



AMENDMENT 3

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ނަންބަރު No:	TES/2015/W-163	
ފަންޑުގެ ނަންބަރު Project:	Provision of Sewerage Facilities in Gdh.Gadhoo	
ޖަހަވަރު Issued Date	Monday, January 18, 2016	
ސަފުޙާގެ އަދަދު No. of Pages: -01	ބޯޕް Boq: -00	ޖަހަވަރު Drawings: -00

Please include this amendment when submitting the bid. ޖަހަވަރު ޖަހާ ފަހަރު މި ޖަހަވަރު ހިމާލައިގެން ޖަހަވަރު ޖަހަން ޖެހިގެން ދަންނަވަންޖެހޭ އެއްވެސް ޖަހަވަރެއް ނެތެވެ.

Attached with this amendment are the answers to clarifications received for the subjected project.

- Attached in the email, pdf format and Excel format.

Please be informed that the Bid Submission Date for this project has been postponed and will now be held on **Tuesday, 9<sup>th</sup> February 2016 at 1000Hrs.**

ނަންބަރު  
Name: Aminath Juweriya

ސަފްޞާ ޖަހަވަރު  
Signature:



S.No	Queries	Reply/Clarification	Date Sent
1	Since the design of the schemes have been done in detail, please clarify if all spaces for the construction of the lift pumping stations has been earmarked and available for construction. Please confirm.	Land availability is confirmed for all the structures.	
2	The sand bedding under the pipelines has been shown as 100 mm in the drawing and 50 mm in the BOQ. This needs clarification as it has cost implications.	Consider 100 mm	
3	The details of the borewell in terms of its depth, anticipated discharge, pumping machinery and borewell diameter needs to be provided.	Typical Details Provided in Design Drawings	
4	The Ultra Filters provided for the RO plant for raw water may not be needed as the water is free from silica, TSS, BOD and COD. This can be dropped from the proposal. This need clarification.	It is a Design Requirement and it has to be provided as per contract document	
5	The capacity of the RO plant in each island is given as 2 x 60 m <sup>3</sup> /day. This needs clarification and confirmation.	The Capacities are different as per the Design , Check the BOQ	
6	The capacity of the Sewerage Treatment units is about 4 times higher than the RO plant capacity. This needs clarification and confirmation.	RO Plant only caters drinking water demand only, and STP for water from all facilities	
7	What would be the source of electricity to run the scheme components – borewell, lifting stations, the RO and the Sewerage Treatment Unit etc.	The main source will be from the Island Electricity power supply. Emergency generators are available for support during electricity breakdowns	
8	The concept of rain water collection and storage at a common tank and subsequent treatment at RO plant is not understood. This needs clarity.	Design is as per MEE and EPA requirements	
9	The details of all pumping machinery at lift pumping stations, RCC effluent manholes, etc. need to be provided to assess the actual requirement.	Typical Details Provided in Design Drawings, Design data can be referred for clarification	
10	The details of the depth of the lift pumping station collection well below the invert level needs to be provided for all locations to assess the working requirements.	All the information is provided in the Design Data.	
11	Length of the 80 mm HDPE pipe in the BOQ for Velidhoo Water Supply is not provided. Kindly clarify.	The 80 mm HDPE pipe is included in the BOQ, Page 1, Item C	
12	Are the details for the services to be realigned would be provided during the execution of the project. Kindly confirm.	Details regarding existing services will be facilitated by the Client; the contractor has to liaise with the utility providers for realigning the same during project execution	
13	Kindly provide the details of local taxes proposed to be paid on the said project.	As per Maldivian Law regulations; details can be obtained from MIRA.	
14	In case some material is imported, would some tax concessions be provided for such an import.	All tax will comply with Maldives Tax Regulation	
15	Thickness of pavement to be provided all arounds the lifting station?	Thickness for Paving may be taken as 60mm	
16	Drawing No:ko-sw-105, the depth of packed pumping unit is not given i.e. height from base to Inlet elevation, else detention capacity is required?	This is a Typical Detail, Design data can be referred for clarification	



Queries	Reply/Clarification	Island Name	Date Sent
1 What is the autonomy days/capacity required for the solar batteries? Are there any specifications of the batteries required?	Depends on the choosen supply vendor, who has to do the necessary battery sizing calculation	Ga. Kolamaafushi N. Velidhoo R. Hulhuthuffaaruu Thulhadoo	
2 Can we confirm the solar capacity as per below? Ga. Kolamaafushi - 55.5KWp Hybrid Solar System N. Velidhoo - 84KWp Hybrid Solar System R. Hulhuthuffaaruu - 55.5 kWp Thulhadoo - 63 kWp	N. Velidhoo - 69.63KW Ga. Kolamaafushi - 48.3KW R. Hulhuthuffaaruu - 48.3 KW B. Thulhadoo - 54.13 kW	Ga. Kolamaafushi N. Velidhoo R. Hulhuthuffaaruu Thulhadoo	
3 Solar structure will be Anodised Zinc Aluminium Frame. Do you have any preferred specification?	Attached the design material specification which is based on our design	Ga. Kolamaafushi N. Velidhoo R. Hulhuthuffaaruu Thulhadoo	
4 Any specification for the Solar panels?	Attached the design material specification which is based on our design	Ga. Kolamaafushi N. Velidhoo R. Hulhuthuffaaruu Thulhadoo	
5 Please advise if there is sample interim statement or payment certificates as mentioned in the bid security.	Will be provided upon contract award	Ga. Kolamaafushi Gdh. Gadhoo N. Velidhoo R. Hulhuthuffaaruu Thulhadoo	
6 From the bid security, the validity of the bid security shall be 3 years. Please advise if Hitachi can propose 1 year validity subjected to renewal on a yearly basis.	Cannot accept renewal of bid security on yerly basis.	Ga. Kolamaafushi N. Velidhoo R. Hulhuthuffaaruu Thulhadoo	
7 Please confirm if the UF permeate tank shall be designed for 10m <sup>3</sup> or 2m <sup>3</sup> .	Selection subject to the RO Plant capacity requirement and Manufacturers recommendation, subject to client's approval	Ga. Kolamaafushi N. Velidhoo R. Hulhuthuffaaruu Thulhadoo	



8	<p>Please confirm location of pump station and STP on Ga. Kolamaafushi is as shown at the following area.</p> <div style="border: 1px solid black; padding: 5px;">  <p>Proposed Pump Station for Kolamaafushi.pdf</p> </div>	<p>The Pumping Station and STP location is prepared and approved by MEE, MHI and Island Council , which is shown on the Layouts. Any changes to the same will be confirmed during project execution</p>	<p>Ga. Kolamaafushi</p>	
9	<p>Hitachi shall be supplying 2 units of UF and 2 units of RO mounted on individual skids. Please confirm</p>	<p>Selection subject to the RO Plant capacity requirement and Manufacturers product Catalog</p>	<p>Ga. Kolamaafushi N. Velidhoo R. Hulhuhuffaaruu Thulhadoo</p>	



10	Please confirm if the pre-treatment for RO is sand filter or UF.	Ultra filter has been considered for pre treatment in Design, Contractor can price the UF seperately	Ga. Kolamaafushi N. Velidhoo R. Hulhudhuffaaruu Thulhadoo	
11	Please advise the dimension of the UF permeate tank.	Selection subject to the manufacturers recommendation subject to client's approval	Ga. Kolamaafushi N. Velidhoo R. Hulhudhuffaaruu Thulhadoo	
12	Can we propose an alternative size to the RO plant room? We will propose the required room dimension in detailed engineering stage. Reference drawing: 1) NV-WS-104 2) RH-WS-102 3) KO-WS-106 4) BT-WS-108	You can propose the alternative size with the supporting documents for the selection RO plant room, subject to client's approval	Ga. Kolamaafushi N. Velidhoo R. Hulhudhuffaaruu Thulhadoo	
13	Please advise the diameter of the copper pipe required for the water meter	Pipe dia shall be as per the size of Water meter	Ga. Kolamaafushi N. Velidhoo R. Hulhudhuffaaruu Thulhadoo	
14	Please confirm if there are any specifications to follow for the design of sewerage treatment system	Refer to the attached STP specification	Gdh. Gadhadoo	
15	Please confirm that the design incoming BOD5 and suspended solids are 91.25kg/day (250mg/l) and 109.4kg/day (300mg/l) respectively. In addition, the discharge BOD5 and suspended solids are 14.60kg/day (40mg/l) and 54.75kg/day (150mg/l) respectively.	The design data is correct	Gdh. Gadhadoo	
16	In drawing no. GG-SW-116, there are two different configurations of sewage treatment units. Please confirm which configuration to follow.	The configurations are same , and represent the Process flow of STP	Gdh. Gadhadoo	
17	Please confirm the location of pump station and CWWTP?	Location shown on the Layouts	Gdh. Gadhadoo	



18	Please advise if there is a sample drawing for maintenance shaft	Check The provided Typical Details for Maintenance shaft	Ga. Kolamaafushi Gdh. Gadhoo N. Velidhoo R. Hulhudhuffaaru Thulhadoo	
19	BT-EL-102 require 5 nos of lifting station ALTS panels at 40A + 33 KVa generator. Quantity does not tally with BOQ. Please advise which to follow, BOQ list or drawing?	Follow the Drawing	Thulhadoo This is similar case for all 5 islands	



20	BT-EL-103 require 1 no of lifting station ALTS panels at 80A + 63 KVA generator. Quantity does not tally with BOQ. Please advise which to follow, BOQ list or drawing?	Follow the Drawing	Thulhadoo This is similar case for all 5 islands	
21	<u>BOQ</u> Item 4.4.7 (350A), Item 4.4.8 (60A) and Item 4.4.9 (125A) ATS Panels cannot be found on any drawing <u>Drawings</u> 5 nos of 40A, 1 no of 80A and 1 no. 300A (BT-EL-108) is not in the BOQ	Follow the Drawing	Thulhadoo This is similar case for all 5 islands	
22	BOQ Item 4.6.1 (Earth Pits), Item 4.7.1 (Lightning protection system) and Item 4.4.3 (diesel generators) Earth Pits/Earthing to follow design as per DWG BT-EL-107?	Follow the Drawing	Thulhadoo This is similar case for all 5 islands	
23	Is there any information on the location or area required for lightning protection?	Each individual building has to be protected against the expected area lightning risk	Ga. Kolamaafushi Gdh. Gadhoo N. Velidhoo R. Hulhuthuffaaruu Thulhadoo	
24	Is there any information/location on telephone system in BOQ under Electrical Worksheet ?	Please refer B. O. Q page No. 21	Ga. Kolamaafushi Gdh. Gadhoo N. Velidhoo R. Hulhuthuffaaruu Thulhadoo	
25	DWG NV-EL-108 (N. Velidhoo) shows the lighting and electrical DB schedule for the office and plant room. Is there such drawings for the other 4 islands?	Yes, there is a drawing for other islands also. Refer Dwg No. KO-EL-108, RH-EL-108, BT-EL-109,	N. Velidhoo	



S.No	Queries	Reply/Clarification	Date Sent
1	1. Has the design been approved by EPA and locations of lift stations, Pumping station etc been approved by Housing Ministry?	The Design is approved by EPA and LS and PS locations approved by Housing Ministry	
2	2. As per our survey we have found that some of the lift stations are located on private house hold lots. Is it possible to construct the lifting stations at such locations? Example LS-2 & LS-4 of Kalamafushi Island and LS-1 of Gadhooc.	The LS and PS locations are finalized by Housing Ministry and Local Councils, Any changes to the same will be confirmed by Mee during project execution phase	
3	3. As per our survey we have found that lot of private house hold septic tanks/lunjunctions are installed on the roads of the island which will definitely be an obstruction for laying the proposed pipes. Some of them can be seen from the ground surface whereas some are not. How do we have to deal with these things during the construction phase? Should we have to include the cost for removing these items & making temporary arrangement? If so please include the item in BOQ.	Bidder may include the cost of removing obstructions under BOQ item 2.1.1( Site preparation)	
4	4. To avoid damages to underground facilities it is necessary to have as-built drawings of the existing networks & structures laid under the ground of each island. Kindly please provide the as-built drawings of all services in the islands. Should we have to bear the cost for damages of anything that has no as-built records?	As built drawings of existing utilities will be provided for successful bidder upon contract award. Contractor will be liable for any damages to the existing structures during project execution although no records are available for as built of existing services.	
5	5. Please provide the pumping main layout to enable us to determine the full material requirement.	Refer to the sewerage Layout Drawings	
6	6. Also rather than laying separate pipe line from each lifting station to pump station, would it be possible for you to revise the design to a single pipe of bigger diameters, as this will avoid installation of numerous pipe lines?	All LS ,Discharging into single pipe of large dia is not advisable, any damage to the main pipe would render the system non functional.	
7	6. Please specify the dimensions of the lifting stations and pumping stations. Also if possible please recommend acceptable manufacturers/suppliers for the packaged lifting station.	Refer to the Typical LS and PS details, Refer to "Grundfos" or similar Package Lift Stations" from suitable Supplier	
8	7. Time period for preparing & submission of bids are found to be very short. Kindly request for extension of time for bid submission.	Will be informed by MoFT	
9	8. Discrepancy in the diameter size of manhole on drawings & BOQ. As per the drawings the dia of manholes are 1000mm however in the BOQ it has been stated that 600mm. Which one shall be governed?	The manholes are of size 1000 mm dia with a 600 mm dia access cover	
10	9. Discrepancy in the pipe material for water network on technical specification & BOQ. Specification section 25.10, Part1, 1.02B, 1.03A and Part2, 2.01A states that water distribution pipes has to be uPVC material whereas the BOQ states that the pipe material shall be HDPE. As per the EPA guideline it has to be HDPE material. Hence MWSC will be quoting for HDPE pipe materials & fittings.	HDPE pipe shall be used as per MEE guidelines	



11	10. HDPE pipe dia 100mm and dia 80mm. Please specify whether this is OD, ID or ND?	This is ND	
12	11. As per the Specification section 2510, Part1, 1.02B, 1.03A and Part2, 2.01A the pressure rating for the pipes of water distribution has to be minimum 8bar. As per the EPA guideline the testing pressure has to be 9bars. MWSC will be quoting for high standard as per EPA guideline.	Pressure testing of Pipes in accordance with EPA guidelines	
13	12. Please explain the rain water collection process in detail. How is the rain water transferred to the storage tanks from the collection points?	Refer to The Detail Design Report for System Description	
14	13. STP is stated to be optional. Is it in the bidder's discretion to quote for it or not? Or even though it is optional will it be mandatory to be quoted? Is there a possibility of awarding the project including STP?	Bidder may quote for STP works. STP will be part of the full contract.	
15	14. In Kolamaafushi Island the sea outfall pump station & STP are located on two different ends of the island far apart and the outfall location is near PS. If the project is awarded with STP should it be effecting on the outfall location and pumping lines. If so how will the change will be addressed. Please include the sewerage line from PS to STP in the BOQ.	The LS and PS locations are finalized by Housing Ministry and Local Councils, Sewage line can be included, any additional changes will be subject to client approval	



16	15. Discrepancies found on the sizes of GRP tanks on all islands. Because of this we are unable to quote for the item hence please advise which one to be followed?  <ul style="list-style-type: none"> <li>Dimensions given on drawings are not matching (LAYOUT DIAGRAM and GRP WATER TANK)</li> <li>Dimensions given on the drawings and BOQ are not matching.</li> <li>Example of the details of GRP tank size given for 1 island is tabulated below.</li> </ul>	Refer to the Respective Water tank drawing , sizes as per the required Volume.	
		Refer to the Respective Water tank drawing , sizes as per the required Volume.	
		Refer to the Respective Water tank drawing , sizes as per the required Volume.	
		The contractor can select the Tank sizes as per the required volume subject to the approval from Client	
17	<b>Kolamaafushi Drawing (Layout) BOQ</b>		
	Tank-1 15,500x10,000	8600x10,000x6000 mm	The contractor can select the Tank sizes as per the required volume subject to the approval from Client
	Tank-2 5,500x10,000	2,900x10,000x6000 mm	The contractor can select the Tank sizes as per the required volume subject to the approval from Client
	Tank-3 3000x5000	6,200x3,000x4000 mm	The contractor can select the Tank sizes as per the required volume subject to the approval from Client
	Tank-4 3,000x3,000	2,100x3,000x4000	The contractor can select the Tank sizes as per the required volume subject to the approval from Client
	Tank-5 4,000x3,000	3,000x3,000x3000 mm	The contractor can select the Tank sizes as per the required volume subject to the approval from Client
18	16. As per our GRP tank manufacturer/supplier, the height of the tanks are limited to 5m and panel sizes comes in 1 m x 1m x 1m & 0.5m x 1m. Could you revise the design based on the availability of the item in market if not please recommend a supplier who could supply the tanks as per your design.	The contractor can select the Tank sizes as per the required volume subject to the approval from Client	

Sl. No	Queries	Document Reference	Reason for query	Clarifications
1	Is this contract a works contract employing Measure and Pay basis or Lump Sum basis one?		Not Clear	The contract is a "Lumpsum" contract; clearly mentioned in the Pricing preambles of BOQ section.
2	It refers to single stage two envelop procurement. If it is so, what is the basis of evaluation for Technical and Financial proposals?		Not Clear	Bid evaluation will be based on the criteria stipulated in Section III-"Evaluation and Qualification Criteria" of the Bidding document
3	What Technical proposals are to be submitted by the bidders?		Not Clear	Shall be as per Section IV- Bidding forms
4	What is the tax reimbursement policy on this project?		Not Mentioned	Shall be as per MIRA regulations
5	Financial effect of change in quantities measured by the contractor is to be borne by the contractor	Specifications	The format of the BOQ of this contract matches with works contract and therefore actual quantities shall be paid for to the contractor.	This is a lumpsum contract. Any change in quantity during project execution will be addressed with Variation Orders.
6	There shall be an allowable leakage for pressure testing of pipes	Specifications	Zero leakage is not practical	Leakage allowance is mentioned in Specifications
7	Should the as built drawings be based on global coordinates?	Specifications	Cost of work will be remarkably high with global coordinates	Bench Marks will be provided at site by the Consultant. As built shall be based on these Bench Marks.
8	Is the work coming under this project tax exempted?	Financial	Pricing is based on this aspect	Tax not exempted. Tax will be applied as per MIRA regulations



9	Are the custom duties for imported materials tax exempted?		Rates will be based on this query	Refer to Tender Documents
10	How is the payment for the well carried out, if the contractor fails to obtain right quantity or right quality of water in the first drilling of a well?		Drilling of a borehole well for fresh water and finding adequate quantity of water in the well can be a trial and error job.	pricing for 6 trail bore wells is mentioned in BOQ, Ref BOQ. Water Supply and Treatment Equipment, item D
11	Location for the tube well is not indicated in the drawing and need to be shown.		Drilling of a successful well may be hard if the location is not shown.	Refer to RO Plant Layout Drawing
12	Location of the extraction of water for the RO plant is not shown		Different locations may bring different water qualities needing different interventions for treatment.	Refer to RO Plant Layout Drawing



S.NO	Queries	Reply/Clarification	Date Sent
1	RO plant & admin building size of water production system is not matching with the BOQ & drawings.	If the Approved RO Plant size doesn't conform to the Building sizes, Final Sizes of the Building to be as per RO Plant manufacturer recommendation along with supportive documents, subject to client's approval	
2	RO plant & admin building size of water production system is not matching with the plan drawing & structural drawings.	If the Approved RO Plant size doesn't conform to the Building sizes, Final Sizes of the Building to be as per RO Plant manufacturer recommendation along with supportive documents, subject to client's approval	
3	In BOQ of B.Thulhaadhoo has separate two items for RO Plant Building in "3.3.1.4 Design and construction of RO Plant Building including Generator room (Aprox = 32m2)" and in "3.3.4.1 RCC RO Plant Building, overall size approximately 7600mm x 4400mm, inclusive of all electromechanical items as shown on Drawings." Please clarify this.	The item 3.3.14 "Design and construction of RO Plant Building including Generator room (Aprox = 32m2)" shall be deleted from the BOQ and the details of the same building can be referred from the modified item 3.3.4.1 "Design and Construction of RCC RO Plant Building (1 No.), overall size approximately 7600mm x 4400mm, inclusive of Generator room and all electromechanical items as shown on Drawings".	
4	In the BOQ of R.Hulhuthufaaruu, N.Velidhoo and Ga.Kolaamaafushi under 3.3.4 RO Building, 3.3.4.1 includes design of RO Building. Since RO plant building design already consists in drawings, is it required to provide price for design of RO building.	RO Plant Building design is included in the drawings for the item 3.3.4.1 in the BOQ of R.Hulhuthufaaruu, N.Velidhoo and Ga.Kolaamaafushi.	



# Nominal Pipe Size Conversion to Metric Size

The following article is taken from the *Construction Metrication* newsletter published by the Construction Metrication Council of the National Institute of Building Sciences.

Pipe is one of the most ubiquitous products in construction. It is made of a wide variety of materials, including galvanized steel, black steel, copper, cast iron, concrete, and various plastics such as AB, PVC, CPVC, polyethylene, and polybutylene, among others.

But like wood 2-by-4's, which are not really 2 inches by 4 inches, pipe is identified by "nominal" or "trade" names that are related only loosely to actual dimensions. For instance, a 2-inch galvanized steel pipe has an inside diameter of about 2-1/8 inches and an outside diameter of about 2-5/8 inches. It is called "2-inch pipe" only for the sake of convenience.

Since few, in any, pipe products have actual dimensions that are in even, round inch-pound numbers, there is no need to convert them to even, round metric numbers. Instead, only their names change – from inch-pound to metric. Pipe cross sectional sizes do not change. Fittings, flanges, couplings, valves, and other piping components are renamed in like manner, as are pipe threads.

Here are the inch pound names for pipe products (called NPS or "nominal pipe size") and their metric equivalents (called DN or "diameter nominal"). The metric designations conform to International Standards Organization (ISO) usage and apply to all plumbing, natural gas,

NPS	DN	NPS	DN
1/8"	6 mm	8"	200 mm
3/16"	7 mm	10"	250 mm
1/4"	8 mm	12"	300 mm
3/8"	10 mm	14"	350 mm
1/2"	15 mm	16"	400 mm
5/8"	18 mm	18"	450 mm
3/4"	20 mm	20"	500 mm
1"	25 mm	24"	600 mm
1-1/4"	32 mm	28"	700 mm
1-1/2"	40 mm	30"	750 mm
2"	50 mm	32"	800 mm
2-1/2"	65 mm	36"	900 mm
3"	80 mm	40"	1000 mm
3-1/2"	90 mm	44"	1100 mm
4"	100 mm	48"	1200 mm
4-1/2"	115 mm	52"	1300 mm
5"	125 mm	56"	1400 mm
6"	150 mm	60"	1500 mm
For pipe over 60", use 1" – 25 mm			

heating oil, and miscellaneous piping used in buildings. Reinforced concrete pipe and corrugated steel pipe used in highways and other civil works construction also use these designations.



Note that all whole-number inch designations on the following chart convert to multiples of 25 mm except for 3-inch pipe, which ISO designates as 80 mm.

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#### Metric Rules-Of-Thumb

1 mm = about 1/25 inch = thickness of a dime

25 mm = about 1 inch (1" = 25.4 mm)

300 mm = about 1 foot (12" = 304.8 mm)

1 m<sup>2</sup> = roughly 10 sq. ft. (1 m<sup>2</sup> = 10.76 sq. ft.)

1 L = about 1 quart (1 L = 1.06 qt.)

1 kg = about 2.2 pounds

1000 kg = 1 Mg = 1 metric ton = about 2200 lbs.



**PART 1 - GENERAL**

**1.01 RELATED DOCUMENTS**

- A. Submitted electrical drawings

**1.02 SUMMARY**

- A. This section includes the following
  - 1. PV modules
  - 2. Mounting structures
  - 3. Automatic change over
  - 4. Charge controllers
  - 5. Multimode Hybrid Inverters / Chargers with possibility for grid – tie for feed – in tariff.
  - 6. Batteries
  - 7. Battery monitoring system.
  
- B. The PV modules specified herein are based on the concept design. Contractor shall use this document for guidance in preparation of procurement strategy and costing purpose only. Revised IFC specifications, drawings and schedules shall be issued prior to start of construction
- C. Mock-up: shall be required to be installed on a location determined by the client. The purpose is to demonstrate the system capability and performance prior to final installation.
  - 1. Install mock-up and obtain Engineer's approval prior to proceeding to the main installation.
  - 2. Schedule: mock-up shall be arranged before the scheduled final installation without affecting the project schedule. Allow enough time for installation, inspection by Engineer and providing comments / approval.
  - 3. An array of 12 panels minimum shall be used.
- D. This specification is performance based and might not necessarily list all required components, ancillaries and accessories. It shall be the contractor responsibility to develop the solution and provide a complete operational solution to the satisfaction of the engineer, where all required components/ancillaries are deemed to be included for a good operation as intended.

**1.03 SYSTEM SELECTION REQUIRMENTS**

- A. PV modules to be submitted shall be based on a complete system design solution, supported by detailed calculations to substantiate the selection made. The proposed solution shall include PV modules, appropriate



## PHOTOVOLTAIC EQUIPMENT

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selection of charge controller, the required automatic change over, inverters, battery chargers, batteries, wires and wire ways, etc.

- B. All necessary protection equipment shall be provided as per code requirements. This includes fuses, breakers, surge protection and the like for safety purpose.

### 1.04 DEFINITIONS

- A. IP code: Required ingress protection to comply with IEC 60529
- B. MPPT: Maximum power point tracking
- C. PV: Photovoltaic.
- D. STC: Standard Test conditions defined in IEC 61215
- E. NOCT: Normal operating cell temperature
- F. Cnom: Battery nominal capacity at 10 hours discharge at 20 deg C according to DIN 40742
- G. Cj., C5, C3 and Cj: Battery capacity at 1 Oh,5h,3h and 1 hour discharge at 20 deg C.

### 1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product based on complete and approved system solution.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for PV panels.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For PV modules.
  - 1. Include plans, elevations, sections, and mounting details
  - 2. Include details of equipment assemblies
  - 3. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 4. Penetration plan and details
  - 5. Details fabrication and assembly
  - 6. Include diagrams for power, signal, and control wiring.
- C. Detailed system calculation and requirements/design, as specified under article 1.3"system selection requirements" above

### 1.06 INFORMATIONAL SUBMITTALS

- A. General: submit listed submittals in accordance with contract conditions and section submittal procedures.
- B. Test and Evaluation Report:
  - 1. Certified test reports showing compliance with specified performance characteristics and physical properties
- C. Manufacturer's instruction: submit manufacturer's storage and installation instructions.
- D. Source Quality Control: Submit documentation verifying that components and materials specified in this section are from a single manufacturer.



## PHOTOVOLTAIC EQUIPMENT

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### E. Qualification statements:

1. Submit letter of verification for manufacturer's qualifications.
2. Submit letter of verification for installer's qualifications.

### F. Field quality-control reports

### G. Sample Warranty: For manufacturer's special materials and workmanship warranty and minimum power output warranty.

## 1.07 CLOSEOUT SUBMITTALS

### A. Operation and maintenance data: For PV modules to include in operation and maintenance manuals. Include as a minimum:

1. Manufacturer's instructions detailing maintenance requirements.

## 1.08 QUALITY ASSURANCE

### A. Qualifications:

#### 1. Manufacturer:

- a. having minimum of 10 years experience manufacturing components similar to or exceeding requirements of project.
- b. Having sufficient capacity to produce and deliver required materials without causing delay in work
- c. Capable of providing field service representation during construction.
- d. Manufacturing facility certified to ISO 9001 and to ISO 14001.

#### 2. Installer:

- a. Experienced installer who is an authorized representative of PV manufacturer for both installation and maintenance of units required for this project. Minimum 5 years of experience for similar installations.

### B. Local representative: provide evidence that proposed equipment manufacturer has a locally established and authorized organization which can be called upon for professional advice and maintenance as may be required, and which can immediately supply spare parts to support day to day and emergency maintenance requirements. Failure to satisfy engineer may disqualify a manufacturer.

### C. Mock-Up: Construct mock-up as follows:

1. Purpose: Construct showing solar electric module to judge quality of work, substrate preparation, and operation of equipment and material application.
2. Dimensions and Process: Construct the required dimensions as directed by the Engineer, using proposed procedures, colors, textures, finishes and quality of work.
3. Locate where directed by the Engineer



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4. Do not proceed with work prior to receipt of written acceptance of mock-up.
5. When accepted, mock-up will demonstrate minimum standard of quality required for this work. Approved mock-up may, or may not, remain part of finished work, as directed by the Engineer.

### D. Reference Standards:

1. American National Standards Institute (ANSI):
  - a. ANSI/UL 1703 Standard for Flat-Plate Photovoltaic Modules and Panels (Or approved equal European Standard).
2. International Electrical Commission (IEC):
  - a. IEC 61215 International Standard (Extended Version) - Crystalline silicon terrestrial photovoltaic (PV) modules - Design qualification and type approval.
  - b. IEC 61646 International Standard - Thin-film terrestrial Photovoltaic (PV) modules - Design qualifications and type approval.
  - c. IEC 61730-1 International Standard - Photovoltaic (PV) module safety qualification - Part 1 - Requirements for construction
  - d. IEC 61730-2 International Standard - Photovoltaic (PV) module safety qualification - Part 2 - Requirements for testing.
3. International Organization for Standardization (ISO):
  - a. ISO 9001 Quality Management Systems.
  - b. ISO 14001 Environmental Management Systems.
4. Underwriters Laboratories, Inc. (UL):
5. Underwriters Laboratories, Inc. (UL):
  - a. UL 790 Standard Test Methods for Fire Tests of Roof Coverings (Or approved equal European Standard).
  - b. UL 1703 Standard for Flat-Plate Photovoltaic Modules and Panels (Or approved equal European standard).
6. PV installation shall comply with NEC Article 690 Solar Photovoltaic Systems, or approved equal European Standard.

E. Products shall be sourced either directly from manufacturer, or from authorized agent/representative.

## 1.09 DELIVERY, STORAGE & HANDLING

### A. Delivery and Acceptance Requirements:



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1. Deliver material in accordance with the related sections of this specification, and in accordance with manufacturer's written instructions
  2. Deliver materials in manufacturer's original packaging with identification labels intact and in sizes to suit project.
- B. Storage and Handling Requirements:
1. Store materials protected from exposure to harmful weather conditions and at temperature conditions recommended by manufacturer.

### 1.10 COORDINATION

- A. Coordinate layout and installation of PV modules components with roof skin and other construction and electrical work, including conduit, piping, equipment, adjacent surfaces, raceways, electrical boxes and fittings, and cabling/wiring work. Maintain required workspace clearances and required clearances for equipment access
- B. Coordinate size and location of mounting structures.

### 1.11 CLIMATIC CONDITIONS

- A. Equipment is to be designed and derated for continuous and trouble free service under the following climatic conditions of Maldives:
  1. Altitude: Coastal sea level.
  2. Maximum ambient temperature: 50 deg C (in the shade).
  3. Minimum ambient temperature: 10 deg C .
  4. Maximum relative humidity: 100 percent.
  5. Atmospheric conditions: Sandy, heavy condensation air blown salinity, and sand storms also prevail.
- B. Equipment, apparatus, material accessories outdoors is to be corrosion and salinity proof. UV stabilized requirement shall be applied for outdoor installations and their surface finish and due certification be provided by manufacturer as necessary.
- C. Manufacturer to calculate how much module power will be lost or gained due to temperature shifts. In hot climates, cell temperatures can reach an excess of 70 deg C.

### 1.12 WARRANTY

- A. Manufacturer's Special Materials and Workmanship Warranty: Manufacturer agrees to repair or replace components of PV modules that fail in materials or workmanship within specified warranty period.
  1. Manufacturer's materials and workmanship warranties include, but are not limited to, the following:



- a. Faulty operation of PV modules.
- b. Defects in materials and workmanship and hot spots.
2. Warranty Period: Five years from date of Substantial Completion
- B. Manufacturer's Special Minimum Power Output Warranty: Manufacturer agrees to repair or replace components of PV modules that fail to exhibit the minimum power output within specified warranty period. Special warranty, applying to modules only, applies to materials only, on a prorated basis, for period specified.
  1. Manufacturer's minimum power output warranties include, but are not limited to, the following warranty periods, from date of Substantial Completion:
    - a. Specified minimum power output to 90 percent or more, for a period of 12 years.
    - b. Specified minimum power output to 80 percent or more, for a period of 25 years.

### 1.13 EXTRA MATERIALS

- A. Spare Parts List:
  1. Provide spare parts as per manufacturer recommendation
- B. Tools and Instruments: Provide tools and instruments required for normal routine inspection, testing, operation and general maintenance, as recommended by the manufacturer.
- C. For PV modules, furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents. Deliver extra materials to the Project site.
  1. PV modules: 2 for every 100 of each type and rating, but not less than 2 of each

## PART 2 - PRODUCTS

### 2.01 STANDARD COMMERCIAL PRODUCTS

### 2.02 SYSTEM DESCRIPTION

1. Connected to a battery bank to provide electricity to Project.
2. The off-grid PV system has a utility back-up
3. System shall generate a total nominal rating of 300 kWp minimum
4. System Components:
  - a. Cell materials
  - b. PV modules.
  - c. Array frame.
  - d. Mounting structure.
  - e. Charge Controller.
  - f. Multimode Hybrid Inverter/Charger.



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Other system components including hybrid inverter/chargers, batteries, over current protection/combiner boxes, etc. are specified in a different section, and are part of contractor's scope

### 2.03 MANUFACTURED UNITS

A. Cell Materials: Polycrystalline

B. Module Construction:

1. Nominal Size: 1999 mm x 981 mm x 40 mm.
2. Weight: 27.8 Kg approximately.
3. Material Composition: 60-cell polycrystalline photovoltaic modules incorporating anti-reflective coated (ARC) glass with an aluminum frame, integrated bypass diodes and MC4 connectors.

C. Performance/Design Criteria:

1. Certified according IEC 61215 (Design qualification and type approval).
2. Certified according to IEC 61646.
3. Certified according to the IEC 61730-1.
4. Certified according to the IEC 61730-2.
5. Complies with UL 790, Class C.
6. Listed to ANSI/UL 1703 (Or Approved European Equal).
7. Loading:
  - a. Frames capable of withstanding loads of not less than 50 psi (2400Pa) in a variety of mounting methods, and suitable for the specified project climatic conditions. Module shall also withstand extreme wind loads anticipated in the project location.

D. Front Panel: Fully tempered glass with antireflective coating

E. Bypass Diode Protection: Internal.

F. Junction Box

1. Size: 39.6 by 100.6 by 13.2 mm.
2. Fully potted, vandal resistant.
3. IP Code: minimum IP66
4. Flammability Test: UL 1703

G. Output Cabling:

1. Quick, multiconnect, polarized connectors.
2. Two-Conductor Harness: No traditional return wire is needed from the end of a row back to the source combiner.

### 2.04 CAPACITIES AND CHARACTERISTICS

A. Minimum Electrical Characteristics (STC):

1. Rated Open Circuit Voltage ( $V_{oc}$ ): 37Vdc.
2. Rated Operating Voltage ( $V_{mp}$ ): 29.8 Vdc
3. Rated Short-Circuit Current ( $I_{sc}$ ): 8.5 A
4. Rated Operating Current ( $I_{mp}$ ): 8.1 A.
5. Maximum Power at STC ( $P_{max}$ ): 240 Wp



B. Minimum Electrical Characteristics (NOCT):

1. Rated Open Circuit Voltage ( $V_{oc}$ ): 34 Vdc.
2. Rated Operating Voltage ( $V_{mp}$ ): 27 Vdc.
3. Rated Short-Circuit Current ( $I_{sc}$ ): 6.8 A.
4. Rated Operating Current ( $I_{mp}$ ): 6.5 A.
5. Maximum Power at NOCT ( $P^{\wedge}$ ): 175 Wp.

C. Other Additional Electrical Characteristics:

1. Tolerance of  $P_{max}$ : 0 to +5 percent.
2. Series Fuse Rating: 20A.
3. Minimum Module Efficiency: 14.7 percent at least.
4. Wind Loading or Surface Pressure: per Maldives Condition.
5. Maximum System Voltage: 1000V dc (IEC)

D. Thermal Characteristics:

1. Operating Module Temperature: -40 deg C to + 85 deg C.
2. Temperature at Nominal Operating Cell Temperature (NOCT): 47  $\pm$  2 deg C.
3. Temperature Coefficient ( $P_{max}$ ): -0.44 %/ deg C.
4. Temperature Coefficient ( $V_{oc}$ ): -0.33%/degC.
5. Temperature Coefficient ( $I_{sc}$ ): +0.05 %/deg C.

E. PV controller,ATS,Battery are installed inside each group inverter located at roof.

## 2.05 MODULE FRAMING

A. PV laminates mounted in anodized extruded-aluminum frames.

1. Entire assembly UL listed for electrical and fire safety, Class C, according to UL 1703, complying with IEC 61215
2. Frame strength: exceeding code requirements.
3. Finish: Anodized aluminum.
  - a. Alloy and temper recommended by framing manufacturer for strength, corrosion resistance, and application of required finish
  - b. Color: As indicated by manufacturer's designations.

## 2.06 ARRAY CONSTRUCTION

A. Framing:

1. Material: Extruded aluminum.
2. Maximum System Weight: Less than 19.53 kg/sq. m.
3. Minimum Distance to Connectors to be used
4. Raceway Cover Plates: Galvanized steel

B. Flat-Roof Mounting:

1. No roof penetrations
2. Self-ballasting
3. Wind-tunnel tested to 160-km/h wind
4. Service Life: 25 years
5. Freestanding system.



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### 2.07 MOUNTINGSTRUCTURES

- A. Roof Mount: Extruded aluminum, with rails, tilt legs, and roof standoffs, unless otherwise shown on the drawings.

### 2.08 HYBRID INVERTER/CHARGER

- A. Control Type: Multi-stage process.
- B. Inverter Electrical Characteristics:
  - 1. Continuous Output Power: 7500 W – 15000W.
  - 2. DC input Voltage range: 41 to 64 Vdc.
  - 3. Nominal AC Input Voltage: 230 Vac.
  - 4. Nominal AC Input frequency: 50 Hz.
  - 5. Nominal AC Output Voltage: 230 Vac +/- 3 percent.
  - 6. Maximum AC pass through current: 56 A.
  - 7. Minimal Continuous AC Output current: 26 A.
  - 8. Maximum Total Harmonic Distorsion: 5percent at rated power.
  - 9. Continuous Battery Charging current: 100 A.
  - 10. Power Factor corrected charging: 0.98.
  - 11. Minimum Peak Efficiency: 95 percent.
  - 12. Ingress Protection: IP20.
- C. Operating Conditions:
  - 1. Operating Ambient Temperatures: Minus 25 deg C to plus 50 deg C.
  - 2. Battery Bank Size: 100 to 15000 Ah.
- D. Hybrid Inverters/Chargers shall have the following:
  - 1. Overcurrent protection.
  - 2. Automatic transfer relay.
  - 3. DC to AC Inverter.
  - 4. Battery Charger.
  - 5. Battery Temperature Sensor.
  - 6. Integrated battery monitoring system.
  - 7. Multiple-units configuration.
  - 8. Grid-interactivity option.
  - 9. Non-volatile memory.
- E. Enclosure:
  - 1. Enclosure type: NEMA 1 indoor enclosure.
  - 2. Enclosure Material: Die-cast Aluminum.
  - 3. Cooling Methods:
    - a. Active cooling system
  - 4. Protective Functions:
    - a. AC over/under voltage.
    - b. AC over/under frequency.
    - c. Ground over current.
    - d. Over temperature.
    - e. AC and DC over current.
    - f. DC over voltage
  - 5. Protective Functions:



Standard liquid crystal display, with user display and on/off toggle switch.

F. Disconnects:

1. Low-voltage disconnect.
2. Low-voltage reconnect.
3. High-temperature disconnect.
4. High-temperature reconnect.

G. Regulatory Approvals:

1. IEEE 1547.1.
2. IEEE 1547.3.
3. UL 1741.
4. Or approved equal European Standard.

H. Warranty:

1. At least 5 years.

## 2.09 BATTERIES

A. Type: 24 OPzV 3000 (according to DIN regulations).

B. Construction:

1. Sealed valve regulated lead-acid, Gel cell type.
2. Maintenance free.
3. Shippable.
4. Recyclable.

C. Performance:

1. Capable of over 1200 discharge at 80 percent Depth of Discharge.
2. Self-Discharge at 20 deg C: less than 2 percent a month.
3. Necessary recharge at least once every 6 months.
4. Deep-Cycling technology.
5. Design life of at least 15 years

D. Electrical Characteristics:

1. Nominal Voltage: 2V.
2. Nominal Capacity  $C_{nom}$ , at 1.80V/Cell: 3000Ah.
3.  $C_{10}$ , at 1.80V/Cell: 3100Ah.
4.  $C_5$ , at 1.77V/Cell: 2600Ah.
5.  $C_3$ , at 1.75V/Cell: 2260Ah.
6.  $C_j$ , at 1.67V/Cell: 1540Ah.
7. Final Discharge Voltage: 1.80V/Cell.
8. Float Voltage at 20 deg C: 2.23 V/Cell.
9. Boost Recharge, with the maximum current of  $0.25 \times C_{10}$ : 2.4V/Cell maximum.
10. Short circuit current: 18000 A
11. Internal Resistance: 0.108 mfl.

E. Operating Conditions:

1. Nominal Temperature: plus 20 deg C +/- 5 deg C.
2. Operating Ambient Temperatures: Minus 20 deg C to plus 40 deg C.
3. Battery bank consists of 2 strings of 12 batteries in series.
4. Battery Bank Size: 6000 Ah, 48 Vdc.



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- F. Batteries shall have the following:
1. Tubular positive plates.
  2. Pasted negative plates.
  3. Dilute sulphuric acid Electrolyte.
  4. High porosity, low internal resistance Separators.
  5. Plastic (ABS) Containers and Lids.
  6. One-way relief valve.
  7. Female treated terminals M10.
  8. High integrity post seals.
  9. Flexible, fully insulated Connectors.
- G. Applicable Standards:
1. IEC 60896-21
  2. IEC 60896-227
  3. DIN 40742

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

- A. Examine substrate areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Do not begin installation until mounting surfaces have been properly prepared.
- C. If preparation of mounting surfaces is the responsibility of another installer, notify Engineer of unsatisfactory preparation before proceeding.
- D. Examine modules and array frame before installation. Reject modules and arrays that are wet, moisture damaged, or mold damaged.
- E. Examine roofs, supports, and supporting structures for suitable conditions where PV system will be installed.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.02 PREPARATION

- A. Ensure structure or substrate is adequate to support solar electric module(s).
- B. Surface Preparation: Prepare surface in accordance with manufacturer's written recommendations and coordinate with relevant Sections of the specification.

#### 3.03 INSTALLATION

- A. Coordinate installation of components in accordance with manufacturer's installation instructions.
- B. Coordinate solar electric module work with work of other trades for proper time and sequence to avoid construction delays.
- C. Accurately fit, align, securely fasten and install free from distortion or defects.



**3.04 FIELD QUALITY CONTROL**

- A. Manufacturer Services: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
  - 1. Coordinate manufacturer's services. Have manufacturer review work involved in handling, installation/application, protection and cleaning of produces, and submit written reports in acceptable format to verify compliance of work with Contract.
  - 2. Manufacturer's Field Services: Provide manufacturer's field services, consisting of product use recommendations and periodic site visits, for product installation inspection in accordance with manufacturer's instructions.
  - 3. Perform tests and inspections with the assistance of a factory-authorized service representative.
  - 4. Schedule site visits to review work at stages listed:
    - a. After delivery and storage of products, and when preparatory work on which work of this Section depends is complete, but before installation begins.
    - b. Twice during progress of work at 25% and 60% complete.
    - c. Upon completion of work, after cleaning is carried out.
  - 5. Obtain reports within three days of review and submit immediately to Engineer.
- B. PV module will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

**3.05 SYSTEM STARTUP**

- A. List actions applicable to operational systems and equipment startup.
  - 1. Commission the system to ensure that it complies with applicable code requirements and manufacturer's requirements.

**3.06 ADJUSTING**

- A. Adjust components and systems for correct function and operation in accordance with manufacturer's written instructions. Coordinate with Section Starting and Adjusting.

**3.07 CLEANING**

- A. Perform cleanup in accordance with the relevant Section of the specification.
- B. Upon completion, remove surplus materials, rubbish, tools and equipment in accordance with the relevant Section of the specification.

**3.08 CLOSEOUT ACTIVITIES**

- A. Demonstration:
  - 1. Coordinate requirements for solar electric module demonstration in accordance with Section Demonstration and Training.
- B. Training: Coordinate training in accordance with Section Demonstration and Training.



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1. Instruct Owner's designated maintenance personnel in care, adjustment and operation of solar electric module system.
2. Provide competent instructor for not less than 8 hours training session(s) after completion and acceptance of work.
3. Forward statement to Owner and Engineer countersigned by maintenance personnel confirming that these instructions have been provided.

### **3.09 PROTECTION**

- A. Protect installed product from damage during construction in accordance with the relevant section of the specification.
- B. Repair damage to adjacent materials caused by solar electric module installation.

### **3.10 MAINTENANCE**

- A. Coordinate maintenance requirements with Section Closeout Submittals and Section Operation and Maintenance Data.

**END OF SECTION**

