ANNEX C_2 - GOVERNMENT'S MASTER SPECIFICATIONS AMENDED
(Note: all sheets form part of the proponent proposal)

Each Proponent shall submit a data sheet containing detailed technical specifications of all the Solar PV System (SPV), type test reports and operation & maintenance manuals.

#	Component	Description
1.	Solar PV Modules/Panels	1.1 Individual Solar PV Module should have a minimum declared output of 400 Wp (under standard test conditions) for monocrystalline SPV modules. 1.2 PV modules must comply with the latest IEC type tests (see list of IEC type tests below). 1.3 PV modules shall be warranted for at least 10 years for failures due to material defects ~~and workmanship~~. 1.4 Workmanship shall be warranted for at least 1 year. 1.5 PV modules must be warranted for output wattage, which should not be less than 90% at the end of the 10 years and 80% at the end of 25 years. 1.6 PV modules maximum power loss at the end of the first year of operation should not be more than 2% of the power at the start of the solar power plant. 1.7 PV modules should have a linear degradation of power not more than 0.7% per year till the 25th year. 1.8 The front surface of the module shall consist of impact resistant, low iron and high transmission toughened glass. 1.9 PV module frame shall be made of corrosion resistant material, which shall be electrically compatible with the structure material selected for the power plant.
2.	Inverter/ Power Conditioning Units	**The proposed inverter shall be of ~~hybrid~~ standard type and have:** 2.1 a warranty for failures due to material defects for at least 10 years 2.2 a workmanship warranty for at least 1 year. 2.3 sinusoidal current modulation with excellent dynamic response. 2.4 compact and weatherproof housing (indoor/ outdoor) 2.5 comprehensive network management functions (including the LVRT and capability to inject reactive power to the grid) 2.6 total harmonic distortion (THD) < 3% 2.7 load loss < 1% of rated power and maximum loss in sleep mode shall be less than 0.05% 2.8 optional VAR controls 2.9 a power factor control range: 0.9 (lead – lag) 2.10 humidity: 95% non – condensing 2.11 unit wise & integrated data logging 2.12 dedicated prefabs / ethernet for networking 2.13 protection against over current, sync loss, over temperature, DC bus over voltage, cooling fan failure, short circuit, lightning, earth fault, surge voltage induced at output due to external source, 2.14 power regulation in the event of thermal overloading. 2.15 set point pre-selection for VAR control 2.16 bus communication via -interface for integration 2.17 remote control via telephone modem or mini web server 2.18 integrated protection in the DC and three phase system 2.19 insulation monitoring of the PV array with sequential fault location 2.20 meet the latest IEC type tests (see list of IEC type tests below). 2.21 an efficiency of more than 98% at full load. 2.22 high overload capacity specified in the proposal. 2.23 an output power factor of a suitable range to supply or sink reactive power. 2.24 internal protection arrangement against sustained fault in the feeder line. 2.25 the dimension, weight, foundation details etc. clearly indicated in the detailed technical specification.

		2.26 both AC and DC lines with suitable fuses and contactors to allow safe start up and shut down of the system. Fuses used in DC circuit shall be DC rated. 2.27 provision for input & output isolation. 2.28 display(s) (LCD or equivalent) to monitor the following DC power input. DC input voltage. DC current AC output power AC voltage & AC Current (all phases) 2.29 the feature to work in tandem with other similar PV Inverter's and be able to be successively switched "ON" and "OFF" automatically based on solar radiation variations during the day. 2.30 operate in synergy and intelligently to optimize maximum generation at all times with minimum losses. ~~2.31 have a facility to change the priority of power from either solar/battery/grid to grid/solar/battery.~~ 2.32 be capable of controlling power factor dynamically. 2.33 have sleep mode. 2.34 shall have provisions/features to allow interfacing with monitoring software and hardware devices. 2.35 use static solid-state components. 2.36 Basic System Operation (Full Auto Mode): The control system shall: 2.37 continuously monitor the output of the solar power plant until pre-set value is exceeded & that value to be indicated. 2.38 continuously monitor the output of the solar power plant until pre-set value is exceeded & that value to be indicated. 2.39 automatically re-enter standby mode when threshold of standby mode reached. 2.40 Protection against faults for PV Inverter shall: 2.41 include appropriate self-protective and self-diagnostic feature to protect itself and the PV array from damage in the event of PV Inverter component failure or from parameters beyond the PV Inverter's safe operating range due to internal or external causes. 2.42 a self-protective feature that do not allow signals from the PV Inverter front panel to cause the PV inverter to be operated in a manner which may be unsafe or damaging. 2.43 be capable of clearing faults due to malfunctioning within the PV Inverter, including commutation failure of protective devices. 2.44 have arrangement for adjusting DC input current and should trip against sustainable fault downstream and shall not start till the fault is rectified. 2.45 In addition, it shall have the following minimum protection against various possible faults. 2.46 Grounding Leakage Faults: The PV Inverter shall have the required protection arrangements against grounding leakage faults. 2.47 Over Voltage & Current: In addition, over voltage protection shall be provided between positive and negative conductor and earth ground such as Surge Protection Devices (SPD). 2.48 Galvanic Isolation: The PV Inverter shall have provision for galvanic isolation with external transformer, if required. 2.49 Anti-islanding (Protection against Islanding of grid): The PV Inverter shall have anti islanding protection. (IEEE 1547/UL 1741/ equivalent BIS standard) 2.50 Unequal Phases: The system shall tend to balance unequal phase voltage (with 3-phase systems). 2.51 Reactive Power: The output power factor of the PV Inverter should be of suitable range to supply or sink reactive power. The PV Inverter shall have internal protection arrangement against any sustained fault in the feeder line and against lightning in the feeder line. 2.52 Isolation: The PV Inverter shall have provision for input & output isolation. Each solid-state electronic device shall have to be protected to ensure long life as well as smooth functioning of the PV Inverter.
3.	Mounting Structure/ Frame	**All PV hardware, rack components and mountings/fixings shall:** 3.1 be high grade stainless steel, aluminum, hot-dipped galvanized steel. 3.2 be corrosion-proof and able to resist at least 25 years of outdoor exposure in the Bermuda environment without suffering significant damage or corrosion. 3.3 be of galvanization thickness should adhere to ASTM 123. 3.4 be designed to be fixed on the roof of the building.

		3.5 have the ability to support solar PV modules at a given orientation, absorb and transfer the mechanical loads to the ground properly. 3.6 be capable of withstanding a wind load of 180 MPH 3.7 have a top module mounting structure designed with a safety factor of not less than 1.5. The design calculation shall be submitted to Government. 3.8 design drawings with the material selected shall be submitted for approval of Government. 3.9 be designed to allow easy replacement of any modules and easy access to the O&M staff and personal and protection. 3.10 be designed for appropriate mechanical and electrical installation.
4.	Installation Materials	**As required following NS/ IS standard** 4.1 The solar PV plant structure shall be grounded properly using adequate number of earthing kits. 4.2 All metal casing of the system shall be thoroughly grounded to ensure safety of the Solar PV system. 4.3 The Solar PV system shall be provided with lighting and over voltage protection. 4.4 The main aim in this protection shall be to reduce the over voltage to a tolerable value before it reaches the system. 4.5 Fuses should be provided to protect against short circuit conditions. 4.6 Full protection against open circuit, accidental short circuit & reverse polarity should be provided. 4.7 The earth resistance value should be less than 5
5.	Cables and Conduits	Proponents shall provide the type test report for each type of cable used before dispatch of the cable. All cables, wired and connectors for use for installation of solar field must: 5.1 be of solar grade which can withstand harsh environment conditions including high temperatures, UV radiation, rain, humidity, dirt, salt, burial and attack by moss and microbes for 25 years and voltages as per latest IEC standards. 5.2 be solar grade multi stranded copper (Cu) with XLPE or XLPO insulation, sheathed and have a voltage rating of 1000 V DC or higher for the runs from solar modules to array junction box and from array junction box to inverter as per the relevant standard. 5.3 use copper conductor wires compliant with IEC 60228, Class 5 of reputed make 5.4 be provided with UV resistant printed ferrules for DC side however, for HT cables, punched/ embossed aluminium tags are required. The marking on tags shall be done with good quality letter and number ferrules of proper sizes so that the cables can be identified easily. 5.5 comply with the TUV 2PfG 1169/09.07 for service life expectancy of 25 years. 5.6 be of appropriate size to be used in the system. 5.7 shall be provided with DC fuse protection. 5.8 meet IEC 60227/IS 694, IEC 60502/IS1554 standards temp. range up to 85°C. 5.9 not exceed 1.0% total voltage drop on the cable segments from the solar PV modules to the solar grid inverter. 5.10 not exceed 2.0% total voltage drop on the cable segments from the solar grid inverter to the building distribution board. 5.11 have cables and wires used for the interconnection of solar PV modules shall be provided with solar PV connectors (MC4) and couplers. 5.12 have all cables and conduit pipes clamped to the rooftop, walls and ceilings with thermo-plastic clamps. **Insulation: Outer sheath of cables shall:** 5.13 have a UV-stabilised outer sheath for Outdoor AC cables. 5.14 be electron beam cross-linked XLPO type. 5.15 have cable drum no. / Batch no. to be embossed/ printed at every one meter. 5.16 have cable jacket of electron beam cross-linked XLPO, flame retardant and UV resistant. **Cable joints and terminations shall:** 5.17 be terminal cable joints only. 5.18 have no more than two cable joints to join cable ends.

		5.19 have joint kits of repute make and to be installed by the certified cable jointer. 5.20 be made with suitable cable lugs & sockets etc., 5.21 be crimped properly and passed through brass compression type cable glands at the entry & exit point of the cubicles.
6.	Combiner/ Junction Boxes	**DC combiner/junction boxes shall:** 6.1 be used to combine the DC cables of the solar module arrays with DC fuse protection for the outgoing DC cable(s) to the DC Distribution Box. 6.2 shall be dust and vermin free and waterproof and made of thermoplastic in compliance with IEC 62208. 6.3 be sunlight/ UV resistive as well as fire retardant & must have minimum protection to IP 65(Outdoor)/ IP 20(indoor) and Protection Class II. 6.4 have a cable entry point fitted with cable glands of appropriate sizes for both incoming and outgoing cables. 6.5 provide independent charging sub-arrays that will be wired to the controller 6.6 have suitable reverse blocking diodes of maximum DC blocking voltage with suitable arrangement for its connection. 6.7 have a suitable surge protection. 6.8 have suitable arrangements for the following. 6.9 have disconnection for each of the groups. 6.10 have test points for each sub-group for quick fault location. 6.11 have group array isolation. 6.12 have current carrying rating suitable with adequate safety factor to interconnect the solar PV array. 6.13 be equipped with appropriate functionality, safety (including fuses, grounding, etc.) and protection. 6.14 have sufficient number of switchboards (DCDB & ACDB). 6.15 have panels/ boxes with suitable cable entry points fitted with cable glands of appropriate sizes for both incoming and outgoing cables. 6.16 have adequate rating fuses & isolating RCD/RCCD/ ELCB. 6.17 provide arrangement for disconnection. 6.18 provide a test point for quick fault location to provide isolation. 6.19 have ratings suitable with adequate safety factor to interconnect to the local/ internal grid. 6.20 have thermal/ heat dissipation arrangement/ vent for safe operation. 6.21 have adequate number of spare terminals 6.22 be provided with adequately rated busbar, incoming control, outgoing control etc. as a separate compartment inside the panel to meet the requirements. 6.23 have all the panels to be designed with sufficient space for working. 6.24 have temperature suitability up to 85°C. 6.25 have separate cable and bus bar alley. **The terminals shall:** 6.26 have terminals of proper size connected to copper bus-bar arrangement. 6.27 have all live terminals and bus bars shrouded. 6.28 have outgoing terminals suitable to receive suitable runs and size of cables required for the Inverter/transformer rating. 6.29 have suitable markings on the bus bars for easy identification and cable ferrules will be fitted at the cable termination points for identification. 6.30 be compatible with MC-4 connectors.
7.	System Voltage	7.1 Installing company can design the system voltage as per requirement and technical correctness. 7.2 The system voltage should be compatible to solar PV module and Inverter~~, and Charge Controller~~
8.	Wiring Restructuring	8.1 The existing wiring to be checked and ensure that circuit for outlets are separated. 8.2 The Wiring for modules interconnection shall be of with hard PVC conduit of approved make. 8.3 Cables inside the control room shall be laid in suitable cable trays of approved make.

		8.4 All the wires used on the LT side shall conform to IEC standards and should be of appropriate voltage grade. Only Copper conductor wires of reputed make should be used for connection in the LT side. 8.5 Cables and wires should be marked with good quality letters and number ferrules for proper identification.
9.	Grounding, Earthing and Lightning Protections	The entire space occupying the SPV array shall be provided with all necessary protections as per IEC 62305 /IS 2309 standard like grounding, earthing, and lightning protection systems for lightning, atmosphere disturbances, etc. as following: **Lightning Protection.** The SPV power plants shall: 9.1 have earth resistance of not more than 5 ohms. 9.2 have all earthing points are bonded together to make them at the same potential. 9.3 be provided with lightning & overvoltage protection aimed to reduce the over voltage to a tolerable value before it reaches the PV or other sub system components as required by the standards. 9.4 deploy the required number of Lightning Arrestors. 9.5 have protection against induced high-voltages and shall be provided by the use of metal oxide varistors (MOVs) and suitable earthing such that induced transients find an alternate route to earth. 9.6 have ESE type lightening arresters, placed at strategic locations to protect the plant from lightening and shall not cause any shadow on the solar modules. 9.7 have necessary foundation / anchoring for holding the lightning conductor in position to be made after giving due consideration to shadow on PV array, maximum wind speed and maintenance requirement at site in future. 9.8 have the lightning conductor earthed through flats and connected to the grounding mats as per applicable International Standards with earth pits. 9.9 have earth pits for each lightning arrestor including accessories, and enclosure 9.10 have surge protection shall be provided on both the DC and the AC side of the solar system. 9.11 have each array structure of the PV system grounded/ earthed properly.
10	Other Considerations/ Requirements	10.1 The location of the water faucets is to be provided for periodic cleaning/washing of the solar PV modules and the same shall be indicated in the drawings 10.2 Nuts and bolts including metallic cubicle shall have to be adequately protected taking into consideration atmosphere and weather prevailing in the area. 10.3 Each solid-state electronic device shall have to be protected to ensure long life of the inverter as well as smooth functioning of the inverter. 10.4 The contractor/manufacturer shall specify installation details of the solar PV modules and the support structures with appropriate drawings. 10.5 The drawings along with the detailed design shall be submitted to Government for approval before starting the erection work. The work will be carried out as per designs approved by Government. 10.6 The minimum clearance between the lower edge of the PV panel and the ground level shall be 800mm. While making foundation design consideration should be given to the weight of the solar modules and a maximum wind speed of 90 KMPH. Seismic factors for the site to be considered while making the design of the foundation. The design of the array structure shall be approved by Government. 10.7 Foundation drawings and design should be submitted to Government for approval before staring the work. 10.8 Nuts and bolts, supporting structures including the roof top module mounting structures shall have to be adequately protected with anti-corrosive paints of sufficient thickness. 10.9 Circuits for heavy high consumption electrical appliance such boiler, air conditioners must be separated. 10.10 Load segregation of the building will be the responsibility of the contractor. 10.11 DC lines shall have suitably rated isolators to allow safe start up and shut down of the system. 10.12 Fuses & Circuit breakers used in the DC lines must be rated suitably. 10.13 Fuses shall have DIN rail mountable fuse holders and shall be housed in thermoplastic IP 65 enclosures with transparent covers.

Certificate: The main equipment supplied for the project should be submitted the latest IEC Type Test certificate during implementation to the project manager for review and approval.

The following standards and compliances shall apply:

1. Efficiency measurement: IEC 61683
2. Environmental testing: IEC 60068-2 or IEC 62093
3. EMC, harmonics, etc.: IEC 61000 series, 6-2, 6-4 and other relevant Standards.
4. Electrical safety: IEC 62109 (1&2), EN 50178 or equivalent
5. Utility interconnections: IEEE standard 929 – 2000 or equivalent
6. Protection against islanding of grid: IEEE1547/ UL1741/ IEC 62116 or equivalent
7. Grid connectivity: Relevant regulation and grid code
8. Reliability test standard: IEC 62093 or equivalent
9. Temperature: IEC 60227/IS 694, IEC 60502/IS1554 standards temp. range
10. Conductors of insulated cables: IEC 60228
11. Switchgear and control gear components: IEC 62208
12. Lightning protection: IEC 62305 /IS 2309/NFC 17–102.