables
- (l) Shrinkage test for XLPE insulation

Following type test as per BS 5467 for armour wires shall be provided with the offer

- (m) Mass of zinc coating

8.2 SAMPLE / ACCEPTANCE TESTS

The following Sample/Acceptance tests shall be witnessed by the inspection Engineer. Extra copies of these test certificates shall also be furnished with the equipment / material, prior to dispatch.

- a. conductor examination
- b. check of dimensions
- c. hot set test for EPR, HEPR and XLPE insulations and elastomeric sheaths
- c. Conductor resistance test,
- d. Test for thickness of insulation and sheath
- e. Partial discharge test
- f. Voltage test and
- g. Insulation resistance (volume resistively) test

9.0 INSPECTION AND TESTING

The selected Bidder shall make necessary arrangements for inspection by the Employer or his representative inspection of goods prior to dispatch and to carry out sample / acceptance tests in his presence.

10.0 OTHER REQUIREMENTS

10.1 Manufacturing Experience

The manufacturer shall have at least 05 years' experience in manufacturing and supply of offered type of cables and manufacturer shall furnish documentary evidence with the offer to prove his manufacturing experience.

10.2 Markings

The cable shall be embossed throughout the length with the name of the manufacturer and the letters "Property of FENAKA", voltage grade, cable size and the year of manufacture. The embossing shall be done only on the outer sheath; the distance between any two consecutive embossing shall not be more than 2 Meter. The cable shall also be embossed with marking for successive length of each 1 m.

Each cable drum shall be labeled (with clear stencil) with the following; (a)"PROPERTY OF FENAKA" (b) Bid No. ... Serial No..... (c) Manufacturer's identification. (d) Cable Type, Voltage grade, Conductor Size and Number of Cores. (e) Number and year of standard adopted. (f) Net Weight & Gross Weight in kg. (g) Length of cable in meter. (h) Direction of rolling (i) Year of Manufacture.

10.3 Packing

The cables shall be supplied in non - returnable drums and the drums shall be made of timber, pressure impregnated against fungal and insect attack, or made of steel suitably protected against corrosion suitable to mount on standard drum jacks.

A polythene lining shall be provided to prevent any damage to cable from the chemical used for preservation of timber. The drum shall be lagged with closely fitted battens to protect cable from damage. The ends of all cables shall be sealed with heat shrinkable caps to prevent the ingress of moisture during transportation and storage.

The cable shall be supplied in wooden drums and the standard drum length shall be relevant IEC standard.

11.0 QUALITY ASSURANCE

The manufacturer shall possess valid ISO 9001 Quality Assurance Certification for the process of design, manufacturer and testing of the cables. The Bidder shall furnish a copy of the ISO Certificate certified as true copy of the original by the Manufacturer, along with the offer.

12.0 SPARE PARTS AND TOOLS

– Not applicable.

13.0 TECHNICAL LITERATURE / SAMPLES

Technical literature / brochures for the offered cable shall be provided. Samples of cables shall be provided upon request.

14.0 WARRANTY

The Bidder shall warrant that all equipment supplied shall have no defect arising from design, materials or workmanship or from any act or omission of the supplier that may develop under normal use of the supplied equipment / material.

This Warranty shall remain valid for 3 years.

15.0 INFORMATION TO BE SUPPLIED BY THE BIDDER

- Catalogues/ Technical literature including technical data and drawings for cables.
- Type test certificates
- Manufacturers ISO 9001 Certifications
- Completed schedule of guaranteed technical particulars
- Manufacturer experience records

16.0 SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS

Schedule of Guaranteed Technical Particulars (GTP) for should be filled by the Bidder. Specimen GTP schedule for LV cables is provided at the end of the specification. Bidder may provide additional information in the GTP schedule as required.

17.0 SCHEDULE OF DEVIATIONS

Any non-compliances / deviations of the offered item in respect of the technical requirements provided in this specification shall be provided using Schedule of Deviations form provided in Section 4 of the bid documents. This form should be provided for each key item of the specification, indicating any deviations or 'no deviations' as applicable.

**SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS
0.6/1 (1.2) kV SINGLE AND MULTI CORE ARMORED POWER CABLES**

(This schedule shall be duly filled by the Bidder)

SI No	Particulars	Unit	Offered	
			Single Core	Four Core
1	Name & Address of Manufacturer	-		
2	Country of Origin	-		
3	Model / catalogue number	-		
4	Applicable Standard/s	-		
5	Voltage Grade Uo/U (Um)	kV		
6.0	Maximum allowable conductor temperature			
6.1	- Load	°C		
6.2	- Short Circuit	°C		
7.0	Conductor			
7.1	Conductor Cross Sectional Area (Range offered as per BOQ)	mm ²		
7.2	Diameter	mm		
7.3	Material	-		
7.4	Form : Solid / Stranded	-		
7.5	Form: Compacted/Un-compacted	-		
7.6	Shape : Round/Shaped	-		
7.7	Flexibility Class As per IS:8130:85	-		
7.8	Number of strands	mm		
7.9	Diameter of strands	mm		
8.0	Insulation			
8.1	Material	-		
8.2	Average thickness	mm		
8.3	Colour Coding of cores	-		
9.0	Inner Sheath			
9.1	Material	-		
9.2	Thickness	mm		
10.0	Armour			
10.1	Material	-		
10.2	Type (Wire / Tape)	-		
10.3	Diameter / Thickness	mm		
11.0	Outer Sheath			
11.1	Material			

SI No	Particulars	Unit	Offered	
			Single Core	Four Core
11.2	Minimum thickness	mm		
11.3	Anti rodents /termite treatment	-		
12.0	Maximum dc resistance at 20°C	Ω / km		
13.0	Current Ratings with derating factors provided ?	S		
14.0	Cable Bending factor	-		
15.0	Type test certificates provided ?	-		
16.0	Technical Literature / Drawings / Samples submitted ?			
17.0	Manufacturer's Quality Assurance Certifications provided ?	-		
18.0	Completed GTPs submitted ? (Yes / No)			
19.0	Schedule of Deviations from specifications Submitted ? (Yes / No)			
20.0	Warranty Period	Yrs		

We certify that the above data are true and correct.

 SEAL AND SIGNATURE OF THE BIDDER/ Date

AP - 003

TECHNICAL SPECIFICATION FOR 11 kV ARMORED POWER CABLES

1.0 SCOPE:

The specification covers the design, testing, supply and delivery of 6.35/1 (1.2) kV grade 3 core copper Conductor, Cross-linked polyethylene (XLPE) insulated, PVC sheathed, armoured, screened Power Cables as per BS6622 / IEC 60502-2 for use in electricity distribution systems in Maldives.

1.1 The cables shall confirm in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation in a manner acceptable to the Employer, who will interpret the meanings of drawings and specification and shall have the power to reject any work or material which, in his judgment is not in accordance therewith.

1.2. Normally the offer should be as per Technical Specification without any deviation. But any deviation felt necessary to improve performance, efficiency and utility of equipment must be mentioned in the "Deviation Schedule" with reasons duly supported by documentary evidence and advantages of such deviation. Such deviation suggested may or may not be accepted. But deviation not mentioned in "Deviation Schedule" will not be considered afterwards.

1.3. The cables may be laid buried directly in ground or laid in ducts, cable trays and terminated for outdoor connection to a distribution transformer or to overhead LT lines, and indoor connection for indoor switchgear.

1.4 The equipment / materials supplied shall be rated to be used under system parameters and service conditions given and clause 2.0 and 3.0 respectively.

2.0 SYSTEM PARAMETERS

Parameter	Low Voltage System	11kV System
Nominal Voltage	0.415/ 0.240 kV	11 kV
Highest System Voltage	0.44 / 0.255 kV	12 kV
Number of Phases	3PN	3
Frequency	50 Hz	50Hz
Neutral Earthing	Solidly Earthed	Solidly earth
3 Phase Short Circuit Levels	Upto 65 kA / 1s	Upto 20 kA / 1s
Impulse Withstand Voltage	6 kV	75 kV (peak)
Power Freq. Withstand Voltage 1 min	2.5 kV	28 kV

3.0 SERVICE CONDITIONS

Parameter	Value
Climate	Typical tropical coast line
Atmosphere	Saliferous, corrosive and dusty
Max. Ambient Temperature	35 °C
Max. Daily average ambient temp.	29 °C
Min Ambient Temp	24 °C

Parameter	Value
Maximum Humidity	90 %
Maximum altitude above M.S.I.	Average 2 m
Average days of rainfall	145 days/ yr
Maximum wind speed	gusts up to 100 km/hr

4.0 STANDARDS:

The equipment and material supplied shall be in accordance with the latest editions of the Standards specified below and amendments thereof.

Standard	Title
BS6622	Electric cables. Armored cables with thermosetting insulation for rated voltages from 3.8/6.6 kV to 19/33 kV. Requirements and test methods
IEC 60502-2	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 2: Cables for rated voltages from 6 kV (Um = 7,2 kV) up to 30 kV (Um = 36 kV)
BS EN/IEC 60811-201,202,203,501	Electric and optical fiber cables - Test methods for nonmetallic materials - Part 201: General tests - Measurement of insulation thickness, Part 202: General tests - Measurement of thickness of metallic sheath, Part 203: General tests – Measurement of overall dimensions, Part 501: Mechanical tests - Tests for determining the mechanical properties of insulating and sheathing compounds
IEC 60228	Conductors for insulated electric cables
IEC 60986	Short-circuit temperature limits of electric cables with rated voltages from 6 kV (Um = 7,2 kV) up to 30 kV (Um = 36 kV)

Material conforming to other internationally accepted standards, which ensure equal or higher quality than the standards mentioned above, may be acceptable, subject to approval by the Employer at his discretion. In case the Bidders who wish to offer material conforming to the other standards, salient points of difference between the standards adopted and the specific standards shall be clearly brought out in relevant schedule. Two copies of such standards with authentic English Translations shall be furnished along with the offer.

5.0 TECHNICAL REQUIREMENTS:

5.1 MAIN FEATURES:

The power cables shall be of 6.35/11 (12) kV grade, stranded compacted, high conductivity, copper conductor, XLPE insulated, screened, ST-2 type extruded PVC outer sheathed, armored cables manufactured and type tested according to standards specified above suitable for 11kV three phase, 50Hz, solidly earthed distribution system.

The cable shall be designed to operate on maximum operating temperature of 90 ° C and maximum short circuit temperature of 250 ° C.

5.2 MATERIALS AND CONSTRUCTION:

5.2.1 CONDUCTOR:

The cable conductor shall be made from Circular Compacted Plain Annealed Copper Conductors having resistance within the limits specified in IEC standard 60228 Class 2.

5.2.2 CONDUCTOR SCREEN

The conductor shall have a non magnetic semi – conducting screen, which will ensure perfectly smooth profile to avoid stress concentration. The conductor screen shall be extruded in the same operation as the insulation and the extruded layer shall be continuous covering the surface of the conductor completely.

Volume resistivity of the screen shall not exceed 500 Ω .m at 90 °C when measured in accordance with BS6622 / IEC 60502-2. Thickness shall be in accordance with BS6622 / IEC 60502-2.

5.2.3 INSULATION

The insulation shall be cross-linked polyethylene (XLPE) applied by extrusion process and cross-linked to form a compact and homogeneous layer in accordance with the standards specified. Minimum thickness shall be in accordance with BS6622 / IEC 60502-2.

The manufacturing process shall ensure that the insulation is free from voids. The insulation shall withstand mechanical and thermal stresses under steady state as well as transient operating conditions. The extrusion method shall give smooth surface of insulation. The insulation shall be so applied that it fits closely on the conductor, and it shall be easily possible to remove it without damaging the conductor. The insulation shall be resistant to chemicals like acids, alkalis, oils and ozone. The insulating material shall have excellent electrical properties with regard to resistivity, dielectric constant and loss factor and shall have high tensile strength and resistance to abrasion. This shall not deteriorate at elevated temperatures or when immersed in water.

The average thickness of insulation shall not be less than the nominal value as specified in BS6622 / IEC 60502-2.

The insulation properties shall be stable under thermal conditions arising out of continuous operation at conductor temperature of 90°C rising momentarily to 250°C under short circuit conditions.

5.2.4 INSULATION SCREEN

To confine electrical field to the insulation, insulation screening consisting of two parts, namely metallic (non- magnetic) and non-metallic (semi conducting) shall be provided.

Phase identification shall be provided in insulation screen by colour or number coding.

5.2.4.1 Non-metallic semi conductive screen :

A non-metallic semi-conducting layer having resistivity not exceeding 500 ohm meter at 90°C shall be provided over the insulation to confine electrical field to the insulation. The insulation screen shall be extruded in the same operation as the conductor screen and the insulation by triple extrusion through single head process. It shall be bonded to insulation and cold strippable. Thickness shall be in accordance with BS6622 / IEC 60502-2.

5.2.4.2 Metallic screen :

The copper metallic overlapped tape shield in helical form or copper wire shall be provided as per BS6622 / IEC 60502-2. The cross-sectional area of the metallic screen shall be able to withstand 1/3rd of the system fault current over the full duration specified.

5.2.5 LAYING UP OF CORES AND CORE IDENTIFICATION

The cores shall be laid-up with a right-hand direction of lay. Individual cores shall be colour coded by suitable means for proper identification.

5.2.6 FILLER AND INNER COVERING

The laid-up cores shall be provided with ST-2 inner sheath applied by extrusion process. It shall be ensured that the shape is as circular as possible. The material of fillers and inner covering shall be non-hygroscopic, compatible with the temperature ratings of the cable. The thickness of the inner sheath shall be as per BS6622 / IEC 60502-2. It shall be applied to fit closely on to the laid up cores and shall be possible to remove easily without causing any damage to the underlying insulated cores.

5.2.7 ARMOUR

Armoring shall be applied over the inner covering with galvanized steel wire armour. Armour shall be applied helically over the inner covering and should withstand the designed short circuit current of the cable. The nominal diameter of the armour wires shall be in accordance with BS 6622 or IEC 60502-2 standards as applicable.

5.2.8 Longitudinal Water Barrier :

Water barrier swelling tape or powder in conductor, over metallic screen, armour shall be provided to provide added protection against longitudinal water penetration.

5.2.6 OUTER SHEATH

The extruded outer sheath of PVC compound insulation over the armoring shall be provided. The PVC compound for the outer sheath shall conform to type ST-2. Suitable additives (to prevent attacks by rodents and termites) shall be provided. Common acids, alkalis, saline solutions etc., shall not have adverse effects on the PVC sheathing material used. Minimum thickness of outer sheath shall be as specified in BS6622 / IEC 60502-2. A coating of Graphite shall be applied over the outer sheath to carry out D.C. Voltage Test.

5.2.7 OTHER

All materials shall comply with the applicable provisions of the tests of the relevant Standards. No recycled PVC is permissible. Fillers shall be suitable for the operating temperature of the insulation & compatible with the insulation material. The Employer reserves the right to ask for documentary proof of the purchase of various materials to be used for the manufacture of cable and to check that the conductor is complying with quality control.

6.0 CURRENT RATING

The cables shall have continuous and short circuit current ratings and derating factors as per relevant IEC / BS Standards. The current ratings shall be based on maximum conductor temperature of 90 deg. C with ambient site condition specified for continuous operating at the rated current. The bidder shall provide tables of maximum current ratings for various cable laying arrangements under the system and service conditions specified in section 2.0 and 3.0.

7.0 SHORT CIRCUIT CURRENT WITHSTAND CAPACITY

The short circuit current carrying capacity of cables shall be as determined in accordance with IEC 60986, to be provided by the Bidder.

8.0 TESTS

8.1 ROUTINE TESTS

The following Routine tests as per BS6622 or IEC 60502-2 shall be carried out on each manufactured cable length and the routine test reports shall be made available to the Employer.

- (a) Spark Test on Oversheath
- (b) Conductor Resistance
- (c) Copper Wire Screen Resistance

- (d) Partial Discharge Test
- (e) Voltage Test on Complete Cable
- (f) Cable Marking
- (g) D.C.Voltage Test on Oversheath

8.2 TYPE TESTS

Certified copies of the type test carried out in accordance with BS 6622 as indicated below shall be furnished with the offer. If cables type tested for IEC standards are offered, such cables will be accepted with a condition that the tests which are not covered or less stringent than BS 6622 shall be performed at pre-shipment inspection, if requested by the Employer.

The test certificates should clearly identify the equipment / material concerned, showing the manufacturer's identity, type/model and basic technical parameters. The type test certificates referred to, shall be issued within 5 years from the date of bid opening from a recognized independent testing authority accredited to ISO/IEC 17025:2005 for carrying out specified type tests and acceptable to the Employer.

(A) Electrical Tests

- (a) Partial Discharge Test
- (b) Bending Test
- (c) Tan 3 in Relation to Voltage
- (d) Tan3din Relation to Temperature
- (e) Heating Cycle Test
- (f) Impulse Voltage Test
- (g) Four-hour Voltage Test
- (h) Adherence of screens at short circuit temperature
- (i) Resistance of the cable at 20°C

(B) Material Tests

- (j) Conductor Screen Resistivity
- (k) Insulation Material
- (l) Insulation Screen Resistivity
- (m) Insulator Screen Cold Strippability
- (n) Semi-conducting Lapped Inner covering Resistance
- (o) Separation Sheath Material
- (p) Tests on Armour
- (q) Tests on Over Sheath Material
- (r) Compatibility Test
- (s) Test under Fire Conditions

8.2 SAMPLE / ACCEPTANCE TESTS

The following Sample/Acceptance tests shall be witnessed by the inspection Engineer. Extra copies of these test certificates shall also be furnished with the equipment / material, prior to dispatch.

- (a) Conductor Material and Construction
- (b) Conductor Screen Application
- (c) Insulation, Hot set Test

- (d) Insulation, Thickness
- (e) Insulation, Concentricity
- (f) Circularity of Cores
- (g) Insulation Tests on Screen
- (h) Metallic Screen, Application
- (i) Measurement of Amour Wires
- (k) Oversheath Thickness
- (l) Four-hour Voltage test

9.0 INSPECTION AND TESTING

The selected Bidder shall make necessary arrangements for inspection by the Employer or his representative inspection of goods prior to dispatch and to carry out sample / acceptance tests in his presence.

10.0 OTHER REQUIREMENTS

10.1 Manufacturing Experience

The manufacturer shall have at least 05 years' experience in manufacturing and supply of offered type of cables and manufacturer shall furnish documentary evidence with the offer to prove his manufacturing experience.

10.2 Markings

The cable shall be embossed throughout the length with the name of the manufacturer and the letters "Property of FENAKA", voltage grade, cable size and the year of manufacture. The embossing shall be done only on the outer sheath; the distance between any two consecutive embossing shall not be more than 2 Meter. The cable shall also be embossed with marking for successive length of each 1 m.

Each cable drum shall be labeled (with clear stencil) with the following; (a) "PROPERTY OF FENAKA" (b) Bid No. ... Serial No..... (c) Manufacturer's identification. (d) Cable Type, Voltage grade, Conductor Size and Number of Cores. (e) Number and year of standard adopted. (f) Net Weight & Gross Weight in kg. (g) Length of cable in meter. (h) Direction of rolling (i) Year of Manufacture.

10.3 Packing

The cables shall be supplied in non-returnable drums. Drums shall be wooden or steel : suitably protected against corrosion. A polythene lining shall be provided to prevent any damage to cable from the chemicals used for preservation of drum.

The drum shall be lagged with closely fitted battens to protect cable from damage. The ends of cables shall be sealed with heat shrinkable caps to prevent the ingress of moisture during transportation and storage. The preferred length of cable per drum shall be 500 meters subject to @ maximum gross drum weight of 5 MT. The cable length per drum shall not vary more than 2%.

11.0 QUALITY ASSURANCE

The manufacturer shall possess valid ISO 9001 Quality Assurance Certification for the process of design, manufacturer and testing of the cables. The Bidder shall furnish a copy of the ISO Certificate certified as true copy of the original by the Manufacturer, along with the offer.

12.0 TRAINING

The Supplier shall provide training on the operation and maintenance of the 11 kV cables which should include hands-on training on cable fault location, cable jointing and termination. Training should be provided for up to 10 Nos FEANKA staffs in each Island.

13.0 SPARE PARTS AND TOOLS

Mandatory Spare parts :

- 01 Spare Stright Through Jointing Kit for each 500 m or part thereof of 11 kV Cu/XLPE/PVC 3C x 70 sqmm, Armoured cable supplied for each Island shall be provided.
- 04 Nos Indoor Termination kids for the same cable shall be provided for each Island (excluding Islands where 11 kV cables are not required to be supplied)

Recommended Spare Parts : Not applicable.

14.0 TECHNICAL LITERATURE / SAMPLES

Technical literature / brochures for the offered cable shall be provided. Samples of cables shall be provided upon request.

15.0 WARRANTY

The Bidder shall warrant that all equipment supplied shall have no defect arising from design, materials or workmanship or from any act or omission of the supplier that may develop under normal use of the supplied equipment / material.

This Warranty shall remain valid for 3 years.

16.0 INFORMATION TO BE SUPPLIED BY THE BIDDER

- Catalogues describing the cables and indicating construction details, compliance standards etc.
- Type test certificates.
- Manufacturers ISO 9001 Certification.
- Completed schedule of guaranteed technical particulars
- Manufacturer experience records

17.0 SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS

Schedule of Guaranteed Technical Particulars should be filled in and submitted by the Bidder **for each size of cable offered**.

18.0 SCHEDULE OF DEVIATIONS

Any non-compliances of the offered item in respect of the technical requirements provided in this specification shall be provided using Schedule of Deviations form provided in Section 4 of the bid documents. This form should be provided for each key item of the specification, indicating any deviations or 'no deviations' as applicable.

**SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS
11 kV ARMORED POWER CABLES**

(This schedule shall be duly filled by the Bidder)

SI No	Particulars	Unit	Offered
1	Name & Address of Manufacturer	-	
2	Country of Origin	-	
3	Model / catalogue number	-	
4	Applicable Standard/s	-	
5.1	Voltage Grade U _o /U (U _m)	kV	
5.2	No of Cores	-	
6.0	Maximum allowable conductor temperature		
6.1	- Load	°C	
6.2	- Short Circuit	°C	
7.0	Conductor		
7.1	Conductor Cross Sectional Area	mm ²	
7.2	Diameter	mm	
7.3	Material	-	
7.4	Form : Solid / Stranded	-	
7.5	Type: Compacted/Un-compacted	-	
7.6	Shape : Round/Shaped	-	
7.7	Flexibility Class As per IS:8130:85	-	
7.8	Number of strands	mm	
7.9	Diameter of strands	mm	
8.0	CONDUCTOR SCREEN		
8.1	Material	mm	
8.2	Thickness (min)	mm	
9.0	INSULATION		
9.1	Material	-	
9.2	Average thickness	mm	
10.0	INSULATION SCREEN		
A	Semi conductive screen		
10.1	Material	-	
10.2	Thickness	mm	
B	Metallic Screen		

SI No	Particulars	Unit	Offered
10.3	Material	-	
10.4	Thickness / Dia	mm	
11	Filler Material		
12	INNER SHEATH		
12.1	Material	-	
12.2	Thickness (min)	mm	
13	ARMOUR		
13.1	Material	-	
13.2	Galvanizing	-	
13.3	Type (Wire / Tape)	-	
13.4	Diameter / Thickness	mm	
14.0	OUTER SHEATH		
14.1	Material		
14.2	Minimum thickness	mm	
14.3	Anti rodents /termite treatment	-	
14.3	Graphite coating ?	-	
15.0	Longitudinal Water Barrier		
15.1	Material	-	
15.2	Locations applied	-	
16.0	Maximum dc resistance at 20°C	Ω / km	
17.0	Current Ratings with derating factors provided ?	S	
18.0	Cable Bending factor	-	
19.0	Max. Partial discharge magnitude at 1.5U _o	Pc	
20.0	Power frequency withstand voltage	kVrms	
21.0	Impulse withstand voltage	kVp	
22.0	Mandatory spare parts will be supplied as per specification ?	-	
23.0	Type test certificates provided ?	-	
24.0	Technical Literature / Drawings / Samples submitted ?	Y/N	
25.0	Manufacturer's Quality Assurance Certifications provided ?	-	

SI No	Particulars	Unit	Offered
26.0	Completed GTPs submitted ? (Yes / No)		
27.0	Schedule of Deviations from specifications Submitted ? (Yes / No)		
28.0	Warranty Period	Yrs	

We certify that the above data are true and correct.

 SEAL AND SIGNATURE OF THE BIDDER/ Date

AP - 004

TECHNICAL SPECIFICATION FOR 0.415/11 KV STEP-UP TRANSFORMER

1.0 SCOPE

This specification covers the design, manufacturing, testing, supply, delivery and performance requirements of 3 Phase, 50 Hz, 0.415 / 11 kV, YNd1, double wound with copper conductor, oil immersed, sealed (hermetically sealed) or non- sealed (conservator) type, ONAN cooled power transformer of capacities as specified in the BOQs for use in electricity distribution systems in Maldives.

Transformers shall have separate primary and secondary windings, oil immersed with natural oil and air cooling (ONAN).

The design of the tank, fittings, bushings, etc. shall be such that it will not be necessary to keep the transformer energized to prevent deterioration as the transformers may be held in reserve or outdoors.

The equipment / materials supplied shall be rated to be used under system parameters and service conditions given and clause 2.0 and 3.0 respectively.

2.0 SYSTEM PARAMETERS

Parameter	Low Voltage System	11kV System
Nominal Voltage	0.415 / 0.240 kV	11 kV
Highest System Voltage	0.44 / 0.255 kV	12 kV
Number of Phases	3PN	3
Frequency	50 Hz	50Hz
Neutral Earthing	Solidly Earthed	Solidly earth
3 Phase Short Circuit Levels	Upto 65 kA / 1s	Upto 20 kA / 1s
Impulse Withstand Voltage	6 kV	75 kV (peak)
Power Freq. Withstand Voltage 1 min	2.5 kV	28 kV

3.0 SERVICE CONDITIONS

Parameter	Value
Climate	Typical tropical coast line
Atmosphere	Saliferous, corrosive and dusty
Max. Ambient Temperature	35 °C
Max. Daily average ambient temp.	29 °C
Min Ambient Temp	24 °C
Maximum Humidity	90 %
Maximum altitude above M.S.l.	Average 2 m
Average days of rainfall	145 days/ yr
Maximum wind speed	gusts up to 100 km/hr

4.0 APPLICABLE STANDARDS:

The equipment and material supplied shall be in accordance with the latest editions of the Standards specified below and amendments thereof.

Standard	Title
IEC Standards :	
IEC 60071	Insulation co-ordination
IEC 60076	Power transformers
IEC 60156	Method for the determination of the electric strength of insulating oils
IEC 60296	Specification for unused mineral insulating oils for transformer and switchgear
IEC 60354	Loading guide for oil-immersed power transformers
IEC 60437	Radio interference test on high-voltage insulators
IEC 60551	Determination of transformer and reactor sound levels
IEC 60616	Terminal and tapping markings for power transformers
IEC 60722	Guide to the lightning impulse and switching impulse testing of power transformers and reactors
ISO Standards :	
ISO 1459	Metallic coatings - Protection against Corrosion by Hot Dip Galvanising - Guiding Principles
ISO 1460	Metallic coatings - Hot dip galvanized coatings on ferrous materials. Gravimetric determination of the mass per unit area
ISO 2178	Non-magnetic coatings on magnetic substrates - Measurements of coating thickness - Magnetic method
ISO 9000:	Quality management and quality assurance standards - Guidelines for selection and use
CENELEC/CEN Harmonized European Standards:	
HD 428	Distribution Transformers

Material conforming to other internationally accepted standards, which ensure equal or higher quality than the standards mentioned above, may be acceptable, subject to approval by the Employer at his discretion. In case the Bidders who wish to offer material conforming to the other standards, salient points of differences between the standards adopted and the specific standards offered shall be clearly indicated in the Technical Proposal. Two copies of such standards with authentic English Translations shall be furnished along with the offer.

5.0 TECHNICAL REQUIREMENTS

5.1 MAIN FEATURES:

	Description	Requirement
Rated Voltage	HV	11 kV
	LV	415 V

Description	Requirement
Frequency	50 Hz
Number of Phases	3
Power ratings	Upto 3500 kVA
Type	Oil immersed, hermetically sealed
Applicable Standard	IEC 60076
Cooling	Self-cooled (ONAN)
Voltage Variation	Off-load tap changer with 5 positions in the HV winding giving $\pm 2 \times 2.5 \%$.
Windings	Copper
Core	Grain orientated silicon steel or Amorphous metal
HV and LV Bushings	Outdoor type
Vector Group	YNd1
Impulse Withstand Voltage	75 kV (peak)
Power Freq. Withstand Voltage 1 min	28 kV
Short time withstand current duration (Under three phase faults)	3 s
Minimum short circuit impedance voltage at 75°C (for transformers above 2000 KVA)	7%
Average winding temperature rise (by resistance measurement) at steady state Continuous Maximum Rating at normal ambient (30°C) under normal service condition.	55 K
Top oil temperature rise at normal ambient (30°C) under normal service condition	50 K
Losses	Maximum Level 1 stipulated loss values as per IEC TS 60076-20 :2017.

5.2 Rated Power

The continuous rating of the step-up power transformer shall be as indicated in the Schedules.

Each Transformer shall be capable of supplying its rated power being the product of rated voltage and rated current on the line side winding (at center tap) expressed in kVA, as defined in IEC 60076-1.

Transformer shall be capable of supplying its rated power continuously under ambient temperature conditions without the temperature rise of the top oil exceeding 50 °C and without the temperature rise of the windings as measured by resistance exceeding 55 °C.

5.3 Overload Capacity

The transformer shall be capable of operating in accordance with the loading guidelines of IEC 60076-7 without exceeding the normal daily use of life and without the transformer winding hot spot temperature exceeding 140 °C.

The Supplier shall submit calculations demonstrating that the above requirements are met. These calculations shall disregard the effect of winding thermal capacity.

5.4 Impedance Voltage

The guaranteed value of impedance measured at 75 °C and center tap shall be approx. 7% for the transformers above 2000 kVA capacity subject to the tolerances as specified in IEC 60076.

The resistance component of impedance measured at 75 °C on the center tap shall not exceed 25 % for all kVA ratings

5.5 Short Circuit Performance

The transformer shall be capable of withstanding the thermal and dynamic effects of short circuits. It shall be able to withstand specified system short circuit level and the duration.

The short circuit characteristics shall be as follows;

- The X/R ratio shall conform to HD 398 / HD 428
- The initial winding hot spot temperature shall be 98 °C
- The final winding hot spot temperature shall be 250 °C

The ability to withstand the thermal and dynamic effects of a short circuit shall be demonstrated in accordance with IEC 60076 and IEC 60354. Calculations / test certificates shall be submitted for approval.

5.6 Transformer Losses

Maximum load losses and maximum no load losses of transformer shall not exceed values Level 1 loss values as per IEC TS 60076-20 :2017.

The Bidder shall state the guaranteed losses. No positive tolerance is allowable on the guaranteed values. Transformers supplied with losses exceeding the guaranteed values are not acceptable, unless Employer agrees to accept the transformer with a penalty imposed to compensate for increased life cycle costs, at his discretion.

The Bidder shall also state the value of guaranteed magnetizing current, subject to the tolerance specified in IEC 60076.

5.6 Flux Density

The flux density at any point of the magnetic circuit when the transformer is connected on the centre tap and operating at normal voltage and frequency shall not exceed 1.65 Tesla. Saturation must not occur at 10 % over voltage.

5.7 Noise Level

The average noise level of the transformers shall not exceed the values given in IEC 60076-10. The measurements shall be carried out in accordance with the above standard at a distance of 300 mm from the envelope of the transformer.

5.8 Tap Changing Characteristics

Each transformer shall be fitted with 5 taps with $\pm 2 \times 2.5\%$ voltage variation. Tap changing and the tap changing mechanism shall have the following characteristics:

- Tap changing shall be carried out with the transformer off-load. An externally operated self-positioning tapping switch shall be provided.
- Provision shall be made for locking the tap switch handle with a padlock.
- Tap changer handles shall be fitted with gasketed covers, so that sealing of the transformer under normal conditions is independent of the switch shaft gland.

6.0 MATERIALS AND CONSTRUCTION

6.1 Core and Coils

The HV and LV windings shall be made of high conductivity copper.

The windings shall be uniformly insulated, and the HV neutral point shall be insulated for full voltage. The insulation material of windings and connections shall be high quality, free from insulation softening, shrinking or collapsing during service. Moreover none of the material used shall disintegrate, carbonize or become brittle under the action of hot oil, under all load conditions.

The core shall be manufactured from non-aging, grain-orientated silicon steel or Amorphous metal. The core and coil assembly shall have the core and coils rigidly connected to the tank and suitable closed lugs shall be provided for removing the core and coil assembly from the tank.

6.2 Cable Boxes and Terminals

Cable boxes for both HV and LV terminations shall be provided. All cable boxes shall be so designed that there will be no excessive stress on any parts due to temperature changes and adequate means shall be provided to accommodate conductor expansion. Insulation levels for bushings shall be at least equal to those specified for the windings.

The Bushings shall be installed ensuring they are easy to be checked and removed without removing the tank cover and the pipe work.

The creepage distances for the bushings and the insulators shall not be less than 25 mm/kV for maximum phase to phase system voltage.

Both HV and LV cable boxes shall be complete with suitable for terminating Copper conductors of as details given below:

HV: For terminating XLPE insulated Copper cables upto 2 Nos 120 sqmm cables per phase.

LV: For terminating XLPE insulated Copper cables upto 6 Nos 630 sqmm cables per phase.

6.3 Earthing Terminals

All transformers shall be provided with a main earthing terminal of stainless steel welded to the tank and be fitted with a stainless steel M12 bolt, nut, spring washer and a lock washer.

6.4 Tank Fabrication

The transformer tank shall be of rigid construction, shall not leak and shall be designed so that the completed transformer can be lifted and transported without permanent deformation or oil leakage. The Supplier shall state what method of leak testing is used.

The tank shall be fabricated of mild steel or stainless steel. If stainless steel is used it shall not discolor or corrode; a minimum grade 304 L is required.

The minimum thickness of the steel tank shall be 3 mm for mild steel and an equivalent thickness for

stainless steel such that its mechanical strength shall be the same as that of the 3 mm thick mild steel tank. Thickness below the minimum value will be considered only in exceptional cases, such as where special protective finishes are used. The Contractor shall provide full information about any such special finish, including any field experience.

The transformer tank and the top cover shall be designed in such a manner as to leave no external pockets in which water can lodge or dust deposits can build up.

The top cover shall be of the bolted type and fitted with neoprene bonded cork seals suitable for temperature as stipulated in this specification. Surfaces at gasketed joints shall be such that an even face is presented to the gasket, thereby eliminating the necessity for the gasket to take up surface irregularities.

The cooling surfaces may be oil filled fins or radiators. Only larger faces of the transformer shall be used to attach cooling surfaces.

In case of sealed type transformers, the tank shall be hermetically sealed and designed to fully withstand pressures that build-up under normal operation and faulty conditions.

All pipes and radiators, which are welded to the tank wall, shall be welded externally.

Transformers shall be wheel mounted. Skids shall be aligned at right angles to the line of the HV bushings.

6.5 Conservator

For non-sealed type transformer, conservator shall be provided as per manufacturer's design. The conservator shall be fitted with **Automatic Maintenance Free Dehydrating Breather**, complete with temperature sensor, ventilation and anti-condensation heating elements and electronic controller. Bidders shall note that this is a mandatory requirement and conventional type dehydrating breathers are not acceptable. Any additional accessories including air release plug, oil gauge etc. shall also be provided.

6.6 Surface Treatment

The transformer tank, radiators and accessories should be adequately protected against corrosion and the Supplier shall submit details of the proposed method of protection. All surfaces shall be thoroughly cleaned of rust, scale, grease and dirt and other foreign matter and all imperfections shall be removed by means of approved methods.

The transformer tank and its steel attachments shall be hot dip galvanized or metallized, followed by painting. The painting system used should be proven and documented and suitable for salty, hot and humid environments.

The outside of the tank shall be painted Gray. The inside of the tank shall be painted with an approved oil & heat resisting (hot oil proof) varnish for inside surface so that the oil cannot come into contact with the tank metal at any time.

6.7 Tank Fittings and Attachments

The following fittings and attachments shall be provided in all transformers:

- Tap changer (off-circuit with pad lockable switch)
- HV bushing assembly
- LV bushings assembly
- Main earthing terminal
- Lifting eyes pulling eyes and jacking pads
- Stainless steel engraved rating and connection plate

- Pressure relief valve
- Dial Type thermometer with contacts and control box for relays
- Protecting irons
- Terminal marking

6.8 Transformer Assembly

The core and windings shall be dried in a vacuum drying oven. The tank, complete with core and windings, shall be filled with oil under a vacuum.

6.9 Transformer Oil

The transformers shall be supplied with class 1 mineral oil conforming to IEC 60296. The Supplier shall submit a detailed specification for the type of oil proposed. The oil shall not contain polychlorinated biphenyls (PCB). The Employer may require evidence that the oil is not contaminated by PCB. If an anti-oxidant is recommended, its use shall be subject to the Employer's approval.

7.0 TESTS

The tests listed hereinafter shall be carried out in accordance with provisions in the referenced standards in the specification.

7.1 Routine Tests

Routine tests shall be carried out on all transformers and the tests shall be conducted in accordance with IEC 60076 /other standards as applicable. Copies of routine test reports shall be provided to the Employer upon request.

The following routine measurements and tests shall be carried out:

- Measurement of winding resistance
- Measurement of voltage ratio and check of polarity and vector group
- Measurement of impedance voltages
- Measurement of load losses
- Measurement of no-load losses and no load current, including measurement of harmonics
- Induced overvoltage withstand test
- Separate source voltage-withstand tests on HV and LV windings
- Bushing routine tests
- Oil leakage test
- Relief Device test
- Dielectric Routine Tests
- Galvanizing tests.

Galvanizing tests shall be carried out on transformer tanks prior to painting. Those shall be routine tests, which shall be part of the routine tests documentation. Testing shall be in accordance with ISO 1460 and is summarized as follows;

The following tests, measurements or inspections shall be carried out on each of the selected samples:

- Visual inspection
- Thickness of galvanizing coat
- Uniformity of galvanizing coat

In the event of disagreement or dispute over the results of the above tests a coating mass test shall be carried out. The result of this test shall be definite and binding.

7.2 Type Tests

Certified copies of the type test carried out in accordance with IEC 60076 /other standards as indicated below shall be furnished with the offer. The test certificates should clearly identify the equipment / material concerned, showing the manufacturer's identity, type/model and basic technical parameters. The type test certificates referred to, shall be issued within 5 years from the date of bid opening from a recognized independent testing authority accredited to ISO/IEC 17025:2005 for carrying out specified type tests and acceptable to the Employer.

- Temperature Rise Test
- Short Circuit Withstand test
- Measurement of zero-sequence Impedances
- Impulse Voltage Test and Power Frequency Test
- Acoustic Sound Level Measurement
- Tank Vacuum Test
- Measurement of Harmonic Level in no load condition
- Oil Analysis

7.3 Sample/Acceptance tests

Sample / acceptance tests shall be carried out in accordance with IEC 60076 and other applicable standards. Employer may nominate his representatives to witness sample / acceptance tests prior to dispatch.

8.0 INSPECTION AND TESTING

The selected Bidder shall make necessary arrangements for inspection by the Employer or his representative for inspection of goods prior to dispatch and to carry out sample / acceptance tests and checks in his presence.

9.0 OTHER REQUIREMENTS

9.1 Manufacturing Experience

The manufacturer shall have at least 05 years' experience in manufacturing and supply of offered type of transformers and manufacturer shall furnish documentary evidence with the offer to prove his manufacturing experience.

9.2 Rating Plate

A weatherproof rating plate shall be provided in accordance with IEC 60076 and showing the following information, indelibly marked:

- Type of transformer
- Specification to which standard it was manufactured
- Manufacturer's name
- Serial number
- Year of manufacturer
- Number of phases
- Rated power
- Rated frequency
- Rated voltage
- Rated currents
- Vector group
- Percentage impedance voltage at rated current
- Type of cooling

- Continuous ambient temperature at which ratings apply
- Property of FENAKA

9.3 Packing and Delivery

The transformer shall be suitably packed for transportation and installation strictly according to the manufacturer's recommendations. Packing shall be suitable for transportation under restricted volumes and rough conditions for local transportation between Male and respective Islands. Bidders may note that heavy duty lifting facilities may not be available in some Islands.

9.4 Operations Manual, Technical Literature and Drawings

The selected Bidder shall supply along with the equipment five copies of operational and maintenance manuals for step-up transformer including all relevant drawings and technical literature, .

10.0 QUALITY ASSURANCE

The manufacturer shall possess valid ISO 9001 Quality Assurance Certification for the process of design, manufacture and testing of the transformers. The Bidder shall furnish a copy of the ISO Certificate certified as true copy of the original by the Manufacturer, along with the offer.

11.0 SPARE PARTS AND TOOLS

Mandatory Spare parts : Spare parts required for 5-year trouble-free operation of the transformer, as recommended by the manufacturer shall be supplied. Bidder shall submit the list of spare parts that would be supplied accordingly along with the Bid submission.

Recommended Spare Parts : In addition to mandatory spare parts the bidder is required to provide list of recommended spare parts for 10 year trouble free under normal operating conditions and specified service conditions, in Schedule No 6 (Section 4). Bidders are responsible to ensure availability of spare parts listed for minimum 10 year period. Bidders shall note that the price of recommended spare parts quoted in this Schedule will not be added to Bid Price and not considered in price evaluation.

12.0 TRAINING

The Contractor shall provide training on the operation and maintenance of the step-up transformer. Training should be provided for up to 10 Nos FEANKA staff in each Island.

13.0 TECHNICAL LITERATURE

Technical literature / data sheet / drawings for the offered transformers shall be provided.

14.0 WARRANTY

The Bidder shall warrant that all equipment supplied shall have no defect arising from design, materials or workmanship or from any act or omission of the supplier that may develop under normal use of the supplied equipment / material.

This Warranty shall remain valid for 3 years.

15.0 INFORMATION TO BE SUPPLIED BY THE BIDDER

- Catalogues/ Technical literature including technical data and drawings.
- Technical literature including technical characteristics of associated equipment.
- Mechanical characteristics of equipment including overall dimensions, weight, constructional features.
- Type test certificates
- List of mandatory Spare parts and tools for 5-year trouble-free operation as per Manufacturer's recommendation that will be supplied together with equipment.

- List of recommended spare parts for 10-year trouble free operation.
- Manufacturers ISO 9001 Certifications
- Completed schedule of guaranteed technical particulars
- Manufacturer experience records
- Training plan

16.0 SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS

Schedule of Guaranteed Technical Particulars should be filled in and submitted by the Bidder. Specimen GTP schedule for step-up transformer is provided at the end of the specification. Bidder may provide additional information in the GTP schedule as required.

17.0 SCHEDULE OF DEVIATIONS

Any non-compliances of the offered item in respect of the technical requirements provided in this specification shall be provided using Schedule of Deviations form provided in Section 4 of the bid documents. This form should be provided for each key item of the specification, indicating any deviations or 'no deviations' as applicable.

**SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS
0.415/11 KV STEP-UP TRANSFORMERS**

(This schedule shall be duly filled by the Bidder for each capacity of the transformer offered)

Sl No	Particulars	Unit	Offered
	Transformer Capacity	KVA	
1	Name & Address of Manufacturer	-	
2	Country of Origin	-	
3	Model / catalogue number	-	
4	Applicable Standard/s	-	
5	Design : Hermetically Sealed / Non-Sealed	-	
6	Type of Cooling	-	
7	Rated Voltage (LV / HV)	kV	
8	Highest System Voltage (LV / HV)	kV	
9	Rated Frequency with % variation	Hz	
10	No of Phases	-	
11	Vector Group	-	
12	Impulse Withstand Voltage	kVpk	
13	Power Freq. Withstand Voltage - 1 min	kV	
14	Current at rated full load and on principal tap (LV / HV)	Amps	
15	Permissible Overloading at LV / HV Winding		
16	Short time thermal rating of LV / HV Windings	kA	
17	Short time withstand current duration	S	
19	Short circuit impedance voltage at 75°C	%	
20	% reactance at rated current and rated frequency at principal tap	%	
21	% resistance at rated current and rated frequency at principal tap	%	
22	Average winding temperature rise above max ambient temp	K	

SI No	Particulars	Unit	Offered
	Transformer Capacity	KVA	
23	Top oil temperature rise above max ambient temp	K	
24	Off load tap changer (no of taps x steps)	-	
25	LOSSES :		
25.1	No load loss at rated voltage and frequency at principal tap	kW	
25.2	Load loss at rated output, rated frequency, corrected for 75 °C winding temperature at principal tap	kW	
26	CORE AND WINDINGS :		
26.1	Core construction / material	-	
26.2	Material of the winding conductor - LV / HV windings	-	
26.3	Insulating material used in windings	-	
27	BUSHINGS (LV / HV)	-	
27.1	Make and Model		
27.2	Rated voltage class	kV	
27.3	Rated current	Amps	
27.4	Minimum creepage distance	mm	
27.5	Cable Box / Terminations Details	-	
28	TANK / FINS / RADIATORS		
28.1	Total volume	Liters	
28.2	Material used for Transformer tank	-	
28.3	Thickness of sheet	mm	
28.4	Surface treatment	-	
28.5	No. of bi-directional wheels provided	-	
29	CONSERVATOR (for non-sealed type tr)		
29.1	Total volume	Liters	
29.2	Accessories provided	-	
29.3	Whether Automatic Maintenance Free type dehydrating breather provided ?	Y/N	

SI No	Particulars	Unit	Offered
	Transformer Capacity	KVA	
30	TRANSFORMER OIL		
30.1	Type of oil		
30.2	Compliance standard		
30.3	Contain PCB / PCB additives ?	Y/N	
31	WEIGHT AND DIMENSIONS		
31.1	Approximate overall dimensions	mm	
31.2	Approximate weight	kg	
31.3	Transformers will be transported with oil ?	Y/N	
32	List of Mandatory Spare parts provided and will be supplied ?	Y/N	
33	Training will be provided as per specification / training plan ?	Y/N	
34	Type test certificates provided ?	Y/N	
35	Manufacturer's Quality Assurance Certifications provided ?	Y/N	
36	Technical Literature / Data Sheet / Drawings submitted ?	Y/N	
36	Completed GTPs submitted ?	Y/N	
37	Schedule of Deviations from specifications Submitted ?	Y/N	
38	Warranty Period	Yrs	

We certify that the above data are true and correct.

 SEAL AND SIGNATURE OF THE BIDDER/ Date

AP - 005

TECHNICAL SPECIFICATION FOR 11/0.415 KV PACKAGE SUBSTATION (PSS) WITH DRY TYPE DISTRIBUTION TRANSFORMER

1.0 SCOPE:

This specification covers design, engineering, manufacture, inspection and testing before supply and delivery at site of 11/0.415 kV Package Substation consisting of 11 kV Ring Main Unit, Dry Type Distribution Transformer and Low Voltage Distribution Panel as per IEC 62271-202 for use in electricity distribution systems in Maldives. The Package Substations will be used to connect power output from proposed PV / FPV sites to the existing 11 kV distribution system.

The following technical specifications provided below for different components forms a part of the complete specifications for packaged substation to be complied with by the Bidder.

Specification #	Description
AP-005 -1	Technical Specifications for 11 kV SF6 Insulated Metal Enclosed Indoor Ring Main Unit for Packaged Substation
AP-005 -2	Technical Specifications for Dry Type Distribution Transformer for Packaged Substation.
AP-005 -3	Technical Specifications for Low Voltage Distribution Panel for Packaged Substation

1.1 The 11 KV packaged substation (PSS) shall be completed with all components, enclosure, interconnections and auxiliary equipment and wiring for full functionality and trouble-free operation under the various operating and service conditions. The tools and accessories required for operation & maintenance shall be in the scope of supply.

1.2 All accessories that form part of the packaged substation as per standard trade and professional practice which are necessary for its proper operation, are deemed to be included in the scope of supply without extra charges.

1.3 All equipment / materials supplied shall be rated to be used under system parameters and service conditions given and clause 2.0 and 3.0 respectively. (Same will be applicable for associated specifications indicated in above table).

Note : For Outdoor Type two and three Way Ring Main Units specified in MVDB schedules, specification # AP-005 -1 for RMU and outdoor enclosure provided herein shall be applicable.

2.0 SYSTEM PARAMETERS

Parameter	Low Voltage System	11kV System
Nominal Voltage	0.415 / 0.240 kV	11 kV
Highest System Voltage	0.44 / 0.255 kV	12 kV
Number of Phases	3PN	3

Parameter	Low Voltage System	11kV System
Frequency	50 Hz	50Hz
Neutral Earthing	Solidly Earthed	Solidly earth
3 Phase Short Circuit Levels	Upto 65 kA / 1 s as req.	Upto 20 kA / 1s
Impulse Withstand Voltage	6 kV	75 kV (peak)
Power Freq. Withstand Voltage 1 min	2.5 kV	28 kV

3.0 SERVICE CONDITIONS

Parameter	Value
Climate	Typical tropical coast line
Atmosphere	Saliferous, corrosive and dusty
Max. Ambient Temperature	35 °C
Max. Daily average ambient temp.	29 °C
Min Ambient Temp	24 °C
Maximum Humidity	90 %
Maximum altitude above M.S.I.	Average 2 m
Average days of rainfall	145 days/ yr
Maximum wind speed	gusts up to 100 km/hr

4.0 STANDARDS:

The equipment supplied shall be in accordance with the latest editions of the Standards specified below and amendments thereof.

Standard	Title
IEC 62271-200	High-voltage switchgear and controlgear – Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 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 62271-103	High-voltage switchgear and controlgear - Part 103: Alternating current switches for rated voltages above 1 kV up to and including 52 kV
IEC 62271-102	High-voltage switchgear and controlgear - Part 102: Alternating current disconnectors and earthing switches
IEC 62271-100	High-voltage switchgear and controlgear – Part 100: Alternating-current circuit-breakers
IEC 62271-1	High-voltage switchgear and controlgear - Part 1: Common specifications for alternating current switchgear and controlgear
IEC 60255	Electrical relays
IEC 61869	Instrument transformer
IEC 60076	Power Transformers

Standard	Title
IEC 61439-1 & 2	Low-voltage switchgear and controlgear assemblies
IEC 60947	Low-voltage switchgear and controlgear
IEC 60529	Degrees of protection provided by enclosures

The standards indicated above shall be applicable to all specifications indicated in the scope.

Material conforming to other internationally accepted standards, which ensure equal or higher quality than the standards mentioned above, may be acceptable, subject to approval by the Employer at his discretion. In case the Bidders who wish to offer material conforming to the other standards, shall submit salient points of differences between the standards adopted and the offered standards. Two copies of such standards with authentic English Translations shall be furnished along with the offer.

5.0 DESIGN CRITERIA

5.1 Technical Parameters

Component	Parameter	Value
High Voltage Switchgear	Rated voltage	11 kV
	Max service voltage	12 kV
	Rated current	630 A
	Rated frequency	50Hz
	No of phases	Three Phase
	1min power frequency withstand voltage	28 kV
	Lightning impulse withstand voltage	75 kVp
	Rated short-time withstand current	21 kA / 1s
	Switchgear type/s	RMU : 2 x LBS 630 A, 1 x VCB 200 A
	IP degree (HV Compartment)	IP67 (Gas Tank) / IP3X or higher
Low Voltage Switchgear	Rated voltage	415 V
	Rated current	As per schedules (upto 2500 A)
	Rated Frequency	50 Hz
	No of phases	3 phase + Neutral
	Rated short-time withstand current	50 kA
	Rated current for feeder	Upto 1250 A
	Feeder quantity	Upto 6 Nos
	Switchgear Types	MCCB, ACB
	IP degree (LV Compartment)	IP 54
Transformer	Voltage	11/0.415 kV
	Max service voltage	12 kV
	Type	Dry type (CRT)
	Vector Group	Dyn11
	Tap changer (off load)	±2x2.5%, ±5%
	IP degree (Transformer Compartment)	IP 3X

Component	Parameter	Value
Enclosure	Material Surface Finish	Galvanized Sheet Steel Interior : painted, Exterior :- Powder coated
	IP degree Internal Arc Protection (type tested)	IP 34 IAC-AB - 21 kA 1s

5.2 Prefabricated Package Sub-Station (PSS) shall be designed in accordance with above technical parameters complying with IEC 62271-202 which shall consist of following main components;

- (a) 11KV 3-way non-extensible SF6 insulated Ring Main Unit with 2 Nos load break switch + 01 No vacuum circuit breaker with O/C & E/F relay for the protection of the transformer and 01 No Fault Passage Indicator (Specification # AP-005 -1).
- (b) 11 / 0.415 kV dry type transformer of capacity as indicated in schedules. (Specification # AP-005 -2)
- (c) 0.4 kV low voltage distribution panel with copper busbars and incoming / outgoing feeders with ACB / MCCB as specified in schedules. (Specification # AP-005 -3).
- (d) Outdoor Enclosure.

5.3 The PSS shall be complete in all respects, fully functional and ready for installation in field. It should be provided with all components, MV and LV interconnections and auxiliary equipment.

5.4 The PSS shall be designed for a) Compactness, b) fast installation, c) maintenance free operation, d) safety for worker/operator & public.

6.0 OUTDOOR ENCLOSURE:

6.1 The outdoor enclosure shall be suitable outdoor installation in saliferous, corrosive, and dusty atmospheric conditions of typical coastline environment.

6.2 Enclosure shall be made of 2mm galvanized sheet steel tropicalized to local weather conditions. A base frame of 4 mm GI shall be provided for assembly of enclosure to ensure its rigidity. Welding should be avoided to prevent enclosure from rusting / corrosion. The enclosure interior shall be painted. Paint shall be carefully selected to withstand tropical coast line service conditions. Exterior of enclosure shall be powder coated (colour : light gray or as agreed with Employer).

6.4 The components of PSS shall be fully enclosed, by either common enclosure or by an assembly of modular compartments. For continues operation of PSS at specified ratings, temperature rise of the components shall be limited to permissible values as stipulated in IEC IEC 62271-202. Each compartment shall be designed to provide ingress protection class as specified in Technical Parameters.

6.5 Covers & Doors: The individual compartments shall have doors provided with locking facility and suitable interlocking arrangement for safety of operator. Access to the MV & LV compartments shall be provided through a double door arrangement. Doors should have stainless steel hinges to prevent corrosion and provided with stoppers as necessary.

6.6 Enclosure shall be designed to have adequate clearance necessary for operations and internal arc protection. Louvers / ventilation openings shall be designed for natural ventilation and thermal

classes whilst maintaining required ingress protection rating. Gasket / Stiffeners shall be provided as required.

6.7 Sloped roof shall be provided to prevent dust and water from settling on the top of the outdoor enclosure. Roof shall be designed to support load upto 250kg/m².

6.8 There shall be an arrangement for internal lighting activated by associated switch for HV, Transformer & LV compartments separately.

6.9 Provision for internal earthing shall be provided with 25x2mm copper bus bars. All metallic components of PSS shall be earthed to a common earthing busbar by adequate size copper cable / strips with terminal and lug arrangement.

6.10 Labels: Labels for warnings, manufacturer's operating instructions, ratings etc. shall be durable & clearly legible.

7.0 PROTECTION AGAINST INTERNAL ARCING DUE TO AN INTERNAL FAULT

The complete PSS assembly shall comply with IAC-AB classification for 20 kA / 1s for protection provided to operators and public as per IEC 62271-202.

8.0 TESTS

The components contained in PSS (HV and LV Switchgear and Transformer) shall be tested according to relevant standards as indicated in specifications AP-005 -1, 2 and 3. In addition relevant tests as applicable for PSS assembly with enclosure and interconnections between HV and LV switchgear shall be tested according to IEC 62271-202.

8.1 Type Tests

The mandatory type tests as applicable for PSS assembly with enclosure and interconnections as per IEC 62271-202 shall be performed, which include the following tests subject to conditions for exclusion of any tests as per standard;

- Dielectric tests
- Temperature rise tests
- Verification of protection tests
- Additional tests on auxiliary and control circuits
- Calculations and mechanical tests
- Internal arc test

Certified copies of the type test carried out in accordance with IEC 62271-202 /other standards as indicated below shall be furnished with the offer. The test certificates should clearly identify the equipment / material concerned, showing the manufacturer's identity, type/model and basic technical parameters. The type test certificates referred to, shall be issued within 5 years from the date of bid opening from a recognized independent testing authority accredited to ISO/IEC 17025:2005 for carrying out specified type tests and acceptable to the Employer.

8.2 Routine Tests

The following routine tests shall be carried in accordance with IEC 62271-202 / other standards subject to conditions for exclusion of any tests as per standard. Copies of routine test reports shall be provided to

the Employer upon request.

- Dielectric test on high voltage interconnection
- Voltage withstand tests on auxiliary circuits
- Functional tests
- Verification of correct wiring

9.0 INSPECTION AND TESTING

The selected Bidder shall make necessary arrangements for inspection by the Employer or his representative inspection of goods prior to dispatch and to carry out sample / acceptance tests and checks as per applicable standards in his presence.

10.0 OTHER REQUIREMENTS

10.1 Manufacturing Experience

The manufacturer shall have at least 05 years' experience in manufacturing and supply of offered type of PSS and manufacturer shall furnish documentary evidence with the offer to prove his manufacturing experience.

10.2 Tools

All special tools and accessories required for installation, operation and maintenance of PSS shall be clearly indicated in the offer and shall be supplied with each PSS. This should include but not limited to padlocks and keys, manual operating handles and any other accessories and tools required for individual components.

10.3 Spare parts and tools

Mandatory Spare parts : Spare parts and tools required for 5-year trouble-free operation of the PSS, as recommended by the manufacturer shall be supplied. Bidder shall submit the list of spare parts that would be supplied accordingly along with the Bid submission.

Recommended Spare Parts : In addition to mandatory spare parts the bidder is required to provide list of recommended spare parts for 10 year trouble free under normal operating conditions and specified service conditions, in Schedule No 6 (Section 4). Bidders are responsible for ensuring the availability of spare parts listed for minimum 10 year period. Bidders shall note that the price of recommended spare parts quoted in this Schedule will not be added to Bid Price and not considered in price evaluation.

10.4 Name Plate

A weatherproof rating plate shall be provided in accordance relevant standards and showing the following information, indelibly marked

- a) Manufacturer's name and trademark.
- b) Serial number and model / type designation.
- c) Applicable rated values.
- d) Number and year of the relevant standard.
- e) Make, model and serial numbers of key components
- f) Ratings of key components
- e) Country and year of manufacture

- f) Project Name
- g) Property of FENAKA

10.5 Labeling

All equipment, control positions, indicator positions, control/indicator identification, terminals, wiring of instrumentation and protection shall be identifiable by clear markings and labeling in English Language with relevant colour code, if any. The labels shall be made out of durable materials and prints permanently edged.

10.6 Operations and Maintenance Manual, Technical Literature and Drawings

The selected Bidder shall supply along with the equipment five copies of operational and maintenance manuals for each component of PSS including all relevant drawings and technical literature .

10.7 Packing

The equipment shall be suitably packed for transportation and installation strictly according to the manufacturer's recommendations. Packing shall be suitable for transportation under restricted volumes and rough conditions for local transportation between Male and respective Islands. Hence Bidder may consider packing and supplying PSS components separately for assembly at site subject to manufacturer's approval. Bidders may note that heavy duty lifting facilities may not be available in some Islands.

11.0 QUALITY ASSURANCE

The manufacturer shall possess valid ISO 9001 Quality Assurance Certification for the process of design, manufacturer and testing of the PSS. The Bidder shall furnish a copy of the ISO Certificate certified as true copy of the original by the Manufacturer, along with the offer.

12.0 WARRANTY

The Bidder shall warrant that PSS and all components supplied shall have no defect arising from design, materials or workmanship or from any act or omission of the supplier that may develop under normal use.

This Warranty shall remain valid for minimum 3 years.

13.0 TRAINING

The Supplier shall provide comprehensive training on the design, installation, operation and maintenance of PSS to FENAKA staffs in each Island. Training should include both theoretical and hands-on on the job training on each component of PSS, i.e RMU, Dry Type Transformer and Low Voltage Distribution Panel. Training should be provided for up to 10 Nos FEANKA staffs in each Island.

14.0 INFORMATION TO BE SUPPLIED BY THE BIDDER

- Catalogues and drawings describing the PSS and indicating construction details, compliance standards etc. (in English Language).
- Type test certificates.
- List of mandatory Spare parts and tools for 5-year trouble-free operation as per Manufacturer's recommendation that will be supplied together with equipment.
- List of recommended spare parts for 10-year trouble free operation.
- Manufacturers ISO 9001 Certification.
- Completed schedule of guaranteed technical particulars
- Manufacturer experience records

- Training Plan

15.0 SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS

Schedule of Guaranteed Technical Particulars should be filled in and submitted by the Bidder.

16.0 SCHEDULE OF DEVIATIONS

Any non-compliances of the offered item in respect of the technical requirements provided in this specification shall be provided using Schedule of Deviations form provided in Section 4 of the bid documents. This form should be provided for each key items of specification, indicating any deviations or 'no deviations' as applicable.

In addition to above, schedule of deviations shall be provided for each of the following specifications for PSS components;

- Specification No : AP-005 -11 kV SF6 Insulated Metal Enclosed Indoor Ring Main Unit for Packaged Substation
- Specification No : AP-005 -2 - Dry Type Distribution Transformer for Packaged Substation
- Specification No : AP-005 -3 - Low Voltage Distribution Panel for Packaged Substation

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS
11/0.415 KV PACKAGE SUBSTATION WITH DRY TYPE DISTRIBUTION TRANSFORMER
(This schedule shall be duly filled by the Bidder)

SI No	Particulars	Unit	Offered
A	PACKAGE SUBSTATION – GENERAL		
1	Name & Address of Manufacturer	-	
2	Country of Origin	-	
3	Model / catalogue number	-	
4	Applicable Standard/s	-	
5	Rated Voltage (HV / LV)	kV	
6	Highest System Voltage (HV / LV)	kV	
7	Rated Frequency with % variation	Hz	
9	Internal Arc Classification	-	
10	IP Ratings: HV Compartment Cable Compartment Transformer Compartment LV Compartment		
11	List of Mandatory Spare parts provided and will be supplied ?	Y/N	
12	Training will be provided as per specification / training plan ?	Y/N	
13	Type test certificates provided ?	Y/N	
14	Manufacturer's Quality Assurance Certifications provided ?	Y/N	
15	Technical Literature / Data Sheets / Drawings submitted ?	Y/N	
16	Completed GTPs submitted ?	Y/N	
17	Schedule of Deviations from specifications Submitted ?	Y/N	
18	Warranty Period for PSS	Yrs	
B	HIGH VOLTAGE SWITCHGEAR 11 kV RMU		
1	Make and Model		

SI No	Particulars	Unit	Offered
	Country of origin	-	
2	Applicable Standards	-	
3	Configurations - LBS (Nos / Rating) /VCB (Nos / Rating)	-	
4	Rated voltage	kV	
5	Max service voltage	kV	
6	Rated current	Amps	
7	Rated frequency	Hz	
8	No of phases	-	
9	Lightning impulse withstand voltage	kV _{pk}	
10	1min power frequency withstand voltage	kV	
11	Rated short-time withstand current	kA / s	
12	Internal Arc Classification (type tested)	-	
13	Extensible / Non-Extensible	-	
14	Cable Test Facility (CTF)	Y/N	
15	Interlocks	-	
16	SCADA Provision ?	Y/N	
17	Seld powered ?	Y /N	
18	LOAD BREAK SWITCH (LBS)		
18.1	Make / Model	-	
	Country of origin	-	
18.2	Rated Current / Load Breaking Capacity	Amps	
18.3	Rated Short Time Current	kA / s	
18.4	Electrical and mechanical endurance class	-	
19	VACUUM CIRCUIT BREAKER		

SI No	Particulars	Unit	Offered
19.1	Make / Model	-	
	Country of origin	-	
19.2	Rated Current / Load Breaking Capacity	Amps	
19.3	Rated Short Time Current	kA / s	
19.4	Electrical and mechanical endurance class	-	
20	EARTHING SWITCH / DISCONNECTOR		
20.1	Make / Model	-	
	Country of origin	-	
20.2	Rated Making Current	kApk	
20.3	Rated Short Time Current	kA / s	
20.4	Electrical and mechanical endurance class	-	
21	PROTECTION RELAYS	-	
21.1	Make / Models	-	
21.2	Country of Origin	-	
21.3	Applicable Standards	-	
21.4	Type (Numerical/ Static)	-	
21.5	Type : Programmable (yes / no)	-	
21.6	Self-powered? (Y/N)	-	
21.7	SCADA Provision ? (Y/N)	-	
22	FAULT PASSAGE INDICATOR	-	
22.1	Make / Model	--	
22.2	Country of Origin	-	
22.3	SCADA Provision (Y/N)		
23	CURRENT TRANSFORMERS		
23.1	Make & Models	-	
	Country of origin	-	
23.2	Applicable standard/s	-	

SI No	Particulars	Unit	Offered
23.3	Rated voltage	kV	
23.4	Rated frequency	Hz	
23.5	Rated short time rating /duration	kA /s	
23.6	Accuracy class (measuring/metering/protection)	-	
23.7	Accuracy limit factor	-	
24	VOLTAGE TRANSFORMERS		
24.1	Make & Models	-	
	Country of origin	-	
24.2	Applicable standard/s	-	
24.3	Rated voltage	kV	
24.4	Rated frequency	Hz	
24.5	Rated Insulation Level	-	
24.5.1	Rated Impulse withstand voltage	kV _{pk}	
24.5.2	Rated power frequency withstand voltage	kV	
24.6	Accuracy Class (measurement./metering/ Protection)	-	
24.7	Rated voltage factor	-	
25	RMU TANK		
25.1	Tank Material / Thickness	-	
25.2	Insulation Medium	-	
25.3	Gas leakage rate per annum	%	
25.4	Degree of protection (IP)	-	
26	CABLE COMPARTMENT		
26.1	Bushings – Make and Model	-	
26.2	Bushings – Type / Rating	-	
26.3	Type of cable terminations provided (Elbow connectors / HS Termination Kits)	-	
27	Type Test Certificates for RMU provided ?	Y / N	
28	Schedule of Deviations for RMU submitted w.r.t. specification # AP-005 -1?	Y/N	

SI No	Particulars	Unit	Offered
C	DRY TYPE DISTRIBUTION TRANSFORMER		
1	Name & Address of Manufacturer	-	
2	Country of Origin	-	
3	Model / catalogue number	-	
4	Applicable Standard/s	-	
5	Rated Capacity Range	kVA	
6	Type of Cooling	-	
7	Rated Voltage (HV / LV)	-	
8	Highest System Voltage (HV / LV)	-	
9	Rated Frequency with % variation	-	
10	No of Phases	-	
11	Vector Group	-	
12	Insulation Class	-	
13	Impulse Withstand Voltage	kVpk	
14	Power Freq. Withstand Voltage - 1 min	kV	
15	Current at rated full load and on principal tap (LV / HV) for each capacity	Amps	
16	Permissible Overloading at (HV / LV) Winding		
17	Short time withstand current rating of (HV / LV) Windings	kA /s	
18	Short circuit impedance voltage at 75°C	%	
18	% reactance at rated current and rated frequency at principal tap	%	
20	% resistance at rated current and rated frequency at principal tap	%	

SI No	Particulars	Unit	Offered
21	Average winding temperature rise above max ambient temp	K	
22	Off load tap changer (no of taps x steps)	-	
23	LOSSES (values to be provided for each capacity rating) :		
23.1	No load loss at rated voltage and frequency at principal tap	kW	
23.2	Load loss at rated output, rated frequency, corrected for 75 °C winding temperature at principal tap	kW	
24	Core construction / material	-	
25	Material of the winding conductor – HV/LV windings	-	
26	Type of insulation and application method	-	
27	Type of Bushings	-	
28	Temperature monitoring and Indication System – Make & Model		
29	Cable Terminations Details	-	
30	Weight and Dimensions	-	
31	Type Test Certificates Provided ?	Y/N	
32	Schedule of Deviations submitted w.r.t. specification # AP-005 -2?	Y/N	
D	LOW VOLTAGE SWITCHGEAR (LV Distribution Panel)		
1	Name & Address of Manufacturer	-	
2	Country of Origin	-	
3	Model / catalogue number	-	
4	Applicable Standard/s	-	
5	No of Phases	-	
6	Rated operating voltage	V	
7	Rated frequency	Hz	

SI No	Particulars	Unit	Offered
8	Rated insulation level : Impulse withstand voltage (peak) Rated insulation voltage	kV	
9	Rated current for main distribution busbar (Specify range as per schedules)	Amps	
10	Rated short-time withstand current	kA/s	
12	Ingress Protection (IP) Class -	-	
13	MCCB		
13.1	Make and Model	-	
	Country of origin		
13.2	Applicable Standards	-	
13.3	Rated operating voltage	V	
13.4	Rated frequency	H	
13.5	No of Poles	-	
13.6	Rated Currents	A	
13.7	Rated short circuit breaking current (rms)	kA	
13.8	Rated insulation level	-	
13.8.1	i) Impulse withstand voltage (peak)	kV	
13.8.2	ii) Rated insulation voltage	V	
13.9	Type of Trip Unit (Thermal-magnetic/ Electronic)	-	
13.9.1	For MCCB ratings upto 630 A	-	
13.9.2	For MCCB ratings above 630 A	-	
13.10	Mechanical life (No. of operations)	-	
13.11	Electrical life (No. of operations)	-	
13.12	Max size of cable termination	-	
14	Air Circuit Breakers (ACB)		
14.1	Name of Manufacturer		
14.2	Country of Origin		
14.3	Model / catalogue number		
14.4	Applicable standard/s		
14.5	Number of poles		

SI No	Particulars	Unit	Offered
14.6	Rated current ratings of offered models (range)	A	
14.7	Rated operating voltage	V	
14.8	Rated frequency	H	
14.9	Rated short circuit breaking current (rms)	kA	
14.10	Rated short circuit making current	kA	
14.11	Rated insulation level	-	
	i) Impulse withstand voltage (peak)	kV	
	ii) Rated insulation voltage	V	
14.12	Type (Fixed / Withdrawable)	-	
14.13	Mechanical life (No. of operations)	-	
14.14	Electrical life (No. of operations)	-	
14.15	Max size of cable termination	-	
15.0	Protection Relays		
15.1	Make / Model	-	
15.2	Country of Origin	-	
15.3	Applicable standard/s	-	
15.4	Type (Numerical/ Static)	-	
15.5	Self-powered (yes / no)	-	
15.6	Type : Programable (yes / no)	-	
15.7	Handheld programming unit provided for each Island ? (yes / no)	-	
15.8	Software provided (yes / no)	-	
15.9	SCADA provision (yes/no)		
6.0	Current Transformers		
16.1	Make / Models		
16.2	Country of Origin		
16.3	Applicable standard/s		

SI No	Particulars	Unit	Offered
16.4	Rated voltage	V	
16.5	Rated frequency	Hz	
16.6	Rated short time rating / duration	kA / s	
16.7	Accuracy Class (Measuring /Metering/Protection)	-	
16.8	Accuracy limit factor	-	
17.0	Energy Metering Instruments		
17.1	Make / Model	-	
17.2	Country of Origin	-	
17.3	Applicable standard/s	-	
17.4	Accuracy class	-	
17.4	programmable type ? (Yes/No)	-	
17.5	Programming software provided? (yes / No)	-	
17.6	Handheld programing tool provided (yes / no)	-	
17.7	Calibration certificates provided? (yes / no)	-	
18	BUSBARS		
18.1	Make / Model	-	
18.2	Country of Origin	-	
18.3	Applicable standard/s	-	
18.4	Material	-	
18.5	Cross Sectional Area / Dimensions	mm ²	
18.6	Type of insulation	-	
18.7	Clearance between busbars	-	
	i) Phase – Phase / Neutral	mm	
	li) Phase - Earth	mm	
18.9	Continuous current carrying capacity	A	
18.10	Maximum Temperature rise at rated current	°C	
18.11	Mounting Arrangements		
19	PANEL CONSTRUCTION		

SI No	Particulars	Unit	Offered
19.1	Material	-	
19.2	Thickness	mm	
19.3	Surface treatment	-	
19.4	Separation	-	
19.5	Earthing provision	-	
19.6	Indications provided on panels	-	
20	Type Test Certificates Provided ?	Y/N	
21	Schedule of Deviations submitted w.r.t. specification # AP-005 -3?	Y/N	
E	OUTDOOR ENCLOSURE		
1	Enclosure Material / Thickness	-	
2	Surface Finish - Interior - Exterior		
3	Lockable covers & doors for individual compartments	Y/N	
4	Ingress Protection Class	-	
5	Internal Arc Protection (type tested)	-	
6	Schedule of Deviations provided for enclosure	Y/N	

We certify that the above data are true and correct.

SEAL AND SIGNATURE OF THE BIDDER/ Date

AP – 005-1

TECHNICAL SPECIFICATIONS FOR 11 KV SF6 INSULATED METAL ENCLOSED INDOOR RING MAIN UNIT FOR PACKAGED SUBSTATION

1.0 SCOPE:

The specification covers engineering, manufacturing, testing, supply, delivery, testing and commissioning of 11 kV SF6 insulated metal enclosed indoor 3-way Ring Main Units (RMU), in accordance with the specifications technical requirements mentioned in the specification, relevant standards and code of operation. The scope also includes the handing over the complete installation after successful commissioning.

1.1 The 11 KV RMU shall be completed with all components, accessories, auxiliary equipment and internal wiring for full functionality and trouble-free operation under the various operating and service conditions. The tools and accessories required for operation & maintenance of RMU shall be in the scope of supply.

1.2 All accessories that form part of the RMU as per standard trade and professional practice which are necessary for its proper operation, are deemed to be included in the scope of supply without extra charges.

1.3 The RMU shall be designed, manufactured and tested as per relevant standards indicated in the specification no AP – 005 : Technical specification for 11/0.4 kV package substation with dry type distribution transformer.

1.3 All equipment / materials supplied with RMU shall be rated to be used under system parameters and service conditions given and clause 2.0 and 3.0 respectively indicated in the specification no AP – 005.

2.0 TECHNICAL REQUIREMENTS

2.1 Technical Parameters

Component	Parameter	Value
RMU Unit and Switchgear	Rated voltage	11 kV
	Max service voltage	12 kV
	Rated current	630 A
	Rated frequency	50Hz
	No. of Phases	Three Phase (3 wire system)
	Insulation Medium	SF ₆
	1min power frequency withstand voltage	28 kV
	Lightning impulse withstand voltage	75 kVp
	Rated short-time withstand current	20 kA / 1s
	Switchgear type/s	LBS 630 A, 1 x VCB 200 A
	Internal Arc Classification	IAC ALFR 20 kA / 1s
	IP degree	- IP 67 for the tank with high voltage components - IP 2X for the front covers of the

Component	Parameter	Value
		mechanism - IP 3X for the cable connection covers
Load Break Switch	Rated Current	630 A
	Rated load breaking capacity	630 A
	Rated short time current	20 kA / 3s
	Rated breaking capacity – cable charging	110 A
	Rated earth fault breaking current	200 A
	Rated short circuit making current	50 kA _{pk}
	Electrical and mechanical endurance class	E3 / M1
Earthing Switch / Disconnecter	Rated Making Current	50 kAp
	Rated short time current	20 kA / 3s
	Electrical and mechanical endurance class	E2 / M0
Vacuum Circuit Breaker	Rated Current	200 A
	Rated short time current	20 kA / 3s
	Rated short circuit breaking current	20 kA
	Rated short circuit making current	50 kA
	Electrical and mechanical endurance class	E2 / M1

2.1 The RMU should be non-extensible type, SF-6 insulated, switchgear combination of 02 Nos Load Break Switch with Earthing Switch for 11 kV ring cable feeders and 01 Nos Vacuum Circuit Breakers with for transformer feeder in the PSS.

2.2 The RMU shall be compact, maintenance free, easy to install, reliable, safe and easy to operate and complete with all parts necessary for their effective and trouble-free operation. Such parts will be deemed to be within the scope of the supply irrespective of whether they are specifically indicated in the commercial order or not.

2.3 RMU Tank and Insulation

The tank containing shall be corrosion resistant stainless steel austenitic grades (non ferrite & non magnetic) of minimum 2.5 mm thickness (as per relevant standards). It shall comply with Internal Arc Classification IAC ALFR 21 kA / 1s.

The insulation medium shall be SF6 gas complying with IEC 60376. The tank shall meet the 'sealed pressure system' criteria in accordance with IEC 62271-200. Accordingly, no handling / refilling of gas shall be required throughout the expected operating life, i.e. minimum 30 years. Sealed pressure systems are completely assembled, filled and tested in the factory. The maximum leakage rate of SF6 gas shall be lower than 0.1% of the total initial mass of SF6 gas per annum. It is preferable to fit an absorption material in the tank to absorb the moisture from the SF6 gas and to regenerate the SF6 gas following arc interruption. There shall be no requirement to 'top up' the SF6 gas.

The degree of protection for RMU tank shall be IP 67. The Front cover mechanism and cable cover shall have IP2X and IP3X degree of protection.

2.4 Busbars

The phase and earth busbars shall be made of electrolytic grade copper complying with relevant standards and switchgear ratings provided in technical parameters table above. The phase bus bars and live parts shall be fully encapsulated by SF6 gas inside the stainless steel tank. Earthing circuit shall be provided with visible earthing contacts to enhance operator safety. Provision shall be made on end of RMU for connecting the earth bus to the external earths of the site installation.

2.5 Load Break Switch (LBS) and Earthing Switch

The LBS and earth switch shall be provided complying with the requirements specified in IEC 62271-102 and 103 and switchgear ratings provided in technical parameters table above.

The LBS shall be provided with motorized operating spring charge mechanism and compatible for remote operation for SCADA integration. A mechanism for manual operation shall also be provided.

LBS operation counter and local / remote control selection switch shall be provided. It shall be provided with 2NO + 2 NC auxiliary contacts.

Earthing switch shall have manual operating mechanism and provided with 1NO+1NC auxiliary contacts. Interlocking shall be provided as indicated in this specification.

2.6 Vacuum Circuit Breaker

Vacuum Circuit Breaker (VCB), Disconnecter and Earth Switch complying with the requirements specified in IEC 62271-100 and 103 and switchgear ratings provided in technical parameters table above.

The VCB shall be provided with motorized spring charge operating mechanism and compatible for remote operation with SCADA integration. Local / remote control selection switch shall be provided. It shall also be fitted with a local system for manual tripping by an integrated push button. VCB shall be provided with 4NO+4NC Auxiliary contacts and operations counter.

The circuit breaker shall be associated with an integrated protection unit that will operate without any auxiliary power supply and shall include current transformers incorporated in the cable chamber as per manufacturer standard type tested design. The CT settings shall be adjustable according to site requirements . Protection core CT complete details should be furnished (Burden, class, ALF).

An electronic relay self-powered through CTs, a low energy release, and a "fast-on" test receptacle for protection testing (with or without CB tripping) shall be provided. The protection system shall ensure circuit breaker tripping as of a minimum operating current which is the rated current of the feeder to be protected.

Earthing switch / Disconnecter shall have manual operating mechanism and provided with 1NO+1NC auxiliary contacts. Disconnecter shall be provided with 2NO+2NC Auxiliary contacts.

Interlocking shall be provided as indicated in this specification.

2.7 Protection Relays (for VCB module)

The relay shall be provided with Phase protection of Definite time/ IDMT element for overcurrent and earth fault with minimum PSM-0.05, Tsm-0.01 having standard characteristics of Standard Inverse, Very inverse, Extremely Inverse as per IEC 60255 standard. The Earth Fault Protection shall be provided of Definite time/ IDMT element having standard characteristics of Standard Inverse, Very inverse, Extremely Inverse as per

IEC 60255 standard. The "Time Multiplier" with minimum set point of 0.05 TMS shall be available. The breaker shall have the provision of LED indication of Trip on Fault High set (DT) for overcurrent and earth fault-min current setting-0.5 In, minimum Time Delay- 20 milliseconds. The relays shall be suitable numerical relay with necessary elements.

On this basis, the relay as a minimum shall provide:

- a) Phase Over Current Protection: (50/51)
- b) Earth Fault Protection: (50N/51N)

The relay shall also be provided with:

- Alphanumeric Liquid Crystal Display (LCD)
- Parameter change capability that is password protected
- Capability to record up to 5 of the latest fault records duly time stamped and stored in
- non-volatile memory for subsequent reading via the above referred RS485/RS 232 port

2.8 Instrument Transformers and Voltage Sensors

3 nos ring type, single core CTs and 3 phase-earth VTs with fuse protection shall be provided in each circuit breaker for protection and metering purpose. The CTs and VTs shall conform to relevant IEC standards. The design and construction shall be sufficiently robust to withstand thermal and dynamic stresses during short circuits. Secondary terminals of CTs & VTs shall be brought out suitably to a terminal block in the RMU LV compartment, which will be easily accessible for testing and connections.

Appropriate capacity and ratings of CTs and PTs shall be provided in the RMU for protection and metering (future) purpose. Further protection relays shall be self-powered through the current transformers (CTs) without requiring an auxiliary power supply to operate. The metering shall not be in the scope of supplier but the provision and space for installation of the separate metering enclosure in future shall be available.

The RMU's other CTs/sensors, for other equipment including Fault Passage Indicators (FPIs), shall be supplied by the FPI manufacturer. These CTs/sensors shall be an integral part of the FPI's design to ensure that they properly match the requirements of the FPI.

A voltage sensor shall be provided for all the functional units of RMU. It shall provide a signal with an accuracy of 5% for voltage presence (VPIS) indication. The voltage shall be detected on the cable side.

2.9 Cable Compartment, Bushings and Cable Terminations:

Each cable compartment shall have IP3X degree of protection. Each compartment shall be provided with three bushings of adequate sizes to terminate the incoming and outgoing cables. Bushings shall be Type C rated for 630 A: 21 kA 1 s, 21 kA 3 s and 60 kA peak.

Following type of 11 kV cable terminations shall be provided with each RMU for each LBS & VCB cable terminations ;

- Insulated field dis-connectable connectors (elbow connectors) of Interface type C (recommended by the manufacturer) with required connectors to terminate 11 kV three core XLPE / Cu cable upto cross section of 120 sqmm ; or
- Termination kit for 11kV, 3 core, armoured cable - 70 sqmm, indoor / heat-shrinkable type including screen and armour earth kits, all accessories and lugs.

2.10 Cable Test Facility (CTF):

Separate cable test facilities that are independent of the cable termination enclosure shall be provided.

It shall be possible to connect cable test equipment (e.g. pressure testing or fault locating equipment) to the cable via separate cable test facility. If additional injection fingers are required to connect test instruments to the CTF terminals it should be provided for each RMU.

Connecting and disconnecting of the cable test leads shall be performed under safe earthed conditions only. Access to the test terminals of the cable test facility shall only be possible when the associated earth switch is in the closed EARTH position.

After connecting the test equipment, which must only be possible under safe earthed conditions, the integrated earth connection shall be removed for testing purposes without interfering with the connected test equipment. After completing the test procedure the integrated earth connection must be reconnected without interfering with the test equipment. The test equipment must be safely removed under full earthed conditions. Under normal service conditions (live cable and busbar) the test connections must be fully earthed.

Each cable test facility shall be interlocked with its associated earth switch and be capable of being padlocked to ensure that the test terminals of the cable test facility are not accessible when the cable is energized. The test terminals must be fully earthed under normal service conditions, access must only be possible when the panel is switched ON in earthed position.

2.11 Indication and Controls

All required indications including the following shall be provided in the front panel;

- Open / close the status of the RMU circuit breakers and load break switches.
- The health of the power supply, which will include battery failure and low voltage indications.
- Open / closed status of RMU earthing switches.
- For SF6 insulated type, low SF6 gas pressure indication.
- For circuit breaker relay operations.
- Indication of main-circuit fault detected by the RMU's FPI
- Voltage presence indication for each functional unit
- Local controls for operation of switchgear
- Manual operating mechanism for switchgear.
- Clearly visible mimic diagram that indicates the different functions and position.

2.12 Interlocks

Suitable fool-proof mechanical, electrical and key interlock system shall be provided to ensure safety of equipment and personnel when operating the RMU locally and remotely. This should include but not limited to suitable electrical and mechanical interlocks to facilitate following;

- Operation of earth switch (ES) is only possible when incoming voltage is not present in cable and LBS / VCB in the functional unit is open.
- Operation of LBS is only possible when ES is open and cable compartment cover is closed.
- Operation of disconnectors is only possible with VCB / LBS is open.
- Opening cable compartment door is only possible when ES is closed.

- Test terminals of the cable test facility are accessible (for connection / disconnection of test leads before / after testing) only when ES is closed

Provision shall be made available for key-locking or padlocking to prevent unauthorized access for LBS / CB / ES controls, cable test facility terminals and cable compartment.

2.13 SCADA Compatibility

The RMU shall be provided with standard interfacing facilities for retrofitting RTUs and communications gateways for integration with existing SCADA and proposed PCMS/EMS systems for monitoring and remote control. It shall be fully SCADA compatible and provide remote access and control for all RMU functional units with motorized control when in remote control mode.

The communication interfaces shall support standard IEC 101/104, DNP3, IEC 61850 and Modbus protocols. The communications protocol for proposed PCMS / EMS is Modbus TCP over an Ethernet network with a minimum data transfer rate of 100 Mbit/s.

2.14 Fault Passage Indicator

Fault Passage Indicators (FPI) shall be installed with 01 No LBS (for one ring feeder unit)

The FPI shall have following functionalities and indication shall be available locally as well as remotely (when connected with SCADA/ EMS in future);

- Indication of phase-phase and phase-earth faults
- Display of parameters & adjustable settings for short circuit (200 – 1000A) and earth fault (10 – 150 A)
- Settings for time delay for inrush currents
- Display of the faulty phase
- Display of load current, maximum current for each phase, frequency and direction of energy flow
- Fault passage indication for remote monitoring (SCADA compatible)

The FPI shall be provided with following resetting options;;

- Manual reset
- Resetting after a set time duration
- Resetting on restoration of supply
- Provision for remote resetting via communication (future)

The FPI shall be self-powered by suitable means and provided with separate CTs for fault detection.

2.15 Power Supply

The RMU shall be provided as a self-powered unit drawing auxiliary power from mains supply through CPT (Control Power Transformer) or by other arrangement.

2.16 Software

All software required for operation of RMU equipment and communication devices shall be supplied with perpetual license.

3.0 TESTS

The RMU be tested according to IEC 62271-200 and other relevant standards.

3.1 Type Tests

The mandatory type tests as applicable as per IEC 62271-200 shall be performed, which include the following tests subject to conditions for exclusion of any tests as per standard;

- Short time current withstand test and peak current withstand test.
- Temperature rise test.
- Short Circuit current making and breaking tests.
- Power frequency voltage withstand test (dry).
- Lightning Impulse voltage with-stand test
- Dielectric tests
- Dielectric tests on auxiliary and control circuits
- Mechanical impact test
- Mechanical operation test.
- Measurement of the resistance of circuits.
- Checking of degree of protection of main tank and outer enclosure
- Switch, circuit breaker, earthing switch making capacity.
- Internal arc withstand test
- Checking of partial discharge on complete unit.
- Pressure withstand test for gas-filled compartments

Certified copies of the type test carried out in accordance with IEC 62271-200 /other standards as indicated below shall be furnished with the offer. The test certificates should clearly identify the equipment / material concerned, showing the manufacturer's identity, type/model and basic technical parameters. The type test certificates referred to, shall be issued within 5 years from the date of bid opening from a recognized independent testing authority accredited to ISO/IEC 17025:2005 for carrying out specified type tests and acceptable to the Employer.

3.2 Routine Tests

The following routine tests shall be carried in accordance with IEC 62271-200 / other standards. Copies of routine test reports shall be provided to the Employer upon request.

- Dielectric test on the main circuit
- Tests on auxiliary and control circuits
- Measurement of the resistance of the main circuit
- Design and visual checks
- Mechanical operation tests
- Tests of auxiliary electrical, pneumatic and hydraulic devices
- Pressure tests of gas-filled compartments

3.3 Acceptance Tests

All or selected the tests listed under Routine Tests above shall be carried out as acceptance test on random samples.

4.0 INSPECTION AND TESTING

The selected Bidder shall make necessary arrangements for inspection by the Employer or his representative inspection of goods prior to dispatch and to carry out sample / acceptance tests and checks as per applicable standards, in his presence.

5.0 OTHER REQUIREMENTS

5.1 Manufacturing Experience

The manufacturer shall have at least 05 years' experience in manufacturing and supply of offered type of RMU and manufacturer shall furnish documentary evidence with the offer to prove his manufacturing experience.

5.2 Accessories & Tools

All special tools and accessories required for installation, operation and maintenance of RMU shall be clearly indicated in the offer and shall be supplied with each RMU. This should include but not limited to manual operating handles, padlocks and keys, earthing cables and connectors and injection fingers (if required) to connect with cable testing equipment leads with CTF (Cable Test Facility) in RMU.

5.3 Spare parts

Mandatory Spare parts : Spare parts and tools required for 5-year trouble-free operation of the RMU in PSS, as recommended by the manufacturer shall be supplied. Bidder shall submit the list of spare parts that would be supplied accordingly along with the Bid submission.

5.4 Name Plate

A rating plate shall be provided in accordance with applicable standards and showing the following information, indelibly marked

- a) Manufacturer's name and trademark.
- b) Serial number, model and type designation.
- c) Applicable rated values.
- d) Number and year of the relevant standard.
- e) Ratings of key components
- e) Country and year of manufacture
- f) Project Name
- g) Property of FENAKA

10.5 Labeling

All equipment, control positions, indicator positions, control/indicator identification, terminals, wiring of instrumentation and protection shall be identifiable by clear markings and labeling in English Language with relevant colour code, if any. The labels shall be made out of durable materials and prints permanently edged.

10.6 Packing

The equipment shall be suitably packed for transportation and installation strictly according to the manufacturer's recommendations. Packing shall be suitable for transportation under restricted volumes and rough conditions for local sea transportation between Male and respective Islands.

10.7 Operations and Maintenance Manual, Technical Literature and Drawings

The selected Bidder shall supply along with the equipment five copies of operational and maintenance manuals for RMU including all relevant drawings and technical literature,

11.0 QUALITY ASSURANCE

The manufacturer shall possess valid ISO 9001 Quality Assurance Certification for the process of design, manufacturer and testing of the RMU. The Bidder shall furnish a copy of the ISO Certificate certified as true copy of the original by the Manufacturer, along with the offer.

12.0 WARRANTY

The Bidder shall warrant that RMU and all components supplied shall have no defect arising from design, materials or workmanship or from any act or omission of the supplier that may develop under normal use.

This Warranty shall remain valid for minimum 3 years.

13.0 TRAINING

The Supplier shall provide comprehensive training on the design, installation, operation and maintenance of RMU to FENAKA staffs in each Island as specified in specification no AP-005. This should include comprehensive training on operation and maintenance of the RMU.

14.0 INFORMATION TO BE SUPPLIED BY THE BIDDER

- Catalogues and drawings describing the RMU and indicating construction details, compliance standards etc. (in English Language).
- Type test certificates.
- Manufacturers ISO 9001 Certification.
- Completed schedule of guaranteed technical particulars
- Manufacturer experience records

15.0 SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS

Schedule of Guaranteed Technical Particulars provided under specification no AP – 005 (for PSS) should be filled in and submitted by the Bidder.

16.0 SCHEDULE OF DEVIATIONS

Any non-compliances of the offered item in respect of the technical requirements provided in this specification shall be provided using Schedule of Deviations form provided in Section 4 of the bid documents. This form should be provided for each key items of the specification, indicating any deviations or 'no deviations' as applicable.

AP – 005 - 2

TECHNICAL SPECIFICATION FOR 11/0.415 KV DRY TYPE DISTRIBUTION TRANSFORMER FOR PACKAGED SUBSTATION

1.0 SCOPE

This specification covers the design, manufacturing, testing, supply, delivery and performance requirements of 3 Phase, 50 Hz, 11/0.415 kV, Dyn11 , Cast Resin, natural air cooled (AN), Dry Type Transformer with off circuit taping links -5% to +5% @ 2.5%, class "H" insulation and temperature rise of 115 K over ambient temperature of 30° C.

1.1 All accessories that form part of the Transformer as per standard trade and professional practice which are necessary for its proper operation, are deemed to be included in the scope of supply without extra charges.

1.3 The transformer shall be designed, manufactured and tested as per relevant standards indicated in the specification no AP – 005 : Technical specification for 11/0.4 kV package substation with dry type distribution transformer.

1.3 All equipment / materials supplied with transformer shall be rated to be used under system parameters and service conditions given and clause 2.0 and 3.0 respectively indicated in the specification no AP – 005.

2.0 TECHNICAL REQUIREMENTS

2.1 MAIN FEATURES:

Description		Requirement
Rated Voltage	HV	11 kV
	LV	415 V
Frequency		50 Hz
Number of Phases		3
Capacity		As per schedules (upto 1500 kVA)
Type		Dry Type
Applicable Standard		IEC 60076
Cooling		natural air cooled (AN)
Voltage Variation		Off-load tap changer with 5 positions in the HV winding giving $\pm 2 \times 2.5 \%$.
Windings		Electrolytic Copper
Core		Grain orientated silicon steel or Amorphous metal
HV and LV Bushings		Indoor type
Vector Group		YNd1

Description	Requirement
IP Degree	IP 00
Impulse Withstand Voltage	75 kV (peak)
Power Freq. Withstand Voltage 1 min	28 kV
Short circuit current	20kA
Short time withstand current duration (Under rated three phase fault currents)	3 s
Minimum short circuit impedance voltage at 75°C	5%
Losses	Maximum Level 1 stipulated loss values for dry type transformers as per IEC TS 60076-20 :2017.

2.2 Rated Power

For specific requirements of the current project, the capacity of the dry type distribution transformer required in different PSS varies from 630 kVA to 1500 kVA.

Each Transformer shall be capable of supplying its rated power being the product of rated voltage and rated current on the line side winding (at center tap) expressed in kVA, as defined in IEC 60076-1.

The transformer shall also be capable of delivering rated current at an applied voltage equal to 105% of the rated voltage.

Also, transformer shall be capable of supplying its rated power continuously under ambient temperature conditions with temperature rise of the windings not exceeding 110 °C.

2.3 Overload Capacity

The transformer shall be capable of operating in accordance with the loading guidelines of IEC 60076-12.

The Supplier shall submit calculations demonstrating that above requirements are met. These calculations shall disregard the effect of winding thermal capacity.

2.4 Impedance Voltage

The guaranteed value of impedance measured at 75 °C and center tap shall be approx. 5% for the distribution transformers of capacity ranging from 630 – 1500 KVA, subject to the tolerances as specified in IEC 60076.

The resistance component of impedance measured at 75 °C on the center tap shall not exceed 25 % for all kVA ratings

2.5 Short Circuit Performance

The transformer shall be capable of withstanding the thermal and dynamic effects of short circuits.

It shall be able to withstand specified system short circuit level and the duration.

The ability to withstand the thermal and dynamic effects of a short circuit shall be demonstrated in accordance with IEC 60076. Calculations / test certificates shall be submitted by the Bidder.

2.6 Transformer Losses

Maximum load losses and maximum no load losses of transformer shall not exceed Level 1 loss values for dry type transformer as per IEC TS 60076-20 :2017.

The Bidder shall state the guaranteed losses. No positive tolerance is allowable on the guaranteed values. Transformers supplied with losses exceeding the guaranteed values will be rejected. The Bidder shall also state the value of guaranteed magnetizing current, subject to the tolerance specified in IEC 60076.

2.7 Noise Level

The average noise level of the transformers shall not exceed the values given in IEC IEC 60076-10. The measurements shall be carried out in accordance with the above standard at a distance of 300 mm from the envelope of the transformer.

2.8 Tap Changing Characteristics

Transformer shall be fitted with 5 taps with $\pm 2 \times 2.5\%$ voltage variation on HV winding. Tap changing and the tap changing mechanism shall have the following characteristics:

- Tap changing shall be carried out with the transformer off-load. An externally operated self-positioning tapping switch shall be provided.
- Provision shall be made for locking the tap switch handle with a padlock.
- Tap changer handles shall be fitted with gasketed covers, so that sealing of the transformer under normal conditions is independent of the switch shaft gland.

3.0 MATERIALS AND CONSTRUCTION

3.1 Core Assembly

The core shall be constructed of the best quality, non-aging, low loss, cold rolled, grain oriented steel laminations insulated on both sides. Laminations shall be "step lap" overlapped to minimize core losses and noise. Amorphous metal cores are also permitted for higher efficiency.

The assembled core shall be braced in suitable steel frames that make up the base-frame and lifting facilities for the complete transformer.

3.2 Windings

The high voltage and low voltage winding shall be made of copper Conductors. HV winding will always be resin casted under vacuum. The position of this mould shall be horizontal during the casting process that shall assure the total elimination of air bubbles that could create air cavities and critical points of partial discharges. LV winding can either be casted or pre-impregnated B-stage epoxy resin and thermally cured in an oven.

Winding design shall be adequate to allow for full encapsulation with filled resin under vacuum. The end turns of the high voltage windings shall have reinforced insulation to take care of the voltage surges likely to occur during switching or any other abnormal condition. The surface of the encapsulated winding shall be smooth and completely closed and impervious to moisture and common industrial contaminants. The HV delta connection shall be made through copper bars protected by heat shrinkable tubing.

3.3 Cable Connections

HV side and LV side of transformer will have the top busbar arrangement for connection of HT side by means of cables / busbar.

3.4 Earthing Terminals

Provision shall be made to connect external earthing at position close to the bottom the enclosure at two points. Earthing terminal shall be adequately dimensioned to receive the external earthing conductor/strip

3.5 Ingress Protection Rating

The transformer shall be of IP 00 protection class and will be installed in the transformer compartment of compact substation having IP2X protection class

3.6 Winding temperature control / indication system:

The transformer shall be equipped with a thermal protection device with sensors and temperature control unit. The sensors should be assembled and wired to the terminal block fixed on the upper part of the transformer. The temperature device shall have two numbers of potential free contacts for trip/alarm.

4.0 TESTS

The tests listed hereinafter shall be carried out in accordance with provisions in the referenced standards in the specification.

4.1 Routine Tests

Routine tests shall be carried out on all transformers and the tests shall be conducted in accordance with IEC 60076-11 /other standards as applicable. Copies of routine test reports shall be provided to the Employer upon request.

The following routine measurements and tests shall be carried out:

- Measurement of winding resistance
- Measurement of voltage ratio and check of polarity and vector group
- Measurement of impedance voltages
- Measurement of load losses
- Measurement of no load losses and no load current, including measurement of harmonics
- Induced overvoltage withstand test
- Separate source voltage-withstand tests on HV and LV windings
- Bushing routine tests
- Oil leakage test
- Dielectric Routine Tests
- Measurement of partial discharges : guaranteed value of partial discharges shall be less than 10 pC.

4.2 Type Tests

Certified copies of the type test carried out in accordance with IEC 60076 /other standards as indicated below shall be furnished with the offer. The test certificates should clearly identify the equipment / material concerned, showing the manufacturer's identity, type/model and basic technical parameters. The type test certificates referred to, shall be issued within 5 years from the date of bid opening from a recognized independent testing authority accredited to ISO/IEC 17025:2005 for carrying out specified type tests and acceptable to the Employer.

- Temperature Rise Test
- Measurement of zero-sequence Impedances
- Impulse Voltage Test and Power Frequency Test
- Acoustic Sound Level Measurement
- Measurement of Harmonic Level in no load condition
- Anti-corrosion protection test

4.3 Acceptance Tests

All or selected the tests listed under Routine Tests above shall be carried out as acceptance test on random samples.

5.0 INSPECTION AND TESTING

The selected Bidder shall make necessary arrangements for inspection by the Employer or his representative inspection of goods prior to dispatch and to carry out sample / acceptance tests and checks in his presence.

6.0 OTHER REQUIREMENTS

6.1 Manufacturing Experience

The manufacturer shall have at least 05 years' experience in manufacturing and supply of offered type of transformers and manufacturer shall furnish documentary evidence with the offer to prove his manufacturing experience.

6.2 Rating Plate

A weatherproof rating plate shall be provided in accordance with IEC 60076 and showing the following information, indelibly marked:

- Type of transformer
- IEC codes must be stated
- Manufacturer's name
- Serial number
- Year of Manufacture
- Insulation Level
- Number of phases
- Rated power
- Rated frequency

- Rated voltage
- Rated currents
- Vector Group
- Impedance voltage at rated current
- Type of Cooling
- Total Mass
- Temperature rise of windings
- Property of FENAKA

6.3 Tools and Accessories

All special tools and accessories required for installation, operation and maintenance of the Transformer shall be clearly indicated in the offer and shall be supplied with each Transformer.

6.4 Spare parts

Mandatory Spare parts : Spare parts and tools required for 5-year trouble-free operation of the Dry Type Transformer in PSS, as recommended by the manufacturer shall be supplied. Bidder shall submit the list of spare parts that would be supplied accordingly along with the Bid submission.

6.5 Packing

The transformer shall be suitably packed for transportation and installation strictly according to the manufacturer's recommendations. Packing shall be suitable for transportation under restricted volumes and rough conditions for local sea transportation between Male and respective Islands.

7.0 QUALITY ASSURANCE

The manufacturer shall possess valid ISO 9001 Quality Assurance Certification for the process of design, manufacturer and testing of the transformers. The Bidder shall furnish a copy of the ISO Certificate certified as true copy of the original by the Manufacturer, along with the offer.

8.0 WARRANTY

The Bidder shall warrant that all equipment supplied shall have no defect arising from design, materials or workmanship or from any act or omission of the supplier that may develop under normal use of the supplied equipment / material.

This Warranty shall remain valid for 3 years.

9.0 TRAINING

The Supplier shall provide comprehensive training on the operation and maintenance of dry type transformer to FENAKA staffs in each Island as specified in specification no AP -005.

10.0 INFORMATION TO BE SUPPLIED BY THE BIDDER

- Catalogues and drawings describing the transformer and indicating construction details, compliance standards etc. (in English Language).
- Type test certificates.
- Manufacturers ISO 9001 Certification.
- Completed schedule of guaranteed technical particulars
- Manufacturer experience records

10.0 OPERATIONS MANUAL, TECHNICAL LITERATURE AND DRAWINGS

The selected Bidder shall supply along with the equipment five copies of operation and maintenance manuals for dry type transformer including all relevant drawings and technical literature.

11.0 SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS

Schedule of Guaranteed Technical Particulars provided under specification no AP – 005 (for PSS) should be filled in and submitted by the Bidder.

12.0 SCHEDULE OF DEVIATIONS

Any non-compliances of the offered item in respect of the technical requirements provided in this specification shall be provided using Schedule of Deviations form provided in Section 4 of the bid documents. This form should be provided for each key items of the specification, indicating any deviations or 'no deviations' as applicable.

AP – 005-3

TECHNICAL SPECIFICATIONS FOR LOW VOLTAGE (LV) DISTRIBUTION PANEL FOR PACKAGE SUBSTATION

1.0 SCOPE

This specification covers the general requirements of the design, manufacture, testing, supply and delivery of Low Voltage Distribution Panel for PSS.

1.1 Whilst this specification provides applicable technical requirements and guidelines, the Supplier shall be fully responsible for designing the LV distribution panels to meet their intended functions. During the implementation stage, the Supplier is required to submit complete design diagrams for approval.

1.2 All accessories that form part of the LV distribution panels as per standard trade and professional practice which are necessary for its proper operation, are deemed to be included in the scope of supply without extra charges.

1.3 The panels shall be designed, manufactured and tested as per relevant standards indicated in the specification no AP – 005 : Technical specification for 11/0.4 kV package substation with dry type distribution transformer.

1.3 All equipment / materials supplied with panels shall be rated to be used under system parameters and service conditions given and clause 2.0 and 3.0 respectively indicated in the specification no AP – 005.

2.0 BASIC FEATURES

2.1 Design

The LV distribution panels shall be of metal clad suitable for indoor application with PVC sleeved copper bus bars. The LV distribution panel shall comply with the following technical characteristics;

Type	- Indoor
Rated operating voltage	- 415 V AC
Rated frequency	- 50 Hz
Rated insulation level :	
Impulse withstand voltage (peak)	- 8 kV
Rated insulation voltage	- 600 V
Rated current for main distribution busbar	- As indicated in schedules
Rated short-time withstand current	- 50 kA / 1 Sec
Ingress Protection (IP)	- IP54 or higher
Internal Separation	- Form 3
Material group (as per IEC 61439-1)	- IIIa
Degree of pollution	- Category III (costal area / outdoor)

The panel consist of incomer and outgoing feeders with circuit breakers as per following configurations;

- (a) **Incomer** – 1No. 3P, 50 kA Moulded Case Circuit Breaker (MCCB) or Air Circuit Breaker (ACB) of specified current rating (as per schedules)
- (b) **Outgoing** – Moulded Case Circuit Breaker (MCCB) 3P, 50 kA, ratings and numbers as specified in schedules.

The MCCBs shall provide overload (L), Delayed short circuit (S), instantaneous short circuit (I) protection to incomer and outgoing feeders.

Earth fault protection shall be provided for outgoing feeders by introducing shunt release to MCCB, set of CTs and earth leakage relay in the control circuit for outgoing feeders.

LV distribution panels shall be designed with all accessories, auxiliary equipment and internal wiring for full functionality and trouble-free operation under the various operating and service conditions.

The internal separation of the panel shall be Form 3a or higher.

2.2 Voltage Protection for Outgoing PV Feeders

- The outgoing feeders that connect to PV installations shall be provided with over / under voltage protection. In this case respective outgoing MCCBs shall be provided with shunt release that will be operated with a simple voltage protection relay.
- The key objective of this application is to trip PV feeder in the event of high over-voltages originating from PV inverters to protect existing consumer installations in the system. This mechanism shall be provided with a suitable bypass arrangement.
- The over / under voltage settings in the voltage protection relay shall be carefully set in consultation with FENAKA so that it will not create unnecessary trippings for normally acceptable over / under voltages.
- Bidders shall note that this mechanism is required to be provided only for outgoing feeders connecting to PV installations as indicated in Schedules.
- The above mechanism may or may not be used by FENAKA depending on the over / under voltage trip settings made available in PV inverters as per applicable regulations for PV / FPV installations.

2.3 Equipment and Materials

2.3.1 Molded Case Circuit Breaker (MCCB) – Incomer and Outgoing

- i) The MCCBs shall be of standard design and construction conforming to IEC 60947-2.
- ii) MCCBs shall be provided with **thermal-magnetic trip unit for ratings upto 630 A and electronic (microprocessor controlled) trip unit for ratings above 630 A.**
- iii) For MCCBs with thermal-magnetic tripping shall have adjustable thermal and magnetic tripping settings. The thermal setting adjustment (I_r adjustment) shall be available upto 0.63 I_n (63% x rated current). The magnetic trip adjustment (I_i) shall be adjustable upto 10 x I_n.
- iv) Both line up and line down power flow must be possible without decreasing MCCBs performance or functionality.

- v) Characteristics of the MCCBs shall be as follows;
- | | | |
|----|--|--------------------|
| a) | Number of poles | - 3 pole |
| b) | Type | - Indoor |
| c) | Rated voltage | - 415 V |
| d) | Rated frequency | - 50 Hz |
| e) | Rated insulation level | |
| | i) Impulse withstand voltage | - 8 kV |
| | ii) Rated insulation voltage | - 800 V |
| f) | Rated normal current (A) | - as per schedules |
| g) | Rated short circuit breaking current (rms) | - 50 kA |
| h) | Mechanical life (No. of operations) | - > 10,000 |
| i) | Electrical life (No. of operations) | - > 3,000 |
- vi) The MCCBs shall be standard models from the following manufactures or equivalent ; ABB, Siemens, Schneider, Terasaki or other internationally reputed manufacturer approved by FENAKA.
- vii) **In case of circuit breakers for higher rating incomer feeders, Bidder may propose ACBs instead of MCCBs**, in which case complete details and technical data sheets of offered ACBs shall be furnished.

2.3.2 Air Circuit Breakers (ACB)

- i) The ACBs shall be provided for high current incomer feeders (over 1600 A) as specified in schedules.
- ii) The ACBs shall be of standard design and construction conforming to IEC 60947. The interrupting medium of the circuit breaker shall be of Air.
- iii) The ACB'S shall be draw out type.
- ii) The control mechanism of the circuit breakers shall be of spring assisted trip free type.
- iii) The circuit breaker shall have a mechanical counter to register the number of circuit breaker operations.
- iv) Characteristics of the Circuit Breakers shall be as follows;
- | | | |
|----|--|--|
| a) | Number of poles | - 3 pole |
| b) | Type | - Indoor, Withdrawable |
| c) | Rated voltage | - 415 V |
| d) | Rated frequency | - 50 Hz |
| e) | Rated insulation level | |
| | i) Impulse withstand voltage (peak) | - 8 kV |
| | ii) Rated insulation voltage | - 800 V |
| f) | Rated normal current | - As per schedules |
| g) | Rated short circuit breaking current (rms) | - 65 kA |
| h) | Rated short circuit making current | - 100 kA _{pk} |
| i) | Mechanical life (No. of operations) | - 15,000 (for I _u < 2500 A) |
| j) | Electrical life (No. of operations) | - 10,000 (for I _u < 2500 A) |
- v) The ACBs shall be standard models from the following manufactures or equivalent ; ABB, Siemens, Schneider, Terasaki or other internationally reputed manufacturer approved by FENAKA.

2.3.3 Protection Relays

- i) Protection relays shall be used to provide overcurrent and earth fault protection for incomer feeders connected with ACBs.
- ii) The programmable type self-powered numerical protection relays, conforming to IEC 60255, shall be used.
- iii) It shall be possible to select the required type of overcurrent and earth fault protection of IDMT characteristics. Appropriate settings shall be determined during the design stage as per specific requirements in respective Islands and submitted for approval of the Employer
- iv) Necessary software package and the handheld programming unit (1 for each Island) shall be supplied with the numerical protection relays to set the protection relays as required.
- v) The numerical relay units shall be suitable for use in the tropical climatic conditions as given under the Clause 3.0 Service Conditions.
- vi) Relays should have memory and recording Features to provide event log, trip log and oscillographic disturbance records. Relays shall be fixed on the front door with trip indicators and alarms.
- vii) The numerical relay unit shall have provision for incorporating SCADA system in future.
- viii) The relays shall be standard models from the following manufactures or equivalent ; ABB, Siemens, Schneider, Terasaki or other internationally reputed manufacturer approved by FENAKA.

2.3.4 Current Transformers

- ii) Current transformers shall conform to IEC 61869 and comply with the following.

		Measuring	Metering	Protection
a)	Class	3.0	0.5	5P
b)	Burden	To match the measuring, metering and protection equipment		
c)	Accuracy limit factor	-	-	10
d)	Frequency	50 Hz	50 Hz.	50 Hz.
e)	C.T. ratios	As per design requirements		

- ii) Magnetization curves and the secondary resistance shall be provided for each type and rating of current transformer. Also, all technical details, routine test reports of CTs shall be furnished with the offer.
- iii) Type Test Certificates Conforming to IEC 61869 shall be furnished with the offer.

2.3.5 Energy Metering Instruments

- i) Energy measurements are required to be provided for incomer feeders to record energy import and export measurements through programmable poly phase metering equipment conforming to relevant IEC. The energy meter shall be Static (Electronic) Three Phase, Accuracy Class 0.5.

- ii) The meters shall be calibrated by the supplier taking into consideration that the errors of current transformers tested separately.
- iv) The necessary software package and the handheld programming unit (1 for each Island) shall be supplied with the PSS.
- v) Volt free switching contact pulse output shall be available to send the energy measurements to the SCADA system. RS232 bus interface shall be available additionally for remote meter reading facility.

2.3.5 Busbars

- i) The LV busbar shall be made of electrical grade high conductivity, hard drawn copper (Tin plated) capable of carrying continuously a current as per the requirements indicated in schedules, without exceeding the maximum temperature rise specified in the IEC Standard 61439.

2.3.7 Cable Terminations

- i) MCCB Terminals shall be suitable for terminating armoured LV cables upto 630 sqmm as indicated in schedules. Necessity terminal block extensions shall be provided if existing terminals are not adequate to terminate specified number / size of cables.
- ii) Facilities for connecting probs for cable testing and cable fault locating in PSS Cable Test Facility (CTF) shall also be provided.
- iii) Stainless Steel clamps, bolts and nuts must be provided to connect the incoming / outgoing feeder cables.

2.3.8 Earthing

- i) The copper earthing conductor shall be provided along the entire length of the panel. The cross-sectional area of earthing conductor shall be such that the current density shall not exceed 200 A/mm² under the specified earth fault conditions.
- ii) It shall be possible to earth the cable with facility for padlocking, and mechanical interlocking shall be provided to prevent earthing the busbar.
- iii) All metallic parts of the functional units intended to be earthed shall be bonded to the earthing conductor of the panel.

2.3. Auxiliary Circuits

- i) Control and auxiliary devices shall be segregated by earthed metallic partitions from the main circuit.
- ii) PVC insulated flexible copper wire 2.5 sqmm shall be used for control wiring. For the purpose of identification, the control wiring shall be provided with numbered tags to distinguish the different circuits, and shall be terminated using suitable terminations.

2.3.10 Metering and Indications

Voltage, Current measurements shall be provided for incomer and outgoing feeders by suitable means.

For incomer feeder in PSS LV distribution panel, energy measurement facility shall be provided through Digital Energy Meter, kWh & kVarh, Class 0.5s with facility for recording energy export and Import.

2.3.11 Construction of Panels

The panel shall be manufactured using high quality electrogalvanized MS plates, treated and powder coated upto 80 micron or higher.

The thickness of the metal sheets shall be at least 1.5 mm, and other plates shall be 1mm. The thickness of the main frame shall not be less than 2 mm.

The panels shall be dust and vermin proof type and cable entries shall be sealed using suitable filler material upon installation.

Each incomer/ outgoing switchgear should be mounted in separate compartments to ensure added safety and ease of operation. Internal Separation shall be Form 3 or higher.

All cables and wiring shall be complete with all necessary terminal plates, cable glands for cable entry, wiring trunkings for small wiring and multi core cables. Wiring trunkings shall be adequate sizes for accommodating incoming and outgoing cables for present and future requirements.

All equipment, control, measuring and monitoring devices, relays, battery chargers, and meters shall be from reputable international brands acceptable to Employer. Drawings and technical specification must be provided with the bid documents.

Labeling shall be provided with each panel, and each circuit. Cabling from CTs shall terminate at the panel on isolating links of the shorting disconnecting type. Shorting Links shall also be provided.

External effects of internal arc shall be limited by a suitable design to prevent any danger to operator. Test evidence in accordance with relevant IEC to verify the design is required.

3.0 OTHER REQUIREMENTS

3.1 Manufacturing Experience

The manufacturer shall have at least 05 years' experience in manufacturing and supply of offered type of LV distribution panels and manufacturer shall furnish documentary evidence with the offer to prove his manufacturing experience.

3.2 Tools

All special tools and accessories required for operation and maintenance of equipment shall be clearly indicated in the offer and shall be supplied with the panels.

3.3 Spares

Mandatory Spare parts : Spare parts and tools required for 5-year trouble-free operation of the LV Distribution Panel in PSS, as recommended by the manufacturer shall be supplied. Bidder shall submit the list of spare parts that would be supplied accordingly along with the Bid submission.

3.4 Name Plates

Name Plates shall include the following information:-

- a) Manufacturer's name and trademark.
- b) Serial number or type designation.
- c) Applicable standards
- d) Applicable rated values.
- d) Number and year of the relevant standard.
- e) Country and year of manufacture
- f) Project Name
- g) Property of FENAKA

3.5 Labeling

All equipment, control positions, indicator positions, control/indicator identification, terminals, small wiring of instrumentation and protection of the panel shall be identifiable by clear markings and labeling in English Language with relevant colour code, if any. The labels shall be made out of durable materials and prints permanently edged. A mimic display of the panel configuration shall also be provided.

3.6 Packing

All equipment shall be suitably packed for transportation and installation strictly according to the manufacturer's recommendations. Packing shall be suitable for transportation under restricted volumes and rough conditions for local transportation between Male and respective Islands.

7.0 TESTS

7.1 Routine Tests

The following Routine tests as per IEC 61439 part 1 & 2 shall be carried out on each distribution panel and the routine test reports shall be made available to the Employer.

- vii) Visual Inspection
- viii) Verification of Electrical Continuity
- ix) Insulation Resistance Test
- x) Verification of Wiring and Connections
- xi) Functional Test
- xii) Verification of Protective Measures

7.2 Type Tests

d) Switchgear Panels

Certified copies of the type test carried out in accordance with clause 6 of the IEC 61439 as indicated below shall be furnished with the offer.

- vii) Temperature Rise Test
- viii) Short-Circuit Withstand Strength Test
- ix) Dielectric Tests
- x) Mechanical Operation Test
- xi) Verification of Degree of Protection
- xii) Clearances and Creepage Distances Test

e) Circuit Breaker (MCCB / ACB)

Certified copies of the Certificates of type tests carried out in accordance with the relevant IEC standard indicated below shall be furnished with the offer.

- ix) Temperature Rise Test

- x) Short-Circuit Withstand Test
- xi) Dielectric Tests
- xii) Mechanical Operation Test
- xiii) Endurance Test
- xiv) Electric Arc Test
- xv) Electromagnetic Compatibility (EMC) Test
- xvi) Verification of Temperature Limits

f) Instrument Transformers and Protection Relays

Certified copies of the certificates of type tests carried out in accordance with the following standards shall be furnished with the offer.

- Current Transformers conforming to IEC 61869.
- Protection Relays conforming to IEC 60255-1

The type test certificates should clearly identify the equipment concerned, showing the manufacturer's identity, type/model and basic technical parameters. The type test certificates referred to, shall be issued within 5 years from the date of bid opening from a recognized independent testing authority accredited to ISO/IEC 17025:2005 for carrying out specified type tests and acceptable to the Employer.

7.3 Sample/Acceptance tests

The following Sample/Acceptance tests shall be witnessed by the inspection Engineer. Extra copies of these test certificates shall also be furnished with the equipment, prior to dispatch.

- j) Verification of Dimensions and Clearances
- ii) Verification of Mechanical Operation
- iii) Verification of Electrical Continuity
- iv) Verification of Insulation Resistance
- v) Verification of Dielectric Properties
- vi) Verification of Protection Measures
- vii) Verification of Temperature Rise

8.0 INSPECTION AND TESTING

The selected Bidder shall make necessary arrangements for inspection by the Employer or his representative inspection of goods prior to dispatch and to carry out in his presence sample / acceptance tests indicated in clause 8.3.

9.0 QUALITY ASSURANCE

The manufacturer shall possess valid ISO 9001 Quality Assurance Certification for the process of design and manufacturer of LV Metal Enclosed Switchgear Panels for the plant where the offered Switchgear panels are manufactured. The Bidder shall furnish a copy of the ISO Certificate certified as true copy of the original by the Manufacturer, along with the offer.

10.0 WARRANTY

The Bidder shall warrant that all equipment supplied shall have no defect arising from design, materials or workmanship or from any act or omission of the supplier that may develop under normal use of the supplied equipment.

This Warranty shall remain valid for 3 years.

11.0 TRAINING

The Supplier shall provide comprehensive training on the design, installation, operation and maintenance of the LV Distribution Panels to FENAKA staffs in each Island together with training for PSS.

12.0 INFORMATION TO BE SUPPLIED BY THE BIDDER

12.1 Documentation be furnished with the offer.

- Catalogues describing the equipment and indicating the model number (in English Language).
- Make, rated values and technical characteristics of breakers,, busbars, instruments, and accessories etc.
- Mechanical characteristics of panels and equipment including overall dimensions, weight, constructional features.
- Type test certificates
- Manufacturers ISO 9001 Certifications
- Completed schedule of guaranteed technical particulars
- Manufacturer experience records

13.0 OPERATIONS MANUAL, TECHNICAL LITERATURE AND DRAWINGS

The selected Bidder shall supply along with the equipment five copies of operational/maintenance manuals for low voltage distribution panel including all relevant drawings, technical literature, hand books, wiring diagrams in order to facilitate easy installation, faultless operation and maintenance.

14.0 SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS

Schedule of Guaranteed Technical Particulars provided under specification no AP – 005 (for PSS) should be filled in and submitted by the Bidder.

15.0 SCHEDULE OF DEVIATIONS

Any non-compliances of the offered item in respect of the technical requirements provided in this specification shall be provided using Schedule of Deviations form provided in Section 4 of the bid documents. This form should be provided for each key items of the specification, indicating any deviations or 'no deviations' as applicable.

TECHNICAL SPECIFICATIONS FOR LOW VOLTAGE DISTRIBUTION BOX (FEEDER PILLARS)

1.0 SCOPE

This specification covers the general requirements of the design, manufacture, testing, supply and delivery of Low Voltage Distribution Box (LV Feeder Pillars) for use in electricity distribution networks in Maldives

1.1 Whilst this specification provides applicable technical requirements and guidelines, the Supplier shall be fully responsible for designing the LV distribution boxes to meet their intended functions. During the implementation stage, the Supplier is required to submit complete design diagrams for approval.

1.2 All accessories that form part of the LV distribution boxes as per standard trade and professional practice which are necessary for its proper operation, are deemed to be included in the scope of supply without extra charges.

1.3 All equipment / materials supplied shall be rated to be used under system parameters and service conditions given and clause 2.0 and 3.0 respectively.

2.0 SYSTEM PARAMETERS

Parameter	Low Voltage System	11kV System
Nominal Voltage	0.415 / 0.240 kV	11 kV
Highest System Voltage	0.44 / 0.255 kV	12 kV
Number of Phases	3PN	3
Frequency	50 Hz	50Hz
Neutral Earthing	Solidly Earthed	Solidly earth
3 Phase Short Circuit Levels	Upto 65 kA / 1 s as req.	Upto 20 kA / 1s
Impulse Withstand Voltage	6 kV	75 kV (peak)
Power Freq. Withstand Voltage 1 min	2.5 kV	28 kV

3.0 SERVICE CONDITIONS

Parameter	Value
Climate	Typical tropical coast line
Atmosphere	Saliferous, corrosive and dusty
Max. Ambient Temperature	35 °C
Max. Daily average ambient temp.	29 °C
Min Ambient Temp	24 °C
Maximum Humidity	90 %
Maximum altitude above M.S.I.	Average 2 m
Average days of rainfall	145 days/ yr
Maximum wind speed	gusts up to 100 km/hr

4.0 STANDARDS:

The equipment supplied shall be designed, manufactured and tested in accordance with the latest editions of the Standards specified below and amendments thereof.

Standard	Title
IEC 61439-1 & 2	Low-voltage switchgear and controlgear assemblies
IEC 60947	Low-voltage switchgear and controlgear
IEC 60255	Electrical relays
IEC 61869	Instrument transformers
IEC 60529	Degrees of protection provided by enclosures

Material conforming to other internationally accepted standards, which ensure equal or higher quality than the standards mentioned above may be acceptable, subject to approval by the Employer at his discretion. In case the Bidders who wish to offer material conforming to the other standards, salient points of difference between the standards adopted and the specific standards shall be clearly brought out in relevant schedule. Two copies of such standards with authentic English Translations shall be furnished along with the offer.

5.0 BASIC FEATURES

5.1 Design

The LV distribution boxes shall be of metal clad suitable for outdoor application. The LV distribution box shall comply with the following technical characteristics;

Type	- OUTDOOR
Rated operating voltage	- 415 V AC
Rated frequency	- 50 Hz
Rated insulation level :	
Impulse withstand voltage (peak)	- upto 8 kV
Rated insulation voltage	- 1000 V
Rated current for main distribution busbar	- As indicated in schedules
Rated short-time withstand current	- Upto 50 kA / 1 Sec
Arc fault - prospective short-circuit current	- Upto 50 kA
Ingress Protection (IP)	- IP54
Internal Separation	- Form 3
Material group (as per IEC 61439-1)	- IIIa
Degree of pollution	- Category III (costal area / outdoor)

The LV distribution box consist of incomer and outgoing feeders with circuit breakers as per following configurations;

- (a) **Incomer** –1No. 3P, 50 kA Moulded Case Circuit Breaker (MCCB) of specified current rating (as per schedules)
- (b) **Outgoing** – Moulded Case Circuit Breaker (MCCB) 3P, 50 kA, ratings and numbers as specified in schedules.

The MCCBs shall provide overload (L), Delayed short circuit (S), instantaneous short circuit (I) protection to incomer and outgoing feeders. The thermal trip setting (I_r setting) shall be adjustable upto $0.63 \times I_n$. The magnetic trip adjustment (I_i) shall be adjustable upto $10 \times I_n$.

LV distribution boxes shall be designed with all accessories, auxiliary equipment and internal wiring for full functionality and trouble-free operation under the various operating and service conditions.

5.2 Voltage Protection for Outgoing PV Feeders

- Some of the outgoing feeders from LV Distribution Boxes are proposed to be connected to Rooftop PV installations as indicated in Schedules.
- In this case respective outgoing MCCBs shall be provided with shunt release that will be operated with a simple voltage protection relay.
- The key objective of this application is to trip PV feeder in the event of high overvoltages originating from PV inverters to protect existing consumers in the system. This mechanism shall be provided with a suitable bypass arrangement.
- The over / under voltage settings in the voltage protection relay shall be carefully set in consultation with FENAKA so that it will not create unnecessary trippings for acceptable normally acceptable over / under voltages.
- Bidders shall note that this mechanism is required to be provided only for outgoing feeders connecting to PV installations only.
- The above mechanism may or may not be used by FENAKA depending on the over / under voltage trip settings made available in PV inverters as per applicable regulations for Rooftop PV installations.

5.3 Equipment and Materials

5.3.1 Molded Case Circuit Breaker (MCCB) – Incomer and Outgoing

- i) The MCCBs shall be thermal-magnetic type of standard design and construction conforming to IEC 60947-2.
- ii) The MCCB shall have adjustable thermal and magnetic tripping settings. The thermal setting adjustment (I_r adjustment) shall be available upto $0.63 I_n$ (63% x rated current).
- iii) Both line up and line down power flow must be possible without decreasing MCCBs performance or functionality.
- iv) Characteristics of the MCCBs shall be as follows;
 - a) Number of poles - 3 pole
 - b) Type - Indoor
 - c) Rated voltage - 415 V
 - d) Rated frequency - 50 Hz

- | | | |
|----|--|--------------------|
| e) | Rated insulation level | |
| | i) Impulse withstand voltage | - 8 kV |
| | ii) Rated insulation voltage | - 800 V |
| f) | Rated normal current (A) | - as per schedules |
| g) | Rated short circuit breaking current (rms) | - 50 kA |
| h) | Mechanical life (No. of operations) | - > 10,000 |
| i) | Electrical life (No. of operations) | - > 3,000 |
- v) The MCCBs shall be standard models from the following manufactures or equivalent ; ABB, Siemens, Schneider, Terasaki or other internationally reputed manufacturer approved by FENAKA.

5.3.4 Busbars

- i) The LV busbar shall be made of electrical grade high conductivity, hard drawn copper capable of carrying continuously a current as per the requirements indicated in schedules, without exceeding the maximum temperature rise specified in the IEC Standard 61439.

5.3.4 Cable Terminations

- i) MCCB Terminals shall be suitable for terminating armoured LV cables as indicated in schedules.
- ii) G.I. clamps, bolts and nuts must be provided to connect the incoming / outgoing feeder cables.

5.3.5 Earthing

- i) The copper earthing conductor shall be provided along the entire length of the panel. The cross-sectional area of earthing conductor shall be such that the current density shall not exceed 200 A/mm² under the specified earth fault conditions.
- iii) All metallic parts of the functional units intended to be earthed shall be bonded to the earthing conductor of the panel.

5.3.6 Auxiliary Circuits

- i) Any control and auxiliary devices shall be segregated by earthed metallic partitions from the main circuit.
- ii) PVC insulated flexible copper wire 2.5 sqmm shall be used for control wiring. For the purpose of identification, the control wiring shall be provided with numbered tags to distinguish the different circuits, and shall be terminated using suitable terminations.

5.3.7 Design and Construction

LV Distribution Boxes shall be free standing type suitable for outdoor installation.

The panel shall be manufactured using high quality electrogalvanized MS plates, treated and powder coated upto 80 micron or higher.

The thickness of the metal sheets shall be at least 1.5 mm, and other plates shall be 1mm. The thickness of the main frame shall not be less than 2 mm.

Canopy within minimum 10 degree slope shall be provided on the top of the LV distribution Boxes. Single / Double Front doors with locking facility shall be provided as per approved design. Lifting Hooks shall be provided.

The panels shall be dust and vermin proof type and cable entries shall be sealed using suitable filler material upon installation.

Each incomer/ outgoing switchgear should be mounted in separate compartments to ensure added safety and ease of operation. Internal Separation shall be Form 3a or higher.

All cables and wiring shall be complete with all necessary terminal plates, cable glands for cable entry, wiring trunkings for small wiring and multi core cables. Bottom cable entry shall be provided.

Labeling shall be provided with each panel, and each circuit.

External effects of internal arc shall be limited by a suitable design to prevent any danger to Operator. Test evidence in accordance with relevant IEC to verify the design is required.

The design including dimensions shall be compatible with existing LV distribution boxes used in the Islands. The contractor is required to prepare and submit suitable design accordingly. Drawings and technical specification must be submitted for approval of FENAKA during design stage.

6.0 OTHER REQUIREMENTS

6.1 Manufacturing Experience

The manufacturer shall have at least 05 years' experience in manufacturing and supply of offered type of LV distribution boxes and manufacturer shall furnish documentary evidence with the offer to prove his manufacturing experience.

6.2 Tools

All special tools and accessories required for operation and maintenance of equipment shall be clearly indicated in the offer and shall be supplied with the panels.

6.3 Spares

Not applicable.

6.4 Name Plates

Name Plates shall include the following information:-

- aa) LV Dist. Box ID (DB No in Schedules)
- a) Manufacturer's name and trademark.
- b) Serial number or type designation.
- c) Applicable standards
- d) Applicable rated values. (Incomer / Outgoing Feeder Breakers)
- d) Number and year of the relevant standard.
- e) Country and year of manufacture
- f) Project Name
- g) Property of FENAKA

6.5 Labeling

All equipment, control positions, indicator positions, control/indicator identification, terminals, small wiring of instrumentation and protection of the panel shall be identifiable by clear markings and labeling in English Language with relevant colour code, if any. The labels shall be made out of durable materials and prints permanently edged. A mimic display of the panel configuration shall also be provided.

6.6 Packing

All equipment shall be suitably packed for transportation and installation strictly according to the manufacturer's recommendations. Packing shall be suitable for transportation under restricted volumes and rough conditions for local transportation between Male and respective Islands.

7.0 TESTS

7.1 The routine and acceptance tests as per IEC 61439 part 1 & 2 shall be carried out on each distribution box and test reports shall be made available to the Employer.

Routine Tests

- i) Visual Inspection
- ii) Verification of Electrical Continuity
- iii) Insulation Resistance Test
- iv) Verification of Wiring and Connections
- v) Functional Test

Sample / Acceptance Tests

- i) Verification of Protective Measures
- ii) Verification of Dimensions and Clearances
- iii) Verification of Mechanical Operation
- iv) Verification of Electrical Continuity
- v) Verification of Insulation Resistance
- vi) Verification of Dielectric Properties
- vii) Verification of Protection Measures
- viii) Verification of Temperature Rise

7.2 Type Tests

Circuit Breaker (MCCB)

Certified copies of the Certificates of type tests carried out on circuit breakers in accordance with the relevant IEC standard indicated below shall be furnished with the offer.

- i) Temperature Rise Test
- ii) Short-Circuit Withstand Test
- iii) Dielectric Tests
- iv) Mechanical Operation Test
- v) Endurance Test
- vi) Electric Arc Test
- vii) Electromagnetic Compatibility (EMC) Test
- viii) Verification of Temperature Limits

The type test certificates should clearly identify the equipment concerned, showing the manufacturer's identity, type/model and basic technical parameters. The type test certificates referred to, shall be issued within 5 years from the date of bid opening from a recognized independent testing authority accredited to ISO/IEC 17025:2005 for carrying out specified type tests and acceptable to the Employer.

8.0 INSPECTION AND TESTING

The selected Bidder shall make necessary arrangements for inspection by the Employer or his representative inspection of goods prior to dispatch and to carry out in his presence sample / acceptance tests indicated in clause 8.3.

9.0 QUALITY ASSURANCE

The manufacturer shall possess valid ISO 9001 Quality Assurance Certification for the process of design and manufacturer of LV Metal Enclosed Switchgear Panels for the plant where the offered Switchgear panels are manufactured. The Bidder shall furnish a copy of the ISO Certificate certified as true copy of the original by the Manufacturer, along with the offer.

10.0 WARRANTY

The Bidder shall warrant that all equipment supplied shall have no defect arising from design, materials or workmanship or from any act or omission of the supplier that may develop under normal use of the supplied equipment.

This Warranty shall remain valid for 3 years.

11.0 INFORMATION TO BE SUPPLIED BY THE BIDDER

13.1 Documentation be furnished with the offer.

- Catalogues describing the equipment and technical data
- Mechanical characteristics including overall dimensions, weight, constructional features.
- Type test certificates
- List of recommended spare parts for 5 year trouble free operation.
- Manufacturer's ISO 9001 Certifications
- Completed schedule of guaranteed technical particulars
- Manufacturer experience records

14.0 OPERATIONS MANUAL, TECHNICAL LITERATURE AND DRAWINGS

The selected Bidder shall supply along with the equipment five copies of operational/maintenance manuals for low voltage distribution boxes including all relevant drawings, technical literature, handbooks, wiring diagrams in order to facilitate easy installation, faultless operation and maintenance.

15.0 SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS

Schedule of Guaranteed Technical Particulars should be filled in and submitted by the Bidder.

16.0 SCHEDULE OF DEVIATIONS

Any non-compliances of the offered item in respect of the technical requirements provided in this specification shall be provided using Schedule of Deviations form provided in Section 4 of the bid documents. This form should be provided for each key items of the specification, indicating any deviations or 'no deviations' as applicable.

**SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS
LV DISTRIBUTION BOXES**

(This schedule shall be duly filled by the Bidder)

Sl No	Particulars	Unit	Offered
1	Name & Address of Manufacturer	-	
2	Country of Origin	-	
3	Model / catalogue number	-	
4	Applicable Standard/s	-	
5	No of Phases	-	
6	Rated operating voltage	V	
7	Rated frequency	Hz	
8	Rated insulation level : Impulse withstand voltage (peak) Rated insulation voltage	kV	
9	Rated current for main distribution busbar (Specify range as per schedules)	Amps	
10	Rated short-time withstand current	kA/s	
11	Arc fault - prospective short-circuit current	kA	
12	Ingress Protection (IP) Class -	-	
13	MCCB		
13.1	Make and Model	-	
13.2	Applicable Standards	-	
13.3	No of Poles	-	
13.4	Ratings (Range)	A	
13.5	Rated short circuit breaking current (rms)	kA	
13.6	Electrical & Mechanical Endurance Class	-	
13.7	Protections provided	-	
13.8	Max size of cable termination	-	
14	BUSBARS		
14.1	Make / Model	-	

SI No	Particulars	Unit	Offered
14.2	Type / Material	-	
14.3	Applicable Standard	-	
14.4	Rated current (Range)	Amps	
15	PANEL CONSTRUCTION		
15.1	Material	-	
15.2	Thickness (main Frame / metal sheets)	mm	
15.3	Surface treatment	-	
15.6	Separation	-	
15.7	Earthing provision	-	
16	Type Test Certificates Provided ?	Y/N	
17	Manufacturer's Quality Assurance Certifications provided ?	-	
18	Completed GTPs submitted ?	-	
19	Schedule of Deviations from specifications Submitted ?	-	
20	Warranty Period for PSS	Yrs	

We certify that the above data are true and correct.

 SEAL AND SIGNATURE OF THE BIDDER/ Date

TECHNICAL SPECIFICATION FOR MEDIUM VOLTAGE SWITCHGEAR PANELS

1.0 SCOPE:

This specification covers design, manufacture, shop testing, inspection, packing, delivery to site, erection, testing and commissioning of Medium Voltage Switchgear Panel (MVDB), fully type tested according to IEC 62271 standards for use with electricity distribution systems in Maldives.

- 1.1 The MVDB shall conform to high standards of engineering, design and workmanship, capable of performing continuous trouble-free operation in a manner acceptable to the Employer, who will interpret the meanings of drawings and specification and shall have the power to reject any work or material which, in his judgment is not in accordance therewith.
- 1.2 This Panel shall be complete with all components necessary for its effective and trouble-free operation along with associated equipment and systems and such components deemed to be within the scope of supplier's supply.
- 1.3. The design of the switchgear shall be exclusive and specific responsibility of the Supplier and should be in accordance with best engineering practice, the relevant standards and project specific requirements.
- 1.5 The equipment / materials shall be rated for continuous operation under system parameters and service conditions given and clause 2.0 and 3.0 respectively.

2.0 SYSTEM PARAMETERS

Parameter	Low Voltage System	11kV System
Nominal Voltage	0.4 / 0.230 kV	11 kV
Highest System Voltage	0.44 / 0.255 kV	12 kV
Number of Phases	3PN	3
Frequency	50 Hz	50Hz
Neutral Earthing	Solidly Earthed	Solidly earth
3 Phase Short Circuit Levels	Upto 65 kA / 1s	Upto 20 kA / 1s
Impulse Withstand Voltage	6 kV	75 kV (peak)
Power Freq. Withstand Voltage 1 min	2.5 kV	28 kV

3.0 SERVICE CONDITIONS

Parameter	Value
Climate	Typical tropical coast line
Atmosphere	Saliferous, corrosive and dusty
Max. Ambient Temperature	35 °C
Max. Daily average ambient temp.	29 °C
Min Ambient Temp	24 °C
Maximum Humidity	90 %
Maximum altitude above M.S.I.	Average 2 m
Average days of rainfall	145 days/ yr
Maximum wind speed	gusts up to 100 km/hr

4.0 STANDARDS:

The switchgear shall be designed, manufactured, tested and supplied in accordance with the latest editions of the Standards specified below and amendments thereof.

Description		IEC Standard
Switchgear		IEC 62271-1
		IEC 62271-200
Devices	Circuit-breakers	IEC 62271-100
	Vacuum contactors	IEC 62271-106
	Disconnectors and earthing switches	IEC 62271-102
	Switch-disconnectors	IEC 62271-103
	Switch-disconnector/fuse combination	IEC 62271-105
	HV HRC fuses	IEC 60282-1
	Voltage detecting systems	IEC 61243-5
Degree of protection		IEC 60529
Insulation		IEC 60071
Instrument transformers / Relays	Instrument transformers	IEC 61869-1
	Current transformers	IEC 61869-2
	Voltage transformers	IEC 61869-3
	Live working - Voltage detectors	IEC 61243
	Electrical Relays	IEC 60255
Installation, erection		IEC 61936-1

Material conforming to other internationally accepted standards, which ensure equal or higher quality than the standards mentioned above, may be acceptable, subject to approval by the Employer at his discretion. In case the Bidders who wish to offer material conforming to the other standards, salient points of difference between the standards adopted and the specific standards shall be clearly indicated. Two copies of such standards with authentic English Translations shall be furnished along with the offer.

5.0 TECHNICAL REQUIREMENTS:

5.1 BASIC FEATURES:

The design of the switchgear shall be based on considerations including safety to personnel and equipment during operation and maintenance, reliability of service, ease of maintenance, mechanical and arc flash protection of equipment, interchangeability of equipment and flexibility for addition of future extensions.

5.1 Design

5.1.1 The arc flash resistant MV switchgear panels shall be of metal clad and extensible type suitable for indoor application. The general technical parameters of panels shall comply with requirements indicated below;

- Rated Operating voltage : 11 kV
- Maximum operating Voltage : 12 kV
- Rated power frequency withstand voltage : 28 kV

- Rated Impulse Withstand Voltage : 75 kV
- Rated Frequency : 50Hz
- Rated Busbar current : 1000 A
- Rated Short-time current : 20 kA
- Duration of short-time current : 3 s
- Internal arc classification : IAC A FLR; 25 kA/ 1s
- Ingress Protection (IP) : IP54 or higher
- Degree of pollution : Category III (costal area / indoor)

5.1.2 11kV Switchgear shall consist of panels comprising of;

- 2 Nos Incomer Panels with 630A 12 kV Motorized Vacuum Circuit Breaker
- 2 Nos Outgoing Panels with 630 A 12 kV Motorized Vacuum Circuit Breaker
- 1 x 1000A 12kV Bus coupler with 1000 A 12 kV Motorized Vacuum Circuit Breaker

5.1.3 The panel shall have following features :

- Factory-assembled, type-tested switchgear according to IEC 62271-200
- Shall use standard components available worldwide which meets the relevant international standards.
- Each section shall be separated with Pressure-resistant partitions. Partition class PM (metal-clad in pressure-resistant design)
- All operations shall be possible only with closed high-voltage door
- Shall be a Metallic enclosure with earthed shutters and partitions
- Internal arc classified switchgear according to IAC A FLR; front, lateral and rear accessibility
- Incoming and outgoing feeders shall be evenly arranged on either side of Bus coupler.
- Cable entry gland plates shall be fixed at the bottom of each feeder panel

5.2 Equipment and Materials

5.2.1 Vacuum Circuit Breakers (VCB)

- The circuit breakers shall be of standard design and construction conforming to IEC 62271-100. The interrupting medium shall be vacuum.
- The VCB'S must be withdrawable type and provided with motor operating mechanism
- The control mechanism of the circuit breakers shall be of spring assisted trip free type with remote / local control selector switch and manual operational facility.
- Circuit Breakers shall be maintenance free and type tested.
- Incoming and Outgoing Circuit Breakers shall be provided with Self Powered Over Current and Earth Fault Relays.
- Shall be provided with ;
 - Mechanical tripped on fault indicator
 - Auxiliary contacts 2 NO and 2 NC
 - Anti-reflex operating handle
 - Shunt Trip circuit for external trip signal
 - Mechanical ON/OFF/EARTH Indication
 - Mechanical counter to register the number of circuit breaker operations.
- Characteristics of the Circuit Breakers shall be as follows for Incoming, Outgoing and Bus coupler;

a)	Number of poles	- 3
b)	Type	- Vacuum
c)	Rated voltage	- 11 kV
d)	Rated frequency	- 50 Hz
e)	Maximum system voltage	- 12 kV
i)	Impulse withstand voltage (peak)	- 75 kV
ii)	Power frequency withstand voltage (rms)	- 28 kV
f)	Rated normal current	- As per Schedules
g)	Rated short circuit breaking current	- 20 kA
i)	Rated short circuit current duration	- 3 Sec
j)	Rated peak short circuit making current	- 50 kA
k)	Rated opening time	- < 0.04 s
l)	No-load closing time	- < 0.06 s
k)	Tripping supply voltage V	- 24 DC
l)	Mechanical life (No. of operations)	- > 20,000
m)	Electrical life (No. of operations)	- > 20,000
n)	Auxiliary contacts	- 2 NC and 2 NO

The VCBs shall be standard models from the following manufactures or equivalent ; ABB, Siemens, Schneider or other reputed make approved by FENAKA.

5.2.3 Earthing Switch

Earthing switches shall be rated equal to the switchgear rating. Earthing switches shall be make-proof and quick make type capable of making Rated Fault Current. Earthing switch shall be operated from the front of the cubicle by means of a removable handle.

5.2.2 Busbars

- i) The 12kV, 1000 A busbar shall be integrated in the cubicle and busbars shall be rated to withstand all dynamic and thermal stresses of the switchgear.
- ii) It shall be made of electrical grade high conductivity, hard drawn copper Tin plated capable of carrying continuously a current as per the requirements without exceeding the maximum temperature rise specified in the IEC Standard or equivalent.
- iii) Busbars shall be rated to withstand all dynamic and thermal stresses for the full length of the switchgear.
- iii) All 12kV live in busbar parts shall be air insulated.

5.2.4 Current Transformers

- i) All current transformers should comply with IEC 61869-1 & 2. Current transformers should be of dry type, with ratings and ratios as required. Standardized block-type current transformers shall be used.
- ii) Current transformers shall comply with the following.

		Measuring	Metering	Protection
a)	Class	3.0	0.5	5 P
b)	Burden	To match the measuring, metering and protection equipment		
c)	Accuracy limit factor	-	-	10
d)	Frequency	50 Hz	50 Hz.	50 Hz.
e)	C.T. ratios	As per design requirements		

- ii) All technical details, type test reports of CTs shall be furnished with the offer.

5.2.5 Voltage Transformers

- i) Voltage transformers shall be of cast epoxy resin insulated type complying with IEC 61869-1 / 3. HRC type fuses or MCBs shall be provided for protection of secondary windings.
- i) The Characteristics of the Voltage Transformer for Metering and Measuring shall be as follows;
 - a) Class - 0.5 metering, 1.0 measuring
 - b) Rated voltage - 12 kV
 - c) Rated insulation level
 - i) Power frequency withstand voltage (rms.) - 28 kV
 - ii) Impulse (1.2/50 μ s) withstand voltage peak - 75 kV
 - d) Rated Voltage factor - 1.2
 - e) Burden - 50 VA
 - f) Frequency - 50 Hz
 - g) Ratio - 11 kV / 110 V
 - h) No of phases - 3
- ii) Type Test Certificates conforming to IEC 61869-1&3 shall be furnished.

5.2.6 Energy Metering Instrument

- i) The energy metering facilities Export and Import measurements shall be provided in incoming and outgoing feeder panels as indicated in 5.3.1.
- ii) The programmable poly phase metering equipment shall conform to IEC - Static (Electronic) Three Phase Meters, Accuracy Class 0.5. The metering equipment shall be of the flush mounting type.
- iii) The meters shall be calibrated by the supplier taking into consideration that the errors of current and voltage transformers tested separately.
- iv) Necessary software package and the handheld programming unit (1 for each Island) shall be supplied with the metering panels.
- v) Volt free switching contact pulse output shall be available to send the energy measurements to SCADA system. RS232 bus interface shall be available additionally for remote meter reading facility.

5.2.7 Protections

- i) Incoming, outgoing and bus coupler Circuit Breakers shall be provided with Self Powered Over Current and Earth Fault Relays conforming to IEC 60255.
- ii) The numerical relay units shall be suitable for use in tropical climatic conditions as given under the Clause 3.0 Service Conditions.
- iii) It shall be possible to select the required type of overcurrent and earth fault protection of IDMT characteristics. Appropriate settings shall be determined during the design stage as per specific requirements in respective Islands and submitted for approval of the Employer.
- iv) Necessary software and the handheld programming unit (1 for each Island) shall be supplied with numerical protection relays to set the protection settings as required.

- v) Relays should have memory and recording Features to provide event log, trip log and oscillographic disturbance records. Relays shall be fixed on the front door with trip indicators and alarms.
- vi) The numerical relay unit shall have provision for incorporating SCADA system.
- vii) The relays shall be standard models from the following manufactures or equivalent ; ABB, Siemens, Schneider or reputed international make acceptable to FENAKA.

5.2.8 Indications

The front panel shall display the mimic diagram of the main circuit with the position indicators for the switching devices. The voltage indicators shall be situated on the front panels. Multifunction Power Meter shall be fixed on the front door for each feeder cubicle, displaying at least Voltage, Current and Power.

The position indicators of VCB shall be visible through the front cover and indicating lights shall be wired to auxiliary contact of the VCB to indicate the status of VCB.

The voltage indicators shall be situated on the front door, one for each module, and indicate the voltage condition of each incoming/outgoing cable. Identification of the phases is achieved with labels L1, L2 and L3 on the front of the voltage indicators. The voltage indicator shall satisfy the requirements of IEC61243.

5.2.9 Cable Compartment and Terminations

Cable Compartment shall have room to terminate up to a maximum of two 11 kV 3 core cables (upto 95 smm) per phase. Removable steel covers bolted to the mainframe shall close the cable compartment and access to the compartment shall be by removing these cable covers.

Each module has a separate cable compartment that is segregated from each other by means of a partition wall.

The ground continuity is achieved when the covers are in place by means of bolted connections. The cable terminals shall be suitable for 3C x 70 sq mm XLPE Cable with straight Cable Termination Protectors.

Terminals shall be suitable for heat shrinkable type cable termination with provision for earthing the armored three phase XLPE insulated cables.

Cable Test Facility (CTF) : Facilities for connecting probs for cable testing and cable fault locating shall be provided.

5.2.10 Earthing

- i) The copper earthing conductor shall be provided along the entire length of the panel. The cross-sectional area of earthing conductor shall be such that the current density shall not exceed 200 A/mm² under the specified earth fault conditions.
- iii) All metallic parts of the functional units intended to be earthed shall be bonded to the earthing conductor of the panel.

5.2.11 Auxiliary Circuits

- i) Control and auxiliary devices shall be segregated by earthed metallic partitions from the main circuit.

- ii) Terminal and other auxiliary apparatus requiring attention while the equipment is in service, shall be accessible without exposure to high voltage conductors.
- iii) Auxiliary switches and auxiliary circuits shall be capable of carrying a current of at least 10A at 24 V.d.c. continuously.
- iv) PVC insulated flexible copper wire 2.5 sqmm shall be used for control wiring. For the purpose of identification, the control wiring shall be provided with numbered tags to distinguish the different circuits, and shall be terminated using suitable terminations.

5.2.12 Interlocking

The following interlocks shall be provided:

- i) Any compartments shall be interlocked such that the breaker must be open and the incoming side disconnected/earthed before the compartment cover/door can be opened.
- ii) The cubicle door shall be interlocked with the circuit breaker to prevent opening of the door with the circuit breaker in the Service/ON position and prevent the insertion of a circuit breaker into the service position with the door open.
- iii) Earth switches shall be interlocked with their associated circuit breaker so that they cannot be closed unless the circuit breaker is open (or disconnected for withdrawable types). It shall be impossible to close a circuit breaker unless its associated earth switch is in the open position.
- iv) Mechanical interlocks to prevent simultaneous closure or opening of the couplers and electrical interlocks to ensure proper sequencing and coordination of operations
- v) A withdrawable circuit breaker shall be mechanically prevented from being inserted into the service position when the bus bar earth switch of the associated bus bar is closed.
- vi) In addition, any other interlocking arrangements deemed necessary for safety of operators and equipment shall be provided.

5.2.13 Construction of Panels

The panels shall be of free-standing type with bottom cable entry facility. The panel shall be manufactured using high quality electrogalvanized MS plates, treated and powder coated upto 80 micron or higher. The surface colour shall match the other existing panels in powerhouse.

The thickness of the metal sheets shall be at least 1.5 mm, and other plates shall be 1mm. The thickness of the main frame shall not be less than 2 mm.

The panels shall be dust and vermin proof type and cable entries shall be sealed using suitable filler material upon installation.

All cables and wiring shall be complete with all necessary terminal plates, cable glands for cable entry, trunkings of adequate size for small wiring and multi core cables.

All equipment, control, measuring and monitoring devices, relays, and meters shall be from reputable international brands acceptable to Employer. Drawings and technical specification must be provided with the bid documents.

The panel skid shall be suitable for mounting on foundation and necessary fixing bolts and rails shall also be provided.

Labeling shall be provided with each panel, and each circuit. Cabling from CTs shall terminate at the panel on isolating links of the shorting disconnecting type. Shorting Links shall also be provided.

External effects of internal arc shall be limited by a suitable design to prevent any danger to operator. Test evidence in accordance with relevant IEC to verify the design is required.

The design including dimensions shall be compatible with existing MVDBs used in the Islands. The contractor is required to prepare and submit suitable design accordingly. Drawings and technical specification must be submitted for approval of FENAKA during design stage.

5.2.14 Internal Arc protection characteristics

The panel shall be type tested for internal arc protection rating of **IAC A FLR; 25 kA/ 1s** as per IEC 62271-200.

5.3 Types of MV Switchgear Panels

5.3.1 MV Switchgear Incoming and Outgoing panels

The incoming and outgoing panels shall be provided with the following components / devices and any additional devices as required according to approved design to ensure full functionality.

- 1 No VCB, 3 Pole motorized with shunt trip-coil with current rating as specified for incoming, outgoing feeder
- 1 Set Busbar, rating, 1000A, Copper, Tin plated
- 1 Set Earth Switch
- 1 No Breaker ON/OFF control with push button, with indicating lights
- 3 Nos Analog Amp meter (0-800A) for R, Y, B
- 1 Lot Live busbar and cable indications
- 1 No Voltmeter c/w selector switch, Analog
- 1 No Digital multifunction power meter
- 1 No Digital Energy Meter, kWh & kVARh, class 0.5 s, import / export
- 1 No x Over current protection relay
- 1 No x earth fault protection relay
- 1 Lot Protection and metering CTs & PTs, sets of relays, fuses and sensors as per approved design
- 1 Lot control cables Cu/PVC 2.5 sqmm
- A schematic mimic representing the system being controlled
- .

5.3.2 MV Switchgear bus coupler Panels

The bus coupler panels complete with bus riser panel as required shall be provided with following components / devices and any additional devices as required according to approved design to ensure full functionality;

- 1 No VCB, 3 Pole motorized with shunt trip-coil with current rating as specified for bus coupler
- 1 Set Busbar, rating, 1000A, Copper, Tin plated
- 1 No Breaker ON/OFF control with push button, with indicating lights
- 1 Lot Live busbar indications
- 1 No x Over current protection relay
- 1 No x voltage protection relay
- 1 Lot Protection and metering CTs & PTs, sets of relays, fuses and sensors as per approved design
- 1 Lot control cables Cu/PVC 2.5 sqmm
- A schematic mimic representing the system being controlled

6.0 SCADA COMPATIBILITY

The supplier / contractor shall make all necessary provisions in design and manufacture of MVDB for interfacing and integrating switchgear panels with central SCADA system located in Male and hybrid Plant Control and Monitoring (PCMS) / Energy management System (EMS) system to be established in

respective Islands (by a third party), allowing for efficient data exchange, monitoring, and control as required.

The central SCADA system is already established to remotely monitor energy production and other parameters of islands power systems in real-time which already covers some of the Islands included in the scope of works.

The PCMS / EMS will be established in all Islands to provide interactive control and monitoring for PV power plants, the Battery Energy Storage Systems (BESS), diesel generators and auxiliaries in order to improve efficiency of diesel usage, maximize PV energy usage and to improve system stability of power distribution systems in respective Islands. PCMS / EMS shall communicate with and provide data to the SCADA system.

The PCMS / EMS communications protocol shall be Modbus TCP over an Ethernet network with a minimum data transfer rate of 100 Mbit/s.

The switchgear panels in MVDB to be supplied by the Contractor shall be fully SCADA enabled and following requirements shall be met.

1. The SCADA provision in MVDB switchgear panels shall include but not limited to measurement data and controls such as voltage, ampere, cos pi, frequency, energy, CB open / close, relay data and settings, warnings /alarms etc. This shall be in accordance with the data, monitoring and control requirements of the existing SCADA and PCMS / EMS systems described above and expected future upgrades. The Contractor during design stage is required to submit proposed input / output schedule for SCADA provision in the Panels including the details of devices / datapoints covered and signal type (SC/DC, SP/DP, DV) etc. for review and approval of Fenaka.
2. The required devices in switchgear panels including VCBs, Relays, Energy Meters, Controllers, auxiliary contracts etc shall be provided with communication interfaces for integration with SCADA / PCMS / EMS systems for provision of data exchange, monitoring, and control functionality.
3. All necessary equipment and material in communication circuits including auxiliary relays, cables, terminal blocks, test switches, isolation devices, auxiliary relays, wiring and labeling shall be provided.
4. Communication Protocol: shall be compatible with SCADA, PCMS/EMS systems described above.
5. Human-Machine Interface: The switchgear panels should have a human-machine interface (HMI) that can display data from the SCADA system and allow operators to manually control the panel as necessary.
7. Security: The switchgear panels should be equipped with appropriate security measures complying with ISO/IEC 27002 standard to prevent unauthorized access to the panel or the SCADA system.

7.0 OTHER REQUIREMENTS

7.1 Manufacturing Experience

The manufacturer shall have at least 05 years' experience in manufacturing and supply of offered type of MV switchgear panels and manufacturer shall furnish documentary evidence with the offer to prove his manufacturing experience.

7.2 Tools

All special tools and accessories required for installation, operation and maintenance of equipment (including handheld programming units where applicable) shall be clearly indicated in the offer and shall be supplied with the panels.

7.3 Spares

Mandatory Spare parts : The Contractor is required to supply mandatory spare parts and tools for 5 year trouble-free operation of the MVDB. This should include all necessary spare parts required for VCBs, primary and secondary circuits, indications etc. that may need to be replaced during 5 year operation under normal operating conditions and specified service conditions, as per manufacturer recommendations. The bidder is required to submit a list of spare parts that would be supplied accordingly for each MVDB in respective Islands, in the technical proposal.

Recommended Spare Parts : In addition to mandatory spare parts the bidder is required to provide list of recommended spare parts for 10 year trouble free operation of MVDB under normal operating conditions and specified service conditions, in Schedule No 6 (Section 4). Bidders are responsible for ensuring the availability of spare parts listed for a minimum 10 year period. Bidders shall note that the price of recommended spare parts quoted in this Schedule will not be added to Bid Price and not considered in price evaluation.

7.4 Name Plates

Name Plates shall include the following information:-

- a) Manufacturer's name and trademark.
- b) Serial number or type designation.
- c) Applicable rated values.
- d) Number and year of the relevant standard.
- e) Country and year of manufacture
- f) Project Name
- g) Property of FENAKA

The name of each functional unit and mimic diagram shall be provided and legible during normal service. The removable parts, if any, shall have a separate name plate with the data relating to the functional unit they belong to, but this name plate need only be legible when removable part is in the removed position.

7.5 Labeling

All equipment, control positions, indicator positions, control/indicator identification, terminals, small wiring of instrumentation and protection of the panel shall be identifiable by clear markings and labeling in English Language with relevant colour code, if any. The labels shall be made out of durable materials and prints permanently edged.

7.6 Packing

All equipment shall be suitably packed for transportation and installation strictly according to the manufacturer's recommendations. Packing shall be suitable for transportation under restricted volumes and rough conditions for local transportation between Male and respective Islands. Bidder may note that heavy duty lifting facilities may not be available in some Islands.

8.0 TESTS

8.1 Type Tests

Panels should be type tested in accordance with IEC62271-200.

Certified copies of the type test carried out accordingly as indicated below shall be furnished with the offer.

- Lightning Impulse Voltage Tests.
- Power Frequency Tests.
- Partial Discharge Tests
- Dielectric Test on Auxiliary and Control circuits
- Temperature-rise tests
- Measurement of resistance of the main circuit.
- Tests on main circuits.
- Tests on main earthing circuits.
- Mechanical operation tests;
 - (a) Interlocks.
 - (b) Switching device and removable parts.
- Verification of degree of protection.
- Measurement of leakage currents.
- Weatherproofing test
- Arcing due to internal faults in all HV Compartments.
- Short time and peak withstand current
- Verification of making and breaking capacities.

In addition to the above, Vacuum Circuit Breakers, Earth Switches, Instrument Transformers and Protection relays should be type tested according to applicable standards and relevant type test reports shall be furnished.

8.2 Routine Tests

Routine tests shall be carried out in accordance with IEC 62271-200. These tests shall be done to ensure the reliability of the unit.

Below listed test shall be performed as routine tests before the delivery of units;

- Power-frequency voltage tests on the main circuit
- Dielectric tests on auxiliary and control circuits
- Measurement of the resistance of the main circuit
- Partial discharge measurement
- Mechanical operation tests
- Tests of auxiliary electrical, pneumatic and hydraulic devices
- Verification of correct wiring

8.3 Sample/Acceptance tests

The following Sample/Acceptance tests as per applicable standards shall be carried out and witnessed by the inspection Engineer. Extra copies of these test certificates shall also be furnished with the equipment, prior to dispatch.

- Power frequency voltage test on main circuit.
- Dielectric test on auxiliary and control circuits.
- Measurement of the resistance of the main circuit.
- Partial discharge measurement.
- Mechanical operation tests.
- Tests on electrical devices.
- Verification of correct wiring

- All routine tests as per IEC 62271-100 for circuit breakers
- Functional tests as specified

9.0 INSPECTION AND TESTING

The selected Bidder shall make necessary arrangements for inspection by the Employer or his representative inspection of goods prior to dispatch and to carry out in his presence sample / acceptance tests.

The report of routine tests performed on each equipment shall be made available for the observation of the inspector and subsequently furnished with the equipment.

10.0 QUALITY ASSURANCE

The manufacturer shall possess valid ISO 9001 Quality Assurance Certification for the process of design and manufacturer of MV Metal Enclosed Switchgear Panels for the plant where the offered Switchgear panels are manufactured. The Bidder shall furnish a copy of the ISO Certificate certified as true copy of the original by the Manufacturer, along with the offer.

11.0 WARRANTY

The Bidder shall warrant that all equipment supplied shall have no defect arising from design, materials or workmanship or from any act or omission of the supplier that may develop under normal use of the supplied equipment.

This Warranty shall remain valid for 3 years.

12.0 TRAINING

The Supplier shall provide comprehensive training on the design, installation, operation and maintenance of the 11 kV Switchgear Panels (MVDB) to FENAKA staffs in each Island. Training should include both theoretical and hands-on on the job training. Training should be provided for up to 10 Nos FEANKA staffs in each Island.

13.0 INFORMATION TO BE SUPPLIED BY THE BIDDER

The following information shall be submitted along with the bid.

- Technical literature including technical data and drawings for panels.
- Technical literature including technical characteristics of breakers, earth switches, busbars, instrument transformers, relays, etc.
- Mechanical characteristics of panels and equipment including overall dimensions, weight, constructional features, interlocks, access covers and doors.
- Type test certificates
- List of mandatory Spare parts and tools for 5 year trouble-free operation as per Manufacturer's recommendation that will be supplied.
- List of recommended spare parts for 10-year trouble free operation.
- Manufacturers ISO 9001 Certifications
- Completed schedule of guaranteed technical particulars
- Manufacturer experience records
- Training Plan

All drawings provided by the Supplier shall be annotated in English. All drawing symbols shall be standardized according to IEC 60617, (Graphical Symbols for Diagrams), and be consistently used.

14.0 OPERATIONS MANUAL, TECHNICAL LITERATURE AND DRAWINGS

Upon completion of installation and commissioning, the Supplier shall provide a comprehensive Operation and Maintenance manual written in English and shall be graphically illustrated for unambiguous interpretation and understanding by maintenance staff.

Five copies of operational/maintenance manuals shall be provided for each type of panel.

The O&M manual shall include the specific details on installation, operation and maintenance such as;

- A detailed technical description of the system.
- A complete list of all system components, with associated manufacturers literature, specifications, and warranties.
- A recommended annual maintenance schedule, with complete maintenance instructions.
- A detailed troubleshooting guides referencing all the system components. This shall include repairs and diagnostic procedures that can be done by the supplier or a qualified third party.
- Emergency shutdown procedures.

15.0 SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS

Schedule of Guaranteed Technical Particulars should be filled and submitted by the Bidder.

16.0 SCHEDULE OF DEVIATIONS

Any non-compliances of the offered item in respect of the technical requirements provided in this specification shall be provided using Schedule of Deviations form provided in Section 4 of the bid documents. This form should be provided for each key items of the specification, indicating any deviations or 'no deviations' as applicable.

**SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS
MEDIUM VOLTAGE SWITCHGER PANEL (MVDB)**

(This schedule shall be duly filled by the Bidder)

#	Particulars	Unit	offed
1.0	MV SWITCHGEAR PANELS		
1.1	Name & Address of Manufacturer	-	
1.2	Country of Origin	-	
1.3	Model / catalogue number	-	
1.4	Applicable Standard/s		
1.5	Rated operating voltage	kV	
1.6	Rated Highest System Voltage	kV	
1.7	Rated frequency	Hz	
1.8	Number of phases	-	
1.9	Rated current for main busbar	A	
1.10	Rated Impulse withstand voltage	kV _{pk}	
1.11	Rated power frequency withstand voltage	kV	
1.12	Rated short-time current	kA/s	
1.12	Internal Arc Classification (As per IEC 62271-200)	-	
1.13	Internal Separation	-	
1.14	Degree of Ingress Protection (IP)	-	
1.15	Degree of pollution Category	-	
1.16	Earthing as per specifications (yes/no)	-	
1.17	SCADA provision (yes/no)	-	
1.18	Temperature rise (As per IEC 62271-200)	°C	
1.19	Particulars of Interlocking provided	-	
1.20	Panel Construction		
1.20.1	Material	-	
1.20.2	Thickness	mm	
1.20.3	Surace Treatment	-	
1.20.4	Panel dimensions	mm	
1.21	Other Particulars	-	
1.22	Manufacturing Experience	Yrs	
2.0	Vacuum Circuit Breakers (VCB)		
2.1	Make / Model	-	
	Country of origin	-	
2.2	Applicable standard/s	-	
2.3	Number of poles	-	
2.4	Rated current ratings of offered models	A	
2.5	Rated operating voltage	kV	
2.6	Rated Impulse withstand voltage (peak)	kV	
2.7	Rated power frequency withstand voltage	kV	
2.6	Rated frequency	Hz	
2.7	Rated short circuit breaking current (rms)	kA	
2.8	Rated short circuit making current (pk)	kA	
2.9	Rated shot time withstand current / duration	kA/s	
2.10	Opening time	ms	
2.11	Closing time	ms	

#	Particulars	Unit	offed
2.12	Method of closing	-	
2.13	Method of tripping	-	
2.14	CB is trip free type (Y/N)	-	
2.15	Motorized operating mechanism (Y/N)		
2.16	Type (draw out)	-	
2.17	i) Mechanical life (No. of operations)	-	
	ii) Electrical life (No. of operations)	-	
2.18	Other Particulars	-	
3.0	Earthing Switches		
3.1	Make / Model	-	
	Country of origin	-	
3.2	Applicable standard/s	-	
3.3	Rated current	A	
3.4	Rated making current	kA	
3.5	Other Particulars	-	
4.0	Busbars		
4.1	Make / Model	-	
	Country of origin	-	
4.2	Applicable standard/s	-	
4.3	Material	-	
4.4	Cross Sectional Area / Dimensions	mm ²	
4.5	Clearance between busbars	mm	
4.6	Continuous current carrying capacity	A	
4.7	Maximum Temperature rise at rated current	°C	
4.8	Mounting Arrangements		
5.0	Protection Relays		
5.1	Make / Models	-	
	Country of origin	-	
5.2	Applicable standard/s	-	
5.3	Type (Numerical/ Static)	-	
5.4	Self-powered (yes / no)	-	
5.5	Type : Programable (yes / no)	-	
5.6	Handheld programming unit provided for each Island (yes / no)	-	
5.7	SCADA provision (yes/no)		
6.0	Current Transformers		
6.1	Make & Models	-	
	Country of origin	-	
6.2	Applicable standard/s	-	
6.3	Rated voltage	kV	
6.4	Rated frequency	Hz	
6.5	Rated short time rating /duration	kA /s	
6.6	Accuracy class (measuring/metering/protection)	-	
6.7	Accuracy limit factor	-	
6.8	Burden (measuring/metering/protection)	VA	
6.9	CT Ratios (measuring/metering/protection)	-	
7.0	Voltage Transformers		
7.1	Make & Models	-	

#	Particulars	Unit	offed
	Country of origin	-	
7.2	Applicable standard/s	-	
7.3	Rated voltage	kV	
7.4	Rated frequency	Hz	
7.5	Rated Insulation Level		
7.5.1	Rated Impulse withstand voltage	kV _{pk}	
7.5.2	Rated power frequency withstand voltage	kV	
7.6	Accuracy Class (measurement./metering)	-	
7.7	V.T. Ratios	-	
7.8	Rated voltage factor	-	
7.9	Burden	VA	
8.0	Energy metering instruments		
8.1	Make / Model	-	
	Country of origin	-	
8.2	Type	-	
8.3	Applicable standard/s	-	
8.4	Accuracy Class	-	
8.5	Calibration certificate provided ? (Y/N)		
8.6	Programmable type ? (Y/N)		
8.7	programming software provided ? (Y/N)		
8.8	hand held programming unit provided for each Island ? (Y/N)		
9.0	List of Mandatory Spare parts for each MVDB provided in technical proposal ? (yes / no)	-	
10.0	Mandatory spare parts will be supplied accordingly ? (yes / no)	-	
10.0	Manufacturer's Quality Assurance Certifications provided (Yes / No)	-	
11.0	Training will be provided as per specification / training plan ? (yes / No)	-	
12.0	Confirmed period of technical support to be provided upon completion	Yrs	
13.0	Completed GTPs submitted ? (Yes / No)	-	
14.0	Schedule of Deviations from specifications Submitted ? (Yes / No)	-	
15.0	Warranty Period	Yrs	

We certify that the above data are true and correct.

SEAL AND SIGNATURE OF THE BIDDER/ Date