

TENDER DOCUMENTS
FOR
JAPAN'S GRANT AID FOR
The Project of Construction of New PV Solar Power System in
Jericho Agro Industrial Park, in Palestine
FY 2018

BY
United Nations Development Programme(UNDP)

TENDER REFERENCE No :

June, 2018

Rev.2

Table of contents

PART I	INSTRUCTIONS TO TENDERERS
PART II	DETAILS OF TENDER CONDITIONS
PART III	TENDER REQUIREMENTS
PART IV	FORM OF CONTRACT
PART V	CONDITIONS OF CONTRACT
PART VI	GENERAL SPECIFICATIONS
PART VII	TECHNICAL SPECIFICATIONS
PART VIII	DRAWINGS
PART IX	IMPLEMENTATION SCHEDULE
PART X	FORM OF TENDER

VII TECHNICAL SPECIFICATIONS

Table of contents

• Table of Contents.....	P-3~8
• List of Figures & Tables.....	P-8
List of Figures	
List of Tables	
• Abbreviation.....	P9~10

I . EQUIPMENT WORKS

CHAPTER 1 GENERL.....	P-12
Section 1 General.....	P-13
Section 2 Applicable standards / Codes.....	P-13
Section 3 Scope of Work.....	P-13
3-1 The Scope of Work	
3-2 Schedule of System equipment	
3-2-1 PV System	
3-3 Design Conditions	
3-3-1 Meteorological conditions	
3-4 Defeat Liability	
Section 4 Electrical requirement.....	P-14
4-1 Electrical requirement	
CHAPTER 2 SYSTEM REQUIREMENT.....	P-14
Section 1 System operational requirement.....	P-14
Section 2 Management and Monitoring data of PV system.....	P-14
2-1 Signal transmitter	
2-2 Data collection item	
2-3 Apparatus	
Section 3 Measurement period, operation interval, data storage period.....	P-15
CHAPTER 3 EQUIPMENT SPECIFICATION.....	P-16
Section 1 PV System.....	P-16
Section 2 Power Conditioner(Inverter).....	P-16
2-1 Type	
2-2 Specification	
Section 3 Connection Box and Collection Box.....	P-16

3-1 Type	
Section 4 Other Equipment.....	P-17
4-1 Testing Equipment	
4-1-1 Insulation tester	
4-1-2 Digital circuit tester	
4-1-3 Clamp meter	
4-2 Maintenance Equipment	
CHAPTER 4 INSPECTION.....	P-19
Section 1 Quality Inspection by the Consultant.....	P-19
1-1 Factory Inspection	
1-2 Collection Inspection prior to shipment	
1-3 Internal Inspection	
1-4 Acceptance test and handover	
Section 2 Inspection for Electrical Performance of PV Modules.....	P-19
Section 3 Acceptance test and Handover.....	P-20
CHAPTER 5 SPARE PARTS and CONSUMABLES PLAN.....	P-20
Section 1 Quality Inspection by the Consultant.....	P-20
II ELECTRICAL and MECHANICAL WORKS.....	P-21
CHAPTER 1 GENERAL REQUIREMENTS.....	P-22
Section 1 General.....	P-22
Section 2 Scope of Work	
Section 3 Related Works Specified under Other Specifications	
Section 4 Submittals	
Section 5 Quality Control.....	P-24
Section 6 Standards	
Section 7 Guarantee.....	P-25
Section 8 Handling and Storage	
Section 9 Spare Parts and Consumables	
CHAPTER 2 PRODUCTS.....	P-26
Section 1 General.....	P-26
1-1 Materials and equipment	
1-2 Standard Products	

- 1-3 The capacity of Equipment
- 1-4 Independent testing
- 1-5 Formal Certificate

CHAPTER 3 EXECUTION.....P-26

Section 1 Workmanship.....	P-26
Section 2 Painting.....	P-27
Section 3 Setting of Equipment	
Section 4 Test and Inspections	
Section 5 Opening.....	P-28
Section 6 Cutting and Patching	
Section 7 Miscellaneous Iron and Steel	
Section 8 Welding	
Section 9 Anchorage.....	P-29
Section10 Cleaning and Protection	
Section 11 Underground Piping Protection.....	P-30
Section 12 Underground wiring and Protection	
Section 13 Hangers and Supports	
Section 14 Wiring and elementary Diagrams	
Section 15 Designation of Equipment.....	P-31

CHAPTER 4 CONSTRUCTIONS.....P-31

Section 1 Conductors (Wire and Cable).....	P-31
1-1 General requirements	
1-1-1 Scope of works	
1-1-2 Applicable Standards	
1-1-3 Submittals	
1-2 Products	
1-2-1 Conductors	
1-3 Execution	
1-3-1 Color Coding	
1-3-2 Accessories	
1-3-3 Wiring	
1-4 Tests	
1-5 Performance test	
Section 2 Raceways (Conduits).....	P-32

2-1 General Requirements	
2-1-1 Scope of work	
2-2 Products	
2-3 Fitting and Accessories	
2-4 Boxes	
2-5 Execution	
2-6 Tests	
Section 3 Wiring Devices.....	P-34
3-1 General Requirements	
3-1-1 Scope of Work	
3-1-2 Products	
3-1-3 Execution	
Section 4 Panel-Board and Cabinet.....	P-35
4-1 General Requirement	
4-1-1 Scope of Work	
4-1-2 Products	
Section 5 Earthing (Grounding).....	P-37
5-1 General Requirements	
5-1-1 Scope of Work	
5-1-2 Products	
5-1-3 Execution	
Section 6 Lightning Protection.....	P-38
7-1 General Requirements	
7-1-1 Scope of Work	
7-1-2 Products	
7-1-3 Execution	
Section 7 Spare Parts and Consumables.....	P-38
8-1 General Requirements	
8-1-1 Scope of Work	
8-1-2 Products	
CHAPTER 5 INSTALLATION SPECIFICATION OF EACH CASE.....	P-39
Section 1 Rooftop of the 12 UNDP Hangers case.....	P-39
1-1 Installation place, a condition,	
1-2 Method of Installation	
1-3 Installation Quantity	

1-4 Installation apparatuses	
1-5 Incidental work.	
1-6 Maximum generation output	
1-7 Expected annual Generation Power	
1-8 Grid Connection point	
Section 2 Expansion Area in Existing PV Station.....	P-40
2-1 Installation place, a condition,	
2-2 Method of Installation	
2-3 Installation Quantity	
2-4 Installation apparatuses	
2-5 Incidental work.	
2-6 Maximum generation output	
2-7 Expected annual Generation Power	
2-8 Grid Connection point	
Section 3 Rooftop of the 8 and 4 Hangers case.....	P-41
3-1 Installation place, a condition,	
3-2 Method of Installation	
3-3 Installation Quantity	
3-4 Installation apparatuses	
3-5 Incidental work.	
3-6 Maximum generation output	
3-7 Expected annual Generation Power	
3-8 Grid Connection point	
CHAPTER 7 THE MANAGEMENT PROCEDURES AFTER THIS PROJECT....	P-42
Section-1 Operation Works.....	P-42
Section-2 Maintenance Works.....	P-43
Section-3 Inspection Works.....	P-43
 List of Table	
Table 1 Schedule of major equipment for PV System.....	P-17,18
Table 2 Items to be inspection for handover.....	P-20

Abbreviations

略語 : Abbreviation	英語名 : English Term	和訳 : Japanese Term
AC	Alternate Current	交流
ASTM	American Society for testing and Materials	アメリカ材料試験協会
BS	British Standard	英国工業規格
CCTV	Closed Circuit Television	監視カメラ
CO2	Carbon Dioxide	二酸化炭素
CSP	Concentrated Solar Power	太陽熱発電
DC	Direct Current	直流
EIA	Environmental Impact Assessment	環境影響評価
FIT	Feed-in Tariffs	固定価格買取制度
F/S	Feasibility Study	予備調査
GDP	Gross Domestic Product	国内総生産
GHG	Green House Gas	温室効果ガス
GoJ	Government of Japan	日本国政府
IEC	Israel Electric Corporation Limited	イスラエル電力公社
IEC Standard	International Electro Technical Commission Standard	国際電気標準規格
JAIP	Jericho Agro-Industrial Park	ジェリコ農産加工団地
JASS	Japanese Architectural Standard Specification	日本建築学会建築工事標準仕様書
JCS	Japanese Cable Maker's Association Standard	日本電線工業会規格
JDECO	Jerusalem District Electricity Company	エルサレム地区電力会社
JEAC	Japan Electric Association Code	電気技術規定
JEC	Japanese Electro-technical Committee Standard	日本電気規格調査会標準規格
JEM	Japan Electrical Manufacturers' Association Standard	日本電機工業会規格
JICA	Japan Industrial Cooperation Agency	日本独立行政法人国際協力機構
LCD	Liquid Crystal Display	液晶ディスプレイ
NASA	The National Aeronautics and Space Administration	アメリカ航空宇宙局
NEDO	New Energy and Industrial Technology Development Organization	新エネルギー産業技術開発機構
NIS	New Israel Shekel	ニューイスラエルシェケル通貨
OFR	Over Frequency Relay	周波数上昇継電器
OVGR	Over Voltage Grounding Relay	地絡過電圧継電器
OVR	Over Voltage Relay	過電圧継電器
PCBS	Palestine Central Bureau of Statistics	パレスチナ統計局

PEA	Palestine Energy Authority	パレスチナエネルギー庁
PEC	Palestine Energy and Environment Research Center	パレスチナエネルギー環境研究センター
PERC	Palestine Electricity Regulatory Council	パレスチナ電力事業諮問委員会
PIEFZA	Palestine Industrial Estate and Free Zone Authority	パレスチナ工業団地特区庁
PTEL	Palestine Transmission Electrical Limited	PEA 諸所轄電力会社
PV System	Photovoltaic System	太陽光発電システム
R.H.	Relative Humidity	相対湿度
RMU	Ring Main Unit	高圧ガス負荷開閉器
ROJ	Representative Office of Japan	在パレスチナ日本代表部事務所
RPS	Renewable Portfolio Standards	再生可能エネルギー割固定枠制度
SPD	Surge Protection Device	避雷器
UFR	Under Frequency Relay	不足周波数継電器
UNDP	United Nations Development Programme	国連開発計画
UPS	Uninterruptible Power-supply System	無停電電源装置
UVR	Under Voltage Relay	不足電圧継電器
VAT	Value-Added Tax	付加価値税

VII TECHNICAL SPECIFICATIONS

- **EQUIPMENT WORKS**
- **MECHANICAL and ELECTRICAL WORKS**

I . EQUIPMENT WORKS

CHAPTER 1 GENERAL

Section 1 General:

This document shall describe the technical specifications for the equipment to be procured and installed for “The Project of Construction of New PV Solar Power System in Jericho Agro Industrial Park, in Palestine”(herein after referred to as the Project)

Section 2 Applicable Standards / Codes

Following standards and codes shall be applied for implementation i.e. design, procurement, installation, construction and T&C of the Project.

- 1) The Electricity Business Act of Japan
- 2) The Japan Technical Standard for Electrical Equipment
- 3) Japanese Industrial Standard (JIS)
- 4) Japan Electric Manufacture’s Association Standard (JEM)
- 5) Japanese Electro-technical Committer’s Standard (JEC)
- 6) Japanese Electric Wire & Cable Maker’s Association Standard (JCS)
- 7) Japan Grid Interconnection Code (JEAC9701-2016)
- 8) IEC standard : IEC61215 IEC61646 IEC61730-1 IEC61730-2
- 9) Ordinance on Industrial Safety and Health

Section 3 Scope of Work

3-1 The Scope of work

The equipment work (hereinafter referred to as ‘the Work’) shall include shop drawing, procurement, fabrication, delivery, storage, installation, adjustment, testing, and commissioning of the equipment to be procured and installed for the Project.

3-2 Schedule of system equipment

3-2-1 PV System

Schedule of system equipment including testing and maintenance equipment to be provided for the PV system for the Project is as shown in 1-3-1 below.

3-3 Design conditions

3-3-1 Meteorological conditions

- (1) Monthly average ambient temperature: 9.2 °C - 42.3 °C (maximum temp. 48.2 °C)
(2015-2017, 3 years)
- (2) Average relative humidity: 42.7% (2015-2017, 3 years)
- (3) Average precipitation: 45.8 - 200.5mm (max 65.7mm/month)
- (4) Annual average wind velocity: 7.1m/s (max 31.0m/s (2015-2017, 3 years)
- (5) Lightning strike consideration :

The Contractor shall take measures to prevent any damage to new and existing

facility/ equipment caused by lightning strikes.

(6) Seismic load consideration :

The possibility of earthquakes in the Project site is much less compared to these of Japan, however, the location of Jericho City adopts stability earthquake force of 0.3G for designs of the concrete basics of ground guest star since the Project site location is in the high-risk zone 3 to establish in "Seismic Hazard Map for Building Codes in the Levant" to apply at the time of the structure design of the building in the autonomous Palestinian areas because there is the Dead Sea Transform. When we install the rooftop of the building and arrive to put the rooftop, strength calculates a big load condition of the load as assumption load in the long-term load of the building, a short term.

(7) Solar Radiation Intensity:

Dairy average solar radiation 2.6-7.9 kWh/m²/d (NASA) Average 5.31kWh/m²

Location information: North latitude 31.861392, East longitude 35.460336

3-4 Defect Liability

- (1) Defect Liability period: one year from the date of the Certificate of Completion of the Works issued by the Consultant.
- (2) If any damage or default is found in the Works and if such damage or default is due to the causes not imputable to the Recipient. In such case, the Contractor shall immediately reinstall or repair such damage or default at his own expense during the defect liability period.
- (3) If such defeats results from the Recipient's or his users' negligence to follow the operation instructions during the defeat liability period, its expenses should be owed by the Recipient. In such case, the Contractor shall immediately repair or replace the defeat by request of the Recipient.

Section 4 Electrical requirement

4-1 The electrical characteristics of power being supplied by Jerusalem District Electricity Company (hereinafter referred to as "JDECO") are described hereinafter

Low-voltage power supply conditions:

- | | |
|--------------------|----------------------------|
| 1) Voltage | 380V/220V, 3 phase 4-wires |
| 2) Frequency | 50Hz |
| 3) Voltage range | ± 5% |
| 4) Frequency range | ± 0.2% |

Since electrical supply conditions which are above mentioned show a steady fluctuation range, the electrical equipment to compose the PV system shall meet the following design conditions that reflect transient fluctuation range,

- | | |
|----------------------------------|------------|
| 1) Steady Voltage range | $\pm 10\%$ |
| 2) Instantaneous Voltage range | $\pm 15\%$ |
| 3) Steady Frequency range | $\pm 3\%$ |
| 4) Instantaneous Frequency range | $\pm 5\%$ |

CHAPTER 2 SYSTEM REQUIREMENT

Section 1 System operational requirement

- 1) The solar cells produce Direct Current (DC) electricity current by solar radiation from the sun and connected to power conditioner.
- 2) The power conditioner converts this DC electricity current to the Alternating Current (AC) electric power that went along with the voltage, frequency, the phase of a customer power supply and does power supply to load.
- 3) When a generated electric power is greater than consumption power a surplus, electric power shall be flow to the grid. (e.g. the day when a factory is closed)
- 4) Power consumption data of generated power from the PV system and the receiving power from the power utility shall be recorded.
- 5) For consecutive system protection, in the event error message of a power conditioner is received, the circuit connected to the power conditioner shall be cut off the consecutive system at the switch in the LV electric distribution board.
- 6) The operation data shall be collected and stored, with a measurement monitor.

Section 2 Management and Monitoring data of PV system

2-1 Signal transmitters

The necessary transmitters to transmit of meteorological data collecting devices shall be installed transducer boxes.

- | | |
|------------------------------------------|---------------------|
| (1) Type: Outdoor type | |
| (2) Input signal: Solar irradiance meter | 0-10mV |
| Thermometer | Pt 100Ω |
| (3) Output signal: | 4-20mA |
| (4) Power supply: | AC:1Phase220V :50Hz |

2-2 Data collection item:

- (1) Output power (kW) from each power conditioner
- (2) Sold electric energy (kWh)
- (3) DC input voltage values for each power conditioner (DC V)
- (4) AC output voltage values for each power conditioner (AC V)
- (5) Solar radiation intensity (W/m²)
- (6) Ambient Temperature (degree centigrade)

2-3 Apparatus

(1) Personal computer (1 set)

- 1) Desktop type with display (22 inch or larger), keyboard and optical mouse
- 2) OS: Windows 10
- 3) Software: for data monitoring and display
- 4) RAM: 4GB or higher
- 5) CPU: 2GHz or faster
- 6) Hard disk: 1TB or higher
- 7) DVD/BD super multi drive
- 8) Color Printer: Size A3 correspondence
- 9) UPS for PC: AC 1phase 220V 50Hz 1200VA or higher
- 10) Operation Conditions: Ambient temperature 10°C~40°C
Relative humidity 20~85%

(2) Solar Radiation meter (2 sets)

- 1) Measuring object : Solar radiation on tilted surface
- 2) ISO classification : Second class or equivalent
- 3) Measurement wave length : 310~2,800nm
- 4) Measurement range : 0~2,000 W/m²
- 5) Accuracy : 2.5% or less(0~1,000 W/m²)
- 6) Installation : On the supporting frame of PV modules
- 7) Operating conditions : Ambient temperature -20°C~70°C
Relative Humidity 30~90%

(3) Thermometer (1 set)

- 1) Type : Pt100Ω
- 2) Resolution : 0.1 degree Celsius
- 3) Accuracy : ±0.2 degree Celsius (at 20 degree Celsius)
- 4) Installation : On the supporting frame of PV modules
- 5) Operation Conditions : Ambient temperature -20°C~70°C
Relative Humidity 30~90%

(4) Apparatus for data detection, A/D converter (6 lot)

Section 3 Measurement period, operation interval, and data storage period

- (1) A measurement interval: 6 seconds
- (2) An operation period: 1 minute
- (3) Data storage period: 1 minute and 1 hour

CHAPTER 3 EQUIPMENT SPECIFICATION

Section 1 PV System

There are several installation locations and methods in this project, and optimum type and install method for each location shall be considered,

For easiness of maintenance, PV modules shall be of same manufacture, same type and same product for all installed locations.

- (1) Module Type: Poly-crystalline cell type
- (2) Maximum Output Power : 345Wp/module or higher(Under STC(Society for Technical Communication))
- (3) Conversion efficiency: 16.0% or higher (Under STC)

Section 2 Power conditioner (Inverter)

- 1) Outdoor type for : Rooftop of the Hangers in Zone-A, B, D, and E.

2-2 Specification

- (1) Maximum output capacity: more than 36.0kW
- (2) Electrical system : 3 phase 4 wires AC380V 50Hz
- (3) Rated Efficiency : 90% or higher (under rated power operation)
- (4) Harmonics distortion: Current Total 5% or less, Current each dimension 3% or less
- (5) Output power factor : 0.95
- (6) Protection for Grid-connected PV system, Over Voltage relay, Under Voltage relay, Up-frequency Relay, Automatic start/stop control (Active and Passive)
- (7) Input voltage range : DC150---500V
- (8) Output power control : Maximum Power Point Tracking control (MPPT: Maximum Power Point Tracking)
- (9) Protection grade : IP65 or higher
- (10) Utility monitoring function: yes
- (11) Islanding protection function: yes
- (12) Operating Temperature Range -20 - +60(7) (M40 version -40 - +60) °C
- (13) Cooling Internal Fan
- (14) Noise < 40 dBA

Section 4 Other Equipment

4-1 Testing Equipment

- 4-1-1 Insulation tester : Testing voltage range: 125/250/500/1000V
Accuracy: $\pm 3\%$ reading, $\pm 4\%$ digit
Testing resistance range: 4/40/200/400/500/2000/4000M Ω
Or more Qty: 1 set
- 4-1-2 Digital circuit tester: Testing objects: AC/DC voltage, AC?DC current impedance

of cable and devices Qty: 1 set

4-1-3 Clamp meter : Digital clamp meter c/w viewer, Auto ranging and range holding function

Accuracy: $\pm 1.5\%$ reading, $\pm 3\%$ digit

Allowable current: up to 2000AAC

Conductor diameter: $\phi 55\text{mm}$ max Qty: 1 set

4-2 Maintenance Equipment

(1) Circuit disconnection rod : Qty: 1 set

(2) Insulation rubber gloves : Qty: 1 set

(3) Insulation rubber boots : Qty: 1 set

(4) Mops : For cleaning PV modules Qty: 5 sets

(5) Kit of tools : Screwdriver (Phillips and Flat blade), Pliers, Nippers, Measuring tape (10m, not steel), Tool Box and others Qty: 1 set

Table-1 : Schedule of major equipment for PV System

Item	Specification	Quantity	Purposes of use
PV modules	Poly-crystalline cells	1 lot	for Generate Electric power
Supporting structure for PV modules	Aluminum alloy, or Hot-dipped steel frames	1 lot	brackets for mount PV panels on rooftop of Hanger or Building or Parking lot
Power conditioner	Rated capacity between 36KW and output voltage shall be 380V. Rated Efficiency: 90% or more. AC Output Factor : 0.95 Harmonics: Integration 5% or less. Each dimension 3% or less. Protection Devices a) Over Voltage Relay (OVR) b) Diode for reverse power protection (OFR) c) Over Frequency relay (OFR) d) Under Frequency relay (UFR) e) Protection of Islanding	1 lot	for change to Alternated current from Direct current. for protect each devices of PV generation systems and facilities from natural and national-grid accidents.

	Operation Passive and Active method. Grade of Protection:IP53 or more		
Connection box	Device to be contained a)Circuit breakers(MCCB) b)Diode for reverse power protection c)Surge Protection devices d)Terminal block Grade of Protection:IP53 or higher	1 lot	for connect generated electric power from PV modules and protect from reverse power or lightning
Collection box	Device to be contained a)Circuit breaker Grade of Protection:IP53 or higher	1 lot	for collect and pass generated power to power conditioner
Meteorological observation instruments	Solar radiation meter	1 nos.	for measurement of sunlight intensities
	Air Thermometer	1 nos.	for measurement of ambient-temperature
	PV module surface Thermometer	1 nos.	for measurement of PV module backside surface temperatures

CHAPTER 4 INSPECTION

Section 1 Quality Inspection by the consultant

As for the quality inspection for the equipment, the following inspections and acceptance test shall be conducted prior to the handover of the equipment.

1-1 Factory inspection

Prior to the shipment of the major i.e. PV module and power conditioner, equipment out of the factory, equipment shall be inspected as to their conformity with required specifications and performance test for the system shall also conducted.

1-2 Collation inspection prior to shipment

Though quantities of the principal equipment shall be confirmed at the time of the factory inspection, quantities of all equipment shall be confirmed during collation inspection prior to shipment to be conducted by third party inspection agency. Place of inspection shall be manufacturer's packing warehouse.

1-3 Interim inspection

Interim inspection (on-site acceptance inspection) shall be conducted for the equipment with the presence of the Consultant immediately after completion of adjustment of the equipment one after the other.

At the inspection, various test data required for the acceptance test shall be collected with the presence of the Consultant through the operation of the equipment by the expert who engaged with installation and adjustment of the said equipment. And at the same time, specification of single and reciprocal operation of the equipment and quantities shall also be confirmed.

The interim inspection shall be held at last day of adjustment and commissioning of the equipment.

1-4 Acceptance test and handover

After completion of guidance on operation, counterparts of the Project with the presence of the Consultant shall verify required efficiency/performance and functions. Acceptance test shall be conducted by operating actual PV system.

After completion of the acceptance test, results of the test and data collected during the interim inspection shall be confirmed among the counterparts, the Consultant and the Contractor. Then, the Project will be handed over to the Implementation Agency (the Palestinian Energy Authority)

Section 2 Inspection for Electrical Performance of PV Modules

Inspection of PV modules shall be conducted in order to confirm its electrical performance described hereinafter.

- 1) Rating output power of PV modules shall comply with relevant IEC standards.

2) Total rating output power of PV modules shall exceed the required amount as described in the 'specification of PV modules'.

Section 3 Acceptance test and handover

Items to be inspected for the PV system shall be as follow.

Items to be inspected	PV modules	Power conditioners	Cable and wiring	Data management and monitoring system	Display
1. Visual inspection	Yes	Yes	Yes	Yes	Yes
2. Insulation test	Yes	Yes	Yes		Yes
3. Insulation resistance test	yes	Yes			Yes
4. Protection test		Yes			
5. Integrated operation test		Yes		yes	Yes

CHAPTER 5 Spare Parts and Consumables plan

- 1) PV module: 0.5% of delivery number of articles
- 2) Fuse of the power conditioner and pilot lamp 100%

II . ELECTRICAL and MECHANICAL WORKS

CHAPTER 1 GENERAL REQUIREMENTS

Section 1 General

- (1) General arrangement and specific conditions shall be as indicated in the Drawings. Proposed departures from the Drawings due to actual field conditions or other causes shall be prepared by the Contractor for approval by the Consultant. The Contractor shall examine the Drawings and shall be responsible for the proper fitting of materials and equipment without alteration.
- (2) Electrical system applied for this work shall be as follows:
Low-voltage AC 380/220V, 3 Phase, 4 wires, 50Hz

Section 2 Scope of Work

The Works to be performed under this chapter of the Specification shall consist of furnishing all Labor, materials, equipment, tools, and incidentals and performing execution required to complete the Electrical and Mechanical works including but not limited to the following.

- (1) General Requirements
- (2) Conductor (Wire and Cable)
- (3) Raceways (Conduits)
- (4) Wiring Devices
- (5) Electrical System
- (6) Panel board and Cabinet
- (7) Grounding (Earthing)
- (8) Lighting Fixture
- (9) Fire Alarm System
- (10) Lightning Protection
- (11) Insulation
- (12) Spare parts and Consumables
- (13) Others

Section 3 Related Works Specified under Other Specifications

- (1) Excavation and Backfill.
- (2) Concrete
- (3) Painting and any other finishing works. (Color and finish shall be approved by the Consultant.)
- (4) Equipment

Section 4 Submittals

Unless otherwise specified under Chapter 3 of 'EQUIPMENT WORKS', submit each submittal required hereinafter.

- (1) Equipment Submittal:

Prior to the commencement of work, the contractor shall submit for approval

certified literature showing ratings and dimensions of equipment, indicating manufacturer and model of fixtures and trim, and/or list all materials and items that are of a different manufacturer or model other than those specified.

(2) Shop drawings:

After the Consultant approval of equipment, the Contractor shall submit for approval dimensioned installation shop drawings to scale showing details where space requirements, present problems, proposed departures from the Contract Documents due to field conditions, and requirements for the concrete work, access panels, insert in slabs and openings in structure. The number of drawing to be submitted shall be A3 sized complete five sets and auto CAD data with a DVD-R or CD-R.

(3) As-built Drawings:

Provide and maintain at the Site a complete set of Drawings for the purpose of recording 'as-built information'. Within 1 month after completion of the Work, the Contractor shall prepare the as-built drawings based on the above and submit prints to the Consultant. The number of drawing to be submitted shall be A3 sized complete five sets and auto CAD data with a DVD-R or CD-R..

(4) Catalogues:

- 1) Five sets of manufacturer's catalogues shall be prepared and submitted to the Consultant in accordance with the Contract.
- 2) Catalogues shall be approved by the Consultant.

(5) Operation and Maintenance Manuals:

Furnish operations and maintenance manuals for all equipment, bound between hard covers, including the manufacturer's name, model and serial number, control diagrams and source of service and replacement parts.

When using published manuals covering several equipment items or several model options, identify which data and instructions apply to the equipment furnished for this Project.

Submit the complete sets of manuals for approval by Consultant prior to final submission them to the Client.

(6) Performance Test and Commissioning Report

Submit the data indicating performance level covering field reports of solar radiation value, insulation resistance value, and equipment tests for acceptance in accordance with the Drawings and Specification before the final inspection.

(7) Manufacturer's Data

Furnish the manufacturer's data for materials and equipment, as directed by the Consultant.

Manufacturer's data include manufacturer's descriptive literature, photographs, drawings, charts, performance and characteristics curves. Identify nameplate, capacity, size and layout dimensions.

(8) **Manufacturer's List**

- 1) Furnish equipment list complete descriptive list of manufactured equipment proposed for the Work to the Consultant for approval within 2 weeks after the commencement of work.
- 2) Lists shall include all equipment shown in the Drawing or specified herein.

(9) **Subscription for electric power incoming diversion work**

The contractor shall conduct subscription for electric power incoming diversion work to the electric power distribution company (JDECO) and shall support the Client to get the permission.

Section 5 Quality Control

The Contractor shall establish and maintain quality control for this Work to assure compliance with the Contract and maintain records of quality control for all operations including but not limited to the items listed below.

- (1) Ensure that all materials and equipment comply with requirements.
- (2) Perform tests for electrical and mechanical systems.
- (3) All equipment / system tests and adjustment in the field to be performed.
- (4) Perform tests in the manner as specified in the Contract or approved by the Consultant before shipping and submit the report to the Consultant for his approval.

Section 6 Standards

Applicable standards and codes are as follows;

- (1) International Electrical Commission (IEC)
- (2) Japanese Industrial Standards (JIS)
- (3) International Organizations for Standardization (ISO)
- (4) British Standard (BS)
- (5) Japanese Architectural Standards Specifications (JASS)
- (6) Standards of the Japan Electrical manufacturer's Association (JEM)
- (7) Standards of Japanese Electro-technical Committee (JEC)
- (8) Japanese Cable Maker's Association Standards (JCS)
- (9) National Fire Protection Association (NFPA)
- (10) National Plumbing Code (NPC)
- (11) Jordanian Standard (JS)

Section 7 Guarantee

- (1) Attention shall be directed to provisions regarding guarantees and warranties for the

Works under this Contract.

- (2) Manufacturers shall provide their standard guarantees for work under this Chapter. However, such guarantees shall be in addition to and not in lieu of all other liability that the manufacturer and the Contractor shall secure by other provisions of the Contract.
- (3) The Contractor shall guarantee that all elements of the systems are of sufficient capacity to meet the specifications required as set forth herein or as indicated.
- (4) Upon receipt of notice from the Employer of failure of the systems or equipment during the guarantee period, the Contractor shall replace the defective equipment or parts immediately.
- (5) Materials and /or equipment for which the effective guarantee term counting from the manufacturing date will be expired and will not be capable of covering the specified guarantee period after the substantial completion of the Project. The Contractor shall term as specified in the Specifications with the Contractor's letter.

Section 8 Handling and Storage

Materials, equipment and all products shall be handled and stored carefully to ensure completed installation without any defect.

Unloading, stacking, moving and storing of material shall strictly comply with the manufacturer's recommendations. Before installation, all materials shall be inspected by the Contractor for defects.

Materials found to be defective before or after installation shall be required to the satisfaction of the Consultant or shall be replaced with new material. Repair or replacement by the Contractor shall be accomplished without additional expenses to the Client.

Section 9 Spare Parts and Consumables

Supply all spare parts indicated in the specification for the proper operation and maintenance of all systems and plants for 1 year from completion of the Works as required by the Specifications. List spare parts recommended by the Contract and/or manufacturers for all systems and plant, with item names, quantity or percentage and prices.

CHAPTER 2 PRODUCTS

Section 1 General

The Consultant shall approve all products, materials and equipment.

1-1 Materials and equipment:

- 1) Materials and equipment shall be as specified in the Drawings and/or the Specifications and suitable for the service intended.
- 2) Materials and equipment shall be unused except those used for testing.
- 3) Equipment to be used shall be backed up by sufficient on-site service and shall be taken care with effective service activities.

1-2 Standard Products

- 1) Materials and equipment shall be of general purpose and standard products.
- 2) Unless otherwise approved by the Consultant, materials and equipment shall have a performance of a satisfactory operation in use for at least 5 years before the Tender Data and shall be the product which is kept in current continuous production.

1-3 The capacity of equipment shall no be less than that indicated in the Drawings and/or specified in the Specifications.

1-4 Conform to the requirements of an independent testing laboratory approved by the Consultant.

1-5 In lieu of a formal certificate for equipment and/or materials issued by the testing laboratory, the alternative submission of the following documents shall be subject to the Consultant approval;

- 1) Catalogue Cuts
- 2) Technical Data
- 3) Manufacturer's testing performance data

CHAPTER 3 EXECUTION

Section 1 Workmanship

- (a) The entire work provided in this Technical Specifications shall be constructed and finished in every respect with good workmanship and in a substantial manner.
- (b) It is not intended that the Drawings shall show every materials, fitting and appliance, but the Contractor shall furnish and install all such parts as may be necessary to complete the systems in accordance with best trade practice and to the satisfaction of the Consultant.
- (c) Coordinate with all other trades regarding the shape, size, and position of all openings required for apparatus in advance of the work so that all openings may be built in advance. Furnish and install all sleeves, supports, etc. hereinafter specified or required.
- (d) Obtain detailed information from manufacturers as to the proper method of installation and connection. Obtain all information from other trades that may be

necessary to facilitate work and completion of the whole Project.

Section 2 Painting

- (a) Except as otherwise specified, all equipment and materials furnished under this Chapter shall have a standard factory applied finish. All practical precautions shall be taken to prevent scratches and damage during shipment, storage and installation. Touch-up shall be where necessary to repair any scratches with proper surface preparation.
- (b) All nameplates bearing descriptive data and all nonferrous surfaces of materials and equipment provided under this Section shall be left unpainted, and clean.
- (c) All bare iron surfaces of pipe, equipment, materials, hangers and supports installed under this Specification shall be painted with one coat of approved rust resistant primer and finish painting as part of the work of this Specification. Painting shall be unnecessary for pipes in concealed area.
- (d) All painting and sizing done under this Chapter shall conform to the applicable equality control that is proposed by the Contractor and approved by the Consultant.

Section 3 Setting of Equipment

- (a) The setting of equipment shall be carefully coordinated with the work and requirements of the other trades involved to ensure compatibility and to avoid conflicts.
- (b) Equipment that is floor-mounted on concrete or masonry slabs, pads and piers, or permanent support.

Section 4 Test and Inspections

- (a) The Contractor shall carry out the following tests and inspections at each phase of construction to confirm that the requirements for the quality, capacity, performance and other items indicated on the Drawings and specified herein with regard to the materials, goods and workmanship are satisfactory. The Contractor shall record the results of each test and inspection, and shall submit them to the Consultant for approval.
 - (1) Before installation
 - 1) Materials; Checking of Standards and condition of materials.
 - 2) Equipment; Checking of shop drawings and manufacturer's instructions.
 - (2) During installation
 - 1) Materials; Inspections of delivered materials
 - 2) Equipment; Inspection at the project site
 - 3) Installation; Tests and inspections shall be as described hereinafter.
 - (3) Upon Completion

- 1) Tests and inspection of appearance, function, performance and trial run.
- (b) If as a result of such test and inspection, the materials, equipment and workmanship are judged unsatisfactory or unacceptable, they shall be rectified and/or replaced immediately at the Contractor's expense.
- (c) The Contractor shall, in advance, consult with the Consultant as to the program, schedule and items of test and inspection to comply with the Consultant's instructions.

Section 5 Opening

All opening in partitions, walls or slabs required for the work of this Chapter, are subject to the approval of the Consultant. Openings shall be finished in accordance with the requirements of the related specifications.

Section 6 Cutting and Patching

- (a) All cutting and patching incidental to and required for the proper installation for the work to be performed under this Chapter. Contractor shall cut anything existing building structure and other materials with specific approval of the Consultant.
- (b) Perform all patching in full accordance with those divisions and sections applying to the various trades, materials, methods, workmanship and finishes involved.
Damaged surfaces shall be restored to their original or better condition.
- (c) Holes may not be cut through concrete structural members.

Section 7 Miscellaneous Iron and Steel

- (a) Furnish and install all steel supports and hangers as shown in the Drawings or as required to support pipe, equipment and materials. Shop drawings of proposed work shall be submitted for the Consultant approval.
- (b) All work shall be cut, assembled, welded and finished by skilled mechanics. Welds shall be ground smooth. Stands, brackets, and framework shall be properly sized and strongly constructed.
- (c) Members shall be generally welded or riveted. Welding shall be at the shop. Field assembly may be carried out by bolting.
- (d) All shop-fabricated iron and steelwork shall be cleaned and dried and given a under coat of rust inhibited paint on all surfaces and in all openings and services.

Section 8 Welding

- (a) All welding shall be executed by skilled and qualified welders in a neat and substantial manner. Welding on piping and structural steel shall be performed only by persons who are currently qualified as a skilled welder, and each such welder shall present his qualifications to the Consultant whenever requested to do so on the job.
- (b) All pipes welding shall be oxy-acetylene or electric arcs. High test welding rods

suitable for the material to be welded shall be used throughout. All special fittings shall be carefully laid out and joints shall be accurately matched at intersections.

Care shall be exercised to prevent the occurrence of protruding weld metal into the pipe. All welds shall be of sound metal free from laps, cold shuts, gas pockets, oxide inclusions and similar defects.

- (c) All necessary precautions shall be taken to prevent fire or other damage occurring from the welding work.

Section 9 Anchorage

- (a) Furnish and install all arrangement required for controlling expansion, contraction and movement of pipe lines and equipment installed under this section.
- (b) Anchors shall be of approve design, secured to the building in an approved manner and sufficiently substantial to overcome the force of expansion of the piping systems.
- (c) Anchors shall be located so as to take maximum advantage of all points where expansion and construction may be taken up.

Section 10 Cleaning and Protection

- (a) Equipment and piping shall be blown out under pressure and cleaned of foreign material, through temporary connections where necessary, before the system is placed in service. Precautions shall be taken to prevent foreign material from getting into the equipment and piping during construction. The manufacturer of chemicals shall recommend and furnish chemicals for the purpose of cleaning and blowing out.
- (b) Protection of finish; fully protect all finish of the materials and equipment against damage from whatever cause during the progress of the work and until the final acceptance. Cover all materials and equipment in storage and during construction to protect finished surfaces from damage or flaw and keep all moving parts perfectly clean and dry. Clean the surfaces of all equipment and fixtures upon completion of the work.
- (c) Surfaces of all equipment and raceways shall be cleaned upon completion of the work.
- (d) Equipment and piping shall be blown

Section 11 Underground Piping Protection

The Contractor shall provide reinforcement works in such intersection areas where vehicles may pass over the piping lines. The Contractor shall prepare shop drawing for the protection works and submit for approval of the Consultant. All underground steel piping shall be protected with anti-corrosive coverage.

Section 12 Underground wiring and Protection

Where special conditions exist, such as the need for reinforcement for wiring and the like where vehicles may pass over the wiring lines, the Contractor shall furnish and install

reinforcement works at such areas or install the wire with the polyvinyl chloride pipe at locations deeper than 0.9m meters from the finished surface.

Section 13 Hangers and Supports

- (a) All required hangers, supports, clamps, sleeves, etc., required for the installation of the electrical work shall be included as a part of the work of this section.
- (b) All materials for required hangers, supports, clamps, sleeves, etc. shall be electro-galvanized steel or painted.
- (c) All horizontal runs of raceways and cable trays shall be properly grouped and hung to true alignment using substantial and appropriate hangers, clamps, conduit straps, etc. Hangers and support locations shall be coordinated with the work of other trades to avoid conflicts. Hangers and supports shall be placed at intervals in accordance with the requirements of Japanese Standards or equivalent. Supporting rods shall be threaded only on ends, with allowance for adjustment, or shall be all threaded in areas where required to suit a particular job condition or application.
- (d) Wire and straphangers will not be permitted. Metal clips or straps using toggle bolts or lead expansion sleeves on masonry and wood screws on woodwork shall secure conduits and fittings. Where fastened to bar joints, bulb-tees and/or flange beams, use wedge hangers, tap clips and flange clips.
- (e) Support conductors in vertical raceways and cable tray in accordance with the requirements of Japanese Standards or equivalent.
- (f) Painting shall make any cutting edge good with anti-corrosive paint.

Section 14 Wiring and elementary Diagrams

The equipment actually installed shall be wired and connected in accordance with the equipment manufacturer's recommendations and shall conform to details in approved wiring diagrams to be furnished by the equipment's manufacturer.

All equipment so connected shall be made to operate in a safe, proper and efficient manner. Note that control circuitry is not necessarily shown completely on the Drawings but shall be furnished by the Contractor and installed in conduits between the points and devices indicated on the diagrams.

Section 15 Designation of Equipment

Use laminated nameplates on the exterior of all electrical apparatus, including switchboards, panel boards, switchboxes, telephone cabinets and other equipment as indicated. Those laminated nameplates shall be of black and white bake lite or similar material, machine engraved through the black layer to expose the white layer, with lettering.

Manufacturer's standard nameplates will be acceptable, if compatible with those used

throughout the Project, and if approved by the Consultant.

CHAPTER 4 CONSTRUCTIONS

Section 1 Conductors (Wire and Cable)

1-1 General requirements

1-1-1 Scope of works

- a) Wire and cable complete with accessories
- b) Installation of miscellaneous items and appurtenances shown and/or required to complete the wire and cable work

1-1-2 Applicable Standards

IEC, BS, JIS, JEC, JEM or equivalent

1-1-3 Submittals

Submit shop drawings and/or catalogue and technical particulars for wire and cable.

1-2 Products

1-2-1 Conductors and cables

Comply with IBC, BS, JIS, JEC, JEM or equivalent

- a) 0.6/1 kV Cu/ Cross Link Poly-ethylene Insulated /Steel Wire Armored /Polyvinyl Chloride Sheathed Cable. (XLPE/SWA/PVC Cable)
- b) 0.6/1 kV Cu/ Cross Link Poly-ethylene Insulated /Steel Wire Armored /Polyvinyl Chloride Sheathed Shielded Cable. (XLPE/SWA/PVC/S Cable)
- c) 0.6/1 kV Cu/ Polyvinyl Chloride Insulated/ Polyvinyl Chloride Sheathed Cable. (PVC/PVC Cable)
- d) 0.6kV Cu/ Polyvinyl Chloride Sheathed Wire (PVC Wire)
- e) Fire resistant PVC/PVC Cable for fire alarm system
- f) 3P 24AWG for RS-485 cables CAT-5 cable as required

Comply with Japanese or international standard.

1-3 Execution

1-3-1 Color Coding

Color coding of wire shall be in accordance with the requirements of the IEC, BS, JIS, JEM or equivalent.

Provide for all service, feeder, branch, control and signaling circuit conductors. Color shall be green for grounding conductors, and black for neutrals. The color of the ungrounded conductors in different voltage system shall be as follows:

- a) 220 volt, 1-phase: Phase A / B / C – Red / Yellow / Blue
 Phase N – Black

- b) 380 volt, 3-phase:
 - Phase A – Red
 - Phase B – Yellow
 - Phase C – Blue
 - Phase N – Black

1-3-2 Accessories

- a) Cable Supports in Risers
- b) Clamping device with insulation wedges and grips
- c) Compression type or twist-on spring loaded connectors and Nylon insulated covering
- d) Use anti-seize compound on tang

1-3-3 Wiring

- a) Thoroughly clean the interior of raceways before wires are run.
- b) Connect wires and cables with suitable connector fittings
- c) Make no connections of cable situated in raceways

1-4 Tests

- a) Continuity and insulation tests:
- b) 380/220V lines: 1,000 volts megger 100 percent of feeders
- c) 220V lines: 500 volts megger 100 percent of feeders
- d) Communication lines 250 volts megger 100 percent of feeders

1-5 Performance test

- a) Prior to connecting equipment
- b) In presence of authorized representatives

Section 2 Raceways (Conduits)

2-1 General Requirements

2-1-1 Scope of Work

- a) Raceways complete with boxes, fittings and accessories
- b) Installation of miscellaneous.

2-2 Products

(1) Polyvinyl Chloride (PVC) Conduit Pipe

- a) PVC Conduit Pipe for Electrical Works (VE);
Comply with JIS C8430, BS or equivalent
- b) Fittings and Accessories
Comply with JIS C8432:1999, or equivalent

(2) High impact Vinyl Pipe (HIVP)

Not used

(3) Galvanized Steel Pipe

- a) Rigid steel Conduit Pipe;

Comply with JIS C8305, G3452, BS or equivalent

2-3 Fittings and Accessories;

Comply with JIS C8330 to C8347, BS or equivalent

(1) Flexible Metal Conduit (FMC)

- a) Flexible Metal Conduit;

Comply with JIS C8309, BS or equivalent

- b) Fitting and Accessories;

Connectors, couplings, etc., suitable for flexible metallic conduit system

(2) Cable Tray/ Cable Ladder

- a) Hot dipped galvanized steel cable tray with cover;

Comply with NEMA, BS or equivalent

- b) Fittings and Accessories;

Comply with NEMA, BS or equivalent

(3) Flexible Expansion Pipe (FEP50, 80)

- a) Comply with JIS C8430, BS or equivalent

2-4 Boxes

2-4-1 Outlet Boxes;

- a) Except as otherwise required by construction, devices or wiring

1. Stamped steel and PVC for fixtures

2. Materials; Electro-galvanized iron sheet

3. Comply with JIS C8340:1999, BS or equivalent

4. Outdoor Location : Weather proof

5. Without Fixture or Device : Blank cover

- b) Junction and Pull Boxes

1. Material : sheet steel

2. Covers : Screw-on, except as noted, paint finish, minimum 1.6mm thickness

2-5 Execution

(1) Raceway and Conduit Pipes

- a) Underground beyond Building;

It shall be at least 600mm from finished ground surface to its top cover

- b) Outlet Boxes shall be painted for rustproof

- c) All metal parts of conduit pipes, cable trays and boxes shall earthed in accordance with the requirements of JIS, BS or equivalent

- d) In case the pipe strength is not sufficient, upon execution of the work or after

the work, measures to increase the strength such as embedding the pipes in concrete, etc. shall be applied

(2) Underground Raceway Marker

- a) Marker shall be concrete peg with minimum dimensions of 100mm×100mm×500mm
- b) Provide the makers on the finished grade above the underground raceway and/or underground electric cable
- c) Provide the maker at intervals of maximum 20 meters and the bending point of the raceway and/or cable.

2-6 Tests

Perform necessary tests as requested by the Consultant.

Section 3 Wiring Devices (for New Monitoring Room)

3-1 General Requirements

3-1-1 Scope of Work

- a) Complete materials as noted
- b) Installation of miscellaneous items and appurtenances shown and/or required to complete the wiring devices.

3-1-2 Products

1) Switches;

Comply with BS, JIS, IEC or equivalent.

AC300V 3A, 15A switch, plastic plate

2) Receptacles (Socket Outlet)

Comply with BS, JIS, IEC or local standard.

Flush mounting and/or surface mounting type 2-poles and earthing pole.

Shop drawings shall be submitted by the contractor for the approval of the Consultant.

3) Plugs

Comply with BS, JIS, IEC and/or local standard

Type ; 2-poles and grounding suitable for socket type.

4) Pilot Lamps

Comply with BS, JIS, JEC, IEC or equivalent.

5) Device Plates

Comply with BS, JIS, JEC, IEC or equivalent.

3-1-3 Execution

1) Tests

Test the operation and/or functions of all wiring devices under load.

2) Installation

- a) Connecting Conductor and Cable;
- b) Conductors or cable shall be connected to each other in the following manner.
- c) Conductors shall be connected so as not to increase electrical resistance before connecting.
- d) Conductors and cables shall be joined so as not to decrease their mechanical strength by more than 20%.
- e) No connection shall be made within conduit or wiring duct.
- f) Conductors and cables shall be connected by means of suitable connector fittings such as compression type connectors.
- g) Where any connections occur, an adhesive vinyl tape shall be wrapped around the joint.
- h) Connection between Conductors and device Terminals;

The device terminals shall be firmly fixed so as not to become loose at the connection. If there is a probability of them becoming loose, a double nut or a spring washer shall be used.

Section 4 Panel-Board and Cabinet (for RMU Transformer House)

4-1 General Requirements

4-1-1 Scope of Work

- a) Low voltage distribution panel-board and power control panel-board complete with cabinet, box, fittings and accessories.
- b) Installation of miscellaneous items and appurtenances shown and/or required to complete the work.

4-1-2 Products

1) Low voltage distribution Panel Board

a) General:

Low voltage distribution panel-board shall be provided and installed as follows unless otherwise specified in this section and drawing and shop drawings shall be approved by the Consultant before manufacturing.

b) Structure:

1. The structure of the Low voltage distribution panel-board shall be manufactured to prevent dust, insects, etc., from penetrating or getting inside.
2. The cabinet for the Low voltage distribution panel-board shall be manufactured of sheet steel with a thickness of 1.6mm or more.

2) Power Control Panel-Board

a) General

Power control panel-board shall be provided and installed as follows unless otherwise specified in this section and drawing and shop drawings shall be approved by the Consultant before manufacturing.

1. The structure of the power control panel-board shall be manufactured to prevent dust, insects, etc., from penetrating or getting inside.
2. The cabinet for the power control panel-board shall be manufactured of sheet steel with a thickness of 1.6mm or more.

3) Terminal Board

a) General

Terminal board shall be provided and installed as follows unless otherwise specified in this section and drawing and shop drawings shall be approved by the Consultant before manufacturing.

1. The structure of the power control panel-board shall be manufactured to prevent dust, insects, etc., from penetrating or getting inside.
2. The cabinet for the terminal board shall be manufactured of sheet steel with a thickness of 1.6mm or more.

4) Earth Terminal Board

a) General

Earth Terminal board shall be provided and installed as follows unless otherwise specified in this section and drawing and shop drawings shall be approved by the Consultant before manufacturing.

1. The structure of the Earth Terminal board shall be manufactured to prevent dust, insects, etc., from penetrating or getting inside.
2. The cabinet for the Earth Terminal board shall be manufactured of sheet steel with a thickness of 1.6mm or more.

Section 5 Earthing (Grounding)

5-1 General Requirements

5-1-1 Scope of Work

- 1) A man ground electrode conductor between the earthing conductor and the earth rods
- 2) Earthing Conductor shall comply with BS, JEC and/or local standard
- 3) Earthing conductors in all lightning and outlet circuits and in all branch circuits whether indicated or not
- 4) Communication System Earthing
- 5) Earth electrodes

- 6) Fittings and Accessories
- 7) Installation of miscellaneous items and appurtenances shown and/or required to complete the Earthing System

5-1-2 Products

- 1) Main conductor;
Bare copper lay, minimum 70mm² cross sectional area
- 2) Bonding Jumpers;
Bare copper, minimum 2.5mm diameter
- 3) Earth Conductor for motors, panels, devices, communication earthing, PVC insulated wire, size as required

5-1-3 Execution

- 1) Installation
 1. Conductors, connections, fittings, etc. shall not be installed in cinder fill or covered with soil containing cinders or other corrosive materials
 2. Earthing electrode or conductor shall be isolated more than 1.0m from others and shall be isolated more than 2.0m from lightning
 3. Earthing electrode shall be installed in a damp but not corrosive place deeper than 0.75m from the ground surface
 4. Conductor shall be installed 0.9m or more from any power line or gas pipe.
 5. Where section area of structural steel member is more than 300cm², they may be used as an earthing conductor, be should confirmed with the Consultant.
- 2) Tests
 1. Measure earthing resistance for each earth rod and total system by earthing resistance meter
 2. Earthing resistance values shall comply with the requirement of the regulation

Section 6 Lightning Protection

6-1 General requirement

6-1-1 Scope of Work

1. Observe compliance with all the provisions in the General Requirements of this Chapter as a part of this section
2. Submit Product data, Shop drawings, Qualification data, Certification and Field quality-control reports
3. Comply with recommendations in NFPA780 (National Fire Protection Association)

4. Installation of miscellaneous items and appurtenances shown and/or required to complete the lighting system
5. All shop drawings shall be approved by the Consultant

6-1-2 Products

1) Lightning Protection System Components

1. Roof-mounted Air Terminals; Lightning arrester class 2, Helita Pulsar or equivalent.
2. Ring Earth Electrode; It shall be as shown in the drawing and as directed and approved by the Consultant
3. Earth electrodes; 19mm diameter x 1.5m length and more as shown on the drawings
4. Earth Terminal Board; It shall be as shown in the drawings and manufactured accede the specification of Chapter 1 in this Chapter.
5. Lightning down conductor; Stranded. Bare copper wire

6-1-3 Execution

1) Installation

1. Install lightning protection components and systems according to NFPA 780
2. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bent.

2) Test

1. Measure grounding resistance by grounding resistance meter
2. Total earthing resistance value shall not exceed 10 Ω .

Section 7 Spare Parts and Consumables

7-1 General Requirements

7-1-1 Scope of Work

Supply all the consumable spare parts as listed in Chapter 1 Section 2 Spare Parts List in this Chapter

1) Submittals

Submit spare parts list containing;

1. Name and quality of materials and devices
2. Related Section Number of the Specification
3. Manufacturer's name, address and telephone number

7-1-2 Products

1) General

All equipment, devices and/or materials shall be provided with required quantity of spare parts as stated below

2) Spare Parts List

1. Any kind of Lamp; Quantity: 10% or at least 1 of Design Quantity
2. Any kind of Fire Detector; Quantity: 10% or at least 1 of Design Quantity
- 3) Note: If there are standard spare parts and tools which are left out or missing from the list of the specifications, they shall be added and notified to the Consultant for approval. All necessary standard spare parts and tools shall be provided as required by the Consultant.

CHAPTER 5 INSTLLATION SPECIFICATION OF EACH CASE

The coverage of this bid book assumes it construction to install photovoltaic (PV) power generation facilities in the following places. In addition, as for the construction specifications of the new construction of other locations listed in a basic design drawing, Contractor shall refer to that place because Consultant will attach it separately as Appendix.

CASE-1) Installation on the rooftop of 12 Hangers of the UNDP

CASE-4) Installation in the Expansion area in the existing PV generation station

Section1

CASE-1 On the rooftop of 12 UNDP Hangers new installation

1-1 Installation place, a condition, the area of the facilities:

A rental factory roof top : Height : 7m, Fire prevention steel building materials, Angle of inclination 5.7 degrees (10% slant)

1-2 Installation method of the Rental factories (Hanger) per the about 504m²/ Building with the frame fixation type made by roof materials bolt fixation stainless steel

(Caution)

The influence on structure with the PV new installation (structural calculation)

About a building to put this PV power generation system on the Rooftop of Hangers,

Contractor shall calculate a dead load and the seismic load calculation.

And the standard to do of the seismic load in (Seismic Hazard Map for Building Codes in the Levant) is based, and assume it 0.3G.

There is not the premise to put PV modules on the rooftop, and the target building assumes the case that the result that a structure is not able to bear for load appeared this time, the Contractor must submit and inform the results of calculation to the Consultant and the Contractor must consider and reduce the setting number of PV modules.

1-3 A number of PV modules installed on each building :

14 series *9 arrays *2 roofs = 252 nos./ Building

1-4 Installation apparatuses: ※FEP50 pipe for *2

Power conditioner*2 (36.0kW), Connection box*2, Collection of direct current electric box*2, LV Cables for LV grid connection, Conduit Pipes and supports.

1-5 Incidental facilities:

A companion ladder for roof level access, Appliance, for maintenance cleaning*1,

1-6 Maximum PV module generation output :

70.56kW/Building (70.56kW*12 = 846.72kW/12 Buildings)

1-7 Expected annual generated energy: 1197.98MWh/12 Buildings

1-8 Grid Connection Point:

Grid connection point shall be in the existing LV Distribution boards in RMU houses thru the new bi-directional meters.

Section 2

CASE-4 Expansion area in the Existing PV generation Station

2-1 Installation place, a condition, the area of the facilities:

Expansion area in the Existing PV generation Area, Ground Mounted Angel of inclination 30.0 degrees

2-2 Installation method :

Galvanizing fire prevention Steel or an aluminum Ground Mounted type

2-3 A number of PV modules installation :

12 series *26 lines = 312 nos.

2-4 Installation apparatuses: ※FEP50 pipe for *2

Power conditioner*2 (36.0kW), Connection box *2, Collection of direct current electric box*2, LV Cable for connection, Pipes cable protection

2-5 Incidental facilities: None

2-6 Maximum PV module generation output : 87.4kWp

2-7 Expected Annual generated energy : 123.66MWh / year

2-8 Grid connection point:

Grid connection point shall be in the NEW Monitoring Room in NEW 2nd floor of the Administration Building thru the new bi-directional meter.

Section 3

CASE-1 On the rooftop of 8 Hangers new installation

CASE-2 On the rooftop of 4 Hangers new installation

3-1 Installation place, a condition, the area of the facilities:

A rental factory rooftop : Height : 7m, Fire prevention steel building materials, Angle of inclination 5.7 degrees (10% slant)

3-2 Installation method of the Rental factories (Hanger) per the about 504m²/ Building

with the frame fixation type made by roof materials bolt fixation stainless steel

(Caution)

The influence on structure with the PV new installation (structural calculation)

About a building to put this PV power generation system on the Rooftop of Hangers.

Contractor shall calculate a dead load and the seismic load calculation.

And the standard to do of the seismic load in (Seismic Hazard Map for Building Codes in the Levant) is based, and assume it 0.3G.

There is not the premise to put PV modules on the rooftop, and the target building assumes the case that the result that a structure is not able to bear for load appeared this time, the Contractor must submit and inform the results of calculation to the Consultant and the Contractor must consider and reduce the setting number of PV modules.

3-3 A number of PV modules installed on each building :

14 series *9 arrays *2 roofs = 252 nos./ Building

3-4 Installation apparatuses: ※FEP50 pipe for *2

Power conditioner*2 (36.0kW), Connection box *2, Collection of direct current electric box*2, LV Cables for LV grid connection, Conduit Pipes and supports.

3-5 Incidental facilities:

A companion ladder for roof level access, Appliance, for maintenance cleaning*1,

3-6 Maximum PV module generation output :

70.56kWp/Building (537.6+70.56*4= 819.84kWp/12 Buildings)

3-7 Expected annual generated energy: 1159.89MWh/12 Buildings

3-8 Grid Connection Point:

Grid connection point shall be in the existing LV Distribution boards in RMU houses thru the new bi-directional meters.

CHAPTER 7 OPEATION AND MAINTENANCE AFTER THIS PROJECT

Now There were only ground mounted type PV power generation facilities of 300kWp, however, after this plan, the Facilities manager need to manage four kinds of PV generation systems in total and must manage it, and it is necessary for study to maintain the organization which is necessary for OPEATION AND MAINTENANCE (O&M), staff placement, the technique level that should hold it, a necessary expense.

Existing PV System had already connected direct consecutive to national grid, however, The Facilities manager will use ourselves inside factory. So The Facilities Manager needs to prepare the more higher technical knowledge, and an organization to manage staffs and it with and to run is necessary for the system.

And It is necessary to conclude the contract of the selling of power purchase of power with the electric power company newly, and the making of organization of early time is necessary.

In additional, The Facilities manager shall examine exchange of PV Panel and Power Conditioner and another facilities before 20 years pass from the setting of facilities.

Section-1 Operation Works.

1-1. An annual management plan.

The Facilities manager shall make an annual generation plan and management plan and manage it whether it make progress as scheduled.

1-2. The evaluation of the PV generation system.

The Facilities manager shall judge whether the PV generation system that this generation system is more proper than weather condition is considered to be it and they shall perform a field work at the time of the electrical power drop down and shall recover immediately.

1-3. Reporting.

The Facilities manager shall summarize the evaluation of progress of the program for the year and the PV generation system in a report and they shall report it every month in an office.

1-4. Monitoring.

The Facilities manager shall perform the site condition of PV generation facilities by a remote monitoring system and they shall cope immediately when alarm signal was seen.

1-5. Various data record safekeeping and a report of the facilities operating.

The Facilities manager shall make various data simplified forms and they shall report and they shall make filing according to an item and shall keep it in a monitoring room and shall report it to an employee on every month regularly in them office.

1-6. An emergency alarm supports.

The Facilities manager shall utilize the warning email transmission function of the remote monitoring system and they shall cope with facilities on emergency alarm for 24 hours for 365 days.

Section 2. Maintenance Works.

2-1. A periodic inspection.

The Facilities manager shall perform confirmation of the everyday visual inspection and data display and monthly check and annual check.

2-2. The details check of the Power Conditioner.

The Facilities manager shall perform the power conditioner details check once in five years.

2-3. The check of incidental facilities.

The Facilities manager shall perform operation check of facilities pro-movement check of the peripheral device (all meters, temperature meters, solar radiation meters, transformers, cables) of PV generation facilities and remote communication system regularly with using testers or a small size a thermal imagery camera.

2-4. Cleaning the module

The Facilities manager shall clean the surface of the module with high pressure once a month to prevent a quantity of generation electric power drop down and aged deterioration.

2-5. The weeding around the facilities.

The Facilities manager shall remove the weed obstacle to the PV generation.

2-6. The exclusive duty placement of the electric chief engineer and the organization of the Emergency contact system.

The Facilities manager shall employ the exclusive duty chief engineer having electric knowledge of the PV power generation, who can do the initial correspondence in emergency alarm, and the Developer shall let a monitoring room engage. In the time when PV generation facilities operate, an engineer shall be resident and shall make the record of various data, analysis, preservation, the report.

When PV generation does not operate (the night when they do not generate electricity), the Facilities manager shall organize the system that when an emergency alarm announced it immediately perform is possible.

Section 3. Inspection Works.

1-1 Visual Inspection

When the Facilities manager carries out a visual inspection, they shall confirm consistency in reference to Documents in conjunction with generation facilities such as Single Line Diagram and layout drawings and Specification.

The Facilities manager shall confirm whether there are not a dirt and the change of color of the solar receiving surface of PV Module, damage, a damage by a fire regularly. In addition, there are not corrosion and the damage of an facilities fitting structure and generation facilities, and the facilities manager shall carry out visual inspection about angle of facilities structures

- 1) PV Module, Array, Fixing Metal Fitting
- 2) Connection Box, Collection Box
- 3) Power Conditioner, Transformer, Fuse

- 4) Cable, Wiring, Facilities
- 5) Amount of Generated Electric Power
- 6) Peripheral condition

1-2 Inspection Equipment

When the Facilities manager shall inspect visual inspections, they shall record the numerical value that measured the conditions of the facilities with a camera, compasses, a scale measure, a point of view meter every time. The Facilities manager shall measure the angle of degree of the facilities and PV Module with a point of view meter and shall leave a record according to a decided format. The Facilities manager shall take the state of the inspection with a camera and stores Photos every date.

- 1) Camera
- 2) Scale Measure, Compasses, Angle Gage
- 3) Thermographic camera

1-3 Report making, Information and Emergency Response

The facilities manager shall record a result of the inspection and summarize it in a report, and they shall add comment to Documents of a decided format and shall report it once a week in an office.

The facilities manager shall watches the temperature rise point of the facilities such as the surface of PV Module and Power Conditioner, Transformer, the Connection and Collection box with a thermographic camera once a month and they shall leave a record.

When the Inspector finds trouble and the damage of facilities, the Facilities manager must separate an electric power distribute without delay and they must take the emergency responses.