

# **REPUBLIC OF LEBANON**

## **MINISTRY OF ENERGY AND WATER**

### **COUNCIL FOR DEVELOPMENT AND RECONSTRUCTION**

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#### **CONTRACT No 19841**

#### **CONSTRUCTION OF DRILLING WATER WELLS, PUMPING STATIONS AND LIFT LINES IN BEINO AND DEIR NBHOUH AREAS**

#### **VOLUME 4**

#### **PARTICULAR SPECIFICATIONS**

**Part 1 - General Requirements**

**Part 2 - Civil Works**

**Part 3 - Mechanical Works**

**Part 4 - Electrical Works**

**Part 5 - Instrumentation and Control**

**Part 6 - Testing and Commissioning of Mechanical/Electrical Equipment**

**Part 7 – Boreholes**

**Part 8 – Solar Energy**

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**MINISTRY OF ENERGY  
AND WATER**

**COUNCIL FOR DEVELOPMENT  
AND RECONSTRUCTION**

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## **PART 1**

### **GENERAL REQUIREMENTS**

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## **PART 1**

### **101. GENERAL REQUIREMENTS**

#### **101.1 APPLICATION OF PARTICULAR SPECIFICATION**

This Particular Specification is to be read and construed together with the General Specification contained in Volume 3 of the Contract Documents for this Tender. In case of ambiguities or discrepancies between this Particular Specification and the General Specification, the Particular Specification shall prevail, except if and to the extent otherwise provided by the Contract or directed by the Engineer.

Whenever the term “Specification” without further qualification is used in the Contract Documents, it shall mean the General Specification together with the Particular Specification.

#### **101.2 LOCATION OF WORKS**

In Beino village at Akkar Caza, the Works cover the deepening and equipping of existing well, the construction and equipping of pumping stations, the construction of a water tower the supply and installation of a new solar energy system to operate the well, the supply and laying of transmission lines (lift line from well to water towers) and construction of additional distribution lines to be connected to the existing network.

In Deir Nbouh Village at Miniyeh Danniyeh Caza, the work covers the drilling and equipping of a new borehole and the supply and installation of all necessary electro-mechanical equipment. In addition, the construction of lift lines, break tanks, pumping stations, and connection to the existing reservoirs, is to improve the water resources at the mentioned villages, due to the scarcity of rain in the last few years and consequently, the severe recession of all springs and wells.

#### **101.3 THE SITE**

The existing well location, pumping station, and proposed water tower in Beino are owned by the municipality and prior to the execution of the works, this site will be privatized to the North Lebanon Water Establishment.

The proposed well and pumping station site in Deir Nbouh is public and prior to implementation of the works, this site will be privatized to the North Lebanon Water Authority.

For work along pipelines within public roads and tracks, the limits of the Site (Conditions of Contract Sub-Clause 1.1) shall be the limits of land in public ownership which shall be taken to be any boundary fence or wall or if there is no such clearly identified boundary the width shall be taken as one meter beyond the edge of the carriageway.

For work along pipelines within private land or open country the Site shall comprise an easement width conforming to the relevant land acquisition documents.

In some areas, the width of the Site will be physically restricted by physical boundaries such as boundary walls or by natural topographic features. The Contractor shall have inspected the Site (Conditions of Contract Sub-Clause 1.1) and shall have included for the provision of any additional working area that he may require outside the limits of the Site (Conditions of Contract Sub-Clause 58.2).

## 101.4 SCOPE OF WORK

The construction works in the present contract are listed below:

### 1-Beino Village:

- Construction of transmission line; lift line from existing well to the proposed water tower. The length-line is 82 meters with a diameter of 150 mm and pipe material ductile iron C40.
- Construction of a distribution line from the proposed water tower to the existing network with a length of 154 m, a diameter of 200 mm and pipe material of Ductile Iron C40.
- Construction of extension distribution lines for the network to be connected to the existing distribution network. The total length of these distribution lines is 3,323m, HDPE material PE 100 and with a diameter of 63 mm.

Distribution Network	DI Pipes	HDPE Pipes	Service Connections	Service Connection Pipes	Water Meters
	(m)	(m)	(nb)	(m)	(nb)
Beino	318	3,323	54	933	54

- Deepening, drilling and equipping Beino borehole (Flow 15 l/s, 200 m depth)
- Construction and Equipping of Beino Pumping Station (Flow:16.5 l/s, Hm=150 m), including the following:
  - Supply and installation of submersible motor pump set for the well.
  - Supply and installation of pipes and hydraulic accessories (rising column, valves, air-release valves, check valves, gate valves, etc...).
  - Supply and installation of liquid chlorination system.
  - Supply and installation of an electrical system
  - Supply and installation of an instrumentation and control system
  - Supply and installation of internal and external electrical lighting, wiring, switches, etc....
  - Supply and installation of one standby generator and fuel tank.
  - Supply and installation of EDL transformer with subscription to EDL.
  - Supply and installation of telemetry cable.
  - Conduction of semi-industrial and industrial testing.
  - Operation of the well for a couple of days prior to its commissioning.
- Construction of a 30 m Water Tower of 300 m<sup>3</sup> capacity.
- Construction of a new solar energy system to operate the well. (Optional Part)

2-Deir Nbouh Village:

- Drilling of borehole.
- Supply and installation of well casing.
- Well development and testing.
- Excavation and backfilling.
- Supply and installation of well submersible pumps.
- Supply and installation of rising steel pipes.
- Supply and installation of surface motor pump set for booster station.
- Supply and installation of an electrical control panel.
- Supply and installation of connecting pipes and hydraulic accessories (valves, air-release valves, check valves, etc...). to link the boreholes to the new break tank or existing reservoir.
- Supply and installation of electromagnetic flow meters.
- Supply and installation of gas chlorinator units.
- Construction of new pumping station buildings.
- Construction of a new lift line.
- Construction of a well-head concrete structure.
- Conduction of semi-industrial and industrial testing.
- Operation of the well for a couple of days prior to its commissioning.



## **101.5 CONDITIONS PREVAILING AT THE SITE OF WORKS**

The Contractor's attention is drawn to his obligation to satisfy himself, before submitting his Tender, as to the conditions prevailing at the Site of Works and its surroundings (Clause 11 of Conditions of Contract) and relevant sections of the General Specification for Civil Engineering Works.

## **101.6 PRIVATE LANDS**

The Contractor shall not enter upon or occupy with men, tools, or materials of any nature, any lands other than the working areas shown on the Drawings, except after consent shall have been received by him from the proper parties and a certified copy of such consent shall have been furnished to the Engineer. Any rentals or damages paid for occupying private lands shall be at the Contractor's expense.

## **101.7 EXISTING SERVICES**

In the course of works, the Contractor will encounter within the limits of the working areas and in the vicinity, miscellaneous above-ground and underground services such as drains, pipes, cables, telephone and electric poles and lines, water supply and similar existing services. The Contractor's attention is directed to the provisions of Clause 101.12.4 of the General Specification with regard to such existing services.

## **101.8 ACCESS ROADS**

### **101.8.1 TEMPORARY ACCESS ROADS**

The necessity of construction of Access Roads and/or temporary roads may arise, in which case such temporary roads shall be subject to the provisions of Clause 101.12.3 of the General Specification for Civil Engineering Works, and shall be executed at the contractor's responsibility and expenses in coordination with the concerned Authorities and according to the Engineer's requirements.

## **101.9 PROGRAM AND MONITORING**

It is a primary requirement of the Employer that a comprehensive knowledge of the status of progress to date, predicted progress, costs and cash flow forecasts is available at all times. The Contractor shall be responsible of the requisite information and shall be responsible for programming the Works, preparation of cash flow estimates and measuring and reporting the progress of the works in an approved format. In order that programming, progress measurements and reporting is executed in a timely and efficient manner, the Contractor shall program the Works, monitor progress and generate cost reports and cash flow projections by utilizing a recognized industry standard approved P.C. based Project Management software package.

The Contractor's master program and cash flow estimates and subsequent updates, submitted in accordance with Clause 14 of Conditions of Contract shall, as a minimum, detail the

sequence of procurement, installing, testing and commissioning, and handing over for each of the work's items including each item described in the Bill of Quantities.

At least 21 days prior to taking possession of any portion of the Site and starting of work, the Contractor shall submit a detailed construction program for that portion of the Site. The detailed construction program shall be to a level to adequately identify the intended sequence of working on each individual item of work. The minimum level of detail shall not be less than that needed to identify each individual payment item included in the Bill of Quantities.

The Engineer's obligation to measure the Works in accordance with Sub-Clause 56.1 of the Conditions of Contract shall be dependent on the Work being programmed and progress being monitored and reported in accordance with the requirements of the Contract.

#### **101.10 LIST OF ABBREVIATIONS**

In the Contract Documents, the following abbreviations have been employed:

uPVC	- Unplasticized Polyvinyl Chloride
D.I.	- Ductile Iron
R.C.	- Reinforced Concrete
C.I.	- Cast Iron
G.S.	- General Specification
C.O.C.	- Conditions of Contract
B.O.Q.	- Bill of Quantity
PN	- Nominal Pressure
DN	- Nominal Diameter
ID	- Inner Diameter
OD	- Outer Diameter

#### **101.11 OR EQUAL CLAUSE**

Wherever references to Standard Specifications, such as British Standards, are made, they shall not be construed to restrict materials to British products. Materials from other scheduled countries will be considered provided that the producer of the material certifies its conformity to the appropriate Standard Specification.

Similarly, whenever a required material or article is specified or shown in the plans by using the name of the proprietary product or of a particular manufacturer or vendor, any material or article which will perform adequately the duties imposed by the general design will be considered equal and satisfactory provided the material or article so proposed is of equal substance and function in the Engineer's opinion. It shall not be purchased or installed without his written approval.

#### **101.12 GOVERNMENT REGULATIONS**

The Contractor shall comply with all provisions of the rules, regulations and orders of Government and Municipal agencies, such as the Public Works Department, Electricity of Lebanon, and Telecommunications Authority.

The Contractor shall co-operate with the Employer in promptly furnishing any information that may be required by such governmental agencies. It shall be the obligation of the

Contractor to keep himself informed of these governmental rules, regulations, and orders and the Contractor shall make the requirements of this article a part of any sub-contract he may enter into.

### **101.13 FACILITIES FOR THE ENGINEER'S REPRESENTATIVE**

Refer to the text of section 101.22 of Volume 3 - Technical Specifications - Part 1 - General Requirements

The Contractor shall provide any necessary protective clothing and safety equipment for the use of authorized visitors to the site including the Employer and his staff and Representatives and those of any relevant authority who have reason to visit the site.

### **101.14 ACCESS TO WORK**

The Engineer and his duly appointed representatives and the Employer or his representatives or agents may at any time and for any purpose whatsoever enter into and upon the work and the premises used by the Contractor. The Contractor shall provide free, proper, and safe facilities therefore.

### **101.15 SURVEY AND SETTING OUT**

All levels used for construction shall be referred to the National Height Datum.

The Contractor shall be responsible for obtaining the location and values of the permanent benchmarks. In cases where such bench Marks do not exist, a site datum shall be agreed with the Engineer.

Prior to the commencement of the work the Engineer shall approve all plans showing benchmarks, limits of plot and auxiliary baselines. The Contractor, under the supervision of the Engineer, shall set out on-site and erect appropriate permanent markers where instructed by the Engineer.

The Contractor shall employ an experienced licensed Surveyor for the duration of the Contract. He shall furnish the Engineer with a duly signed map showing the various centerlines, baselines, and reference points permitting the renewal of markers and boundaries of parcels and blocks, if destroyed. Before starting and during earthwork on the site, the Contractor shall set out a net of square coordinates at distances not exceeding 10 m in each direction. A peg shall be driven at each intersection and at other relevant points and levels of peg tops and of ground at the same spot shall be measured.

The levels of the ground and the levels and dimensions of existing features shown on the Drawings are not guaranteed to be correct.

Wherever dimensions or levels are marked on the Drawings such dimensions or levels shall take precedence over dimensions scaled from the Drawings. Where no dimensions or levels are shown on the Drawings, instructions shall be obtained from the Engineer. Large scale drawings shall be taken in preference to drawings of smaller scale.

### **101.16 NOTICE BOARDS**

The Contractor shall provide and erect sign boards at the sites (Nb.4, & refer to Annex 1 of this volume) where works are being executed, giving information to the public on the Project and the Employer and further details as will be prescribed by the Employer. The location and number of the sign boards at the sites will be indicated by the Engineer. The Contractor shall maintain, alter, move and adapt the sign boards from time to time as instructed by the Engineer. The display of any named Subcontractors or any other information associated with the Works shall be to the approval of the Engineer.

### **101.17 MANUFACTURE'S CERTIFICATES**

The Contractor shall furnish the Engineer with a manufacturer's certificate confirming compliance to the specification in respect of all items of equipment.

The original and one copy of the manufacturer's certificate shall be delivered to the Engineer not later than 14 days prior to the intended date of delivery of the Item to site.

### **101.18 PRECAUTIONS AGAINST CONTAMINATION OF THE WORK**

The Contractor shall at all times take every possible precaution against contamination of the works. The site and all permanent and temporary works shall be kept in a clean, tidy and sanitary condition. The Contractor shall at all times take measures to avoid contamination of the existing water courses and drains by petrol, oil or other harmful materials.

### **101.19 ACCESS TO PROPERTIES**

The Contractor shall not disrupt any private or public access way without first providing alternative arrangements.

### **101.20 TOPOGRAPHIC SURVEY**

Where the Contractor gets the approval of the Engineer to execute a topographical survey, mapping shall be at 1:200 with contour lines at an interval of 1 meter. A ground profile along the centerline of the pipe route shall be provided and shall be at the same scale of the construction drawings relative to the contract.

The extent of mapping shall be the width of roads or dual carriageways up to the property lines on either side of the public land, or one meter from the edge of the road whichever is nearer to the road centerline.

In open areas and along water courses the mapping corridor shall be 20 meters. The mapping shall be supplied on film plotted from digital data.

All control points, and heights shall be related to the National Height Datum in meters. Station Descriptions with distances to reference objects and a list of coordinates and heights shall be submitted to the Engineer.

Permanent bench marks shall be constructed from steel pins, road nails or painted marks on existing stable features. A minimum of two site benchmarks shall be established on existing stable features.

All man-made hand detail features, road edges, curbs, existing manholes, inspection covers, culverts, and underground service pipeline shall be surveyed in their true position and shown by conventional symbols. The detection of the existing services will be paid separately and must be approved by the Engineer.

Any surveyor who will subcontract topographical works from the Contractor shall be approved of by the Engineer. However, the Contractor will still be held responsible for the accuracy of the survey until it gets approved by the Engineer.

#### **101.21 DRAWINGS AND DOCUMENTS**

All drawings and documents submitted by the Contractor shall have been checked and signed, shall be ready for issue and shall bear the title of the drawing, the scale, the date, the Contract number and name, the document number complying with an approved numbering system, the name and references of the Contractor, the name of the Employer and the Engineer, the date of approval by the Contractor and the signature of the person responsible for the approval.

Unless otherwise specified, the Contractor shall allow a minimum of 15 days for approval of drawings and documents by the Engineer.

#### **101.22 MEASUREMENT AND PAYMENT**

Unless otherwise provided for in the B.O.Q, all costs incurred in complying with the requirements of this Division 101 shall be deemed to be included by the Contractor in his unit rates in the Bill of Quantities and shall not be paid for separately.

**PART 2**  
**CIVIL WORKS**

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**KUWAIT FUND FOR ARAB ECONOMIC DEVELOPMENT  
CONSTRUCTION OF DRILLING WATER WELLS, PUMPING STATIONS AND LIFT LINES  
IN BEINO AND DEIR NBHOUH AREAS  
VOLUME 4 – PARTICULAR SPECIFICATIONS**

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## **201. CONCRETE WORKS**

### **201.1 GENERAL**

#### **201.1.1 LIFE SPAN OF CONCRETE STRUCTURE**

New works are to be designed for a life of 50 years.

#### **201.1.2 CODES AND STANDARDS**

Complementary or new design shall as far as possible be carried out in compliance with relevant International Standards such as:

- BS Standards.
  - ACI and Uniform Building code.
  - EUROCODES
  - AFPS 90
- or equivalent standards

### **201.2 SOIL PARAMETERS**

The Contractor shall carry out soil investigations to satisfy himself with the prevailing soil conditions for all sites.

### **201.3 MATERIALS**

#### **201.3.1 GRADES OF CONCRETE**

The minimum grades of concrete for the various structures are given as follows:

<b>Grade</b>	<b>Component</b>
C30	Reinforced concrete for Reservoirs (400 Kg cement/cu.m)
C30	Reinforced concrete for Buildings and Structures (350 Kg cement/cu.m)
C25	Reinforced concrete for thrust blocks (350 Kg cement/cu.m)
C20	Mass concrete and Blinding concrete (250 Kg cement/cu.m)

Reinforced and mass concrete must be vibrated. Cement used for structures in contact with wastewater and buried surfaces in contact with underground water shall be sulfate resisting Portland cement (BS 4027). Cement for all other structures shall be ordinary or/and rapid hardening Portland cement (BS12).

Admixtures and mix design of the different Grades of concrete shall be submitted for approval prior to commencing the work.

### **201.3.2 REINFORCEMENT**

All reinforcing steels shall be Type 2 High Yield Bars and comply with the requirement of BS 8110 and shall have a specified characteristic strength of 420 N/mm<sup>2</sup>.

Dowel bars and stirrups shall be Mild Steel grade 25,  $f_y = 250$  N/mm<sup>2</sup>.

Lap lengths shall be 50 diameters. Mechanical bending for  $\phi \geq 12$  mm is required.

### **201.3.3 MINIMUM COVER OF REINFORCEMENT**

The concrete cover for all steel bars including stirrups shall not be less than 40 mm in structures where concrete surfaces are in contact with water.

Where concrete surfaces are in contact with soil, the cover of reinforcement shall not be less than 40 mm.

The cover of reinforcement in external surfaces of structures, and all elements of buildings shall not be less than 30 mm.

Formwork for all concrete surfaces in contact with water and/or soil and internal surface (walls and ceilings) of technical rooms shall be of form panels (marine plywood or metallic formwork) in order to obtain a regular and smooth finish.

### **201.3.4 CLASSES OF EXPOSURE AND CRACK WIDTH**

External and internal walls, columns and beams are to be considered as subject to severe exposure as defined in Sub-Clause 3.3.4 of BS 8110.

The faces of structures in contact with ground shall also be considered as subject to severe exposure.

Concrete surfaces in contact with water are designed for a maximum crack width of 0.2 mm.

### **201.3.5 ADMIXTURES**

Admixtures (retarders, mass waterproofing, silica fume, ...) are to be added to concrete in contact with liquid. Technical sheets and the mix design of concrete shall be submitted for approval.

## **202. COMMON REQUIREMENTS**

All metal sheets shall be 3mm thick minimum. All metal works shall be epoxy painted over a primer. Ventilation openings or other shall be taken into consideration.

Aluminum works shall be of first quality and glazing shall be 8mm thick.

All hardware shall be water resistant.

Buried walls shall receive a bituminous coating for protection.

Washable paint, acid resistant shall be applied elsewhere (Primer and two coats over a double layer of mastic). A tyrolean render or stone cladding shall be applied on the external surfaces of buildings.

## **203. PIPELINES AND PIPEWORK**

### **203.1 TRENCH EXCAVATION**

Excavation for pipelines shall be carried out in accordance with Sub-Section 201.3.2 of the General Specifications. During the pipe laying, jointing, testing of pipes and backfilling, the trench shall be completely dry.

The trench shall be as per the trench details included in the contract drawings.

The Contractor shall excavate the trenches without damaging existing pipes, cables and any other structure. In this respect, the Contractor shall excavate the necessary depth or change the route in order to avoid damaging the pipes, cables, and culverts that cross the roads.

In case the modification of the pipe depth or route is impossible, the Contractor shall, after the approval of the Engineer, undertake all the necessary works including excavation, fill and concrete works, etc... to modify the culvert in a way to maintain the passing section of the culvert, the cost of these works, after getting the approval of the Engineer should be measured as a concrete work (according to concrete works item).

The Contractor shall clear away within the same day, all excavated material arising from trenches and headings on asphalted roads as the work proceeds, and shall keep these roads free from any accumulations and clear in a good condition, to the satisfaction of the Engineer.

In addition to Sub-Section 201.3.2 of the General Specifications, Earthwork shall not be classified in accordance with the hardness of the excavated material, all excavation should be classified as common excavation and the Contractor shall take the sole responsibility for his assessment of excavated material and conditions. He should also use all suitable materials in the permanent construction required under the contract.

In addition to all the above, the excavated material arising from trenches executed on main roads should be removed from site, transported to environmentally approved disposal areas accepted by the Engineer, all that at the contractor expenses without any extra cost, and the trenches on main roads should be backfilled with imported clean granular material.

### **203.2 BACKFILLING OF PIPE TRENCHES**

Backfilling shall be carried out in accordance with the Ministry of Public Works decree No. 13495 dated 5/11/98 (Refer to Annex 1 of this volume) and in accordance with related general specifications of Volume 3.

In case of ambiguities or discrepancies between the content of the above-mentioned decree and the general specifications, the decree shall prevail.

All pipes shall be placed in granular material (fine, coarse) bedding and surround if the pipeline is above water table, and in gravel bedding and surround if the pipeline is below water table.

Backfilling of pipes trenches on main roads should be executed using imported clean granular material and should be compacted by layers 30 cm thick each.

a) Material unsuitable for filling:

Shall mean material other than suitable material and unless accepted by the Engineer shall include:

- Material from swamps, marshes, or bogs and solids containing more than 12% organic matter when tested in accordance with Test 8 of BS 1377, and which occurs below the top soil layer.
- Clay-based materials of liquid limit exceeding 40 and/or plasticity index exceeding 10 as and if directed by the Engineer,
- Boulders.
- Maximum granular diameter > 5 cm.

### 203.3 PIPELINES AND MATERIALS

As specified in the BOQ, Preferred C-class ductile iron pipes and HDPE pipes shall be used.

Moreover, the materials used shall comply with the requirements of Section 101.9 of the General Specifications. Any unsuitable material not satisfying the specifications shall be rejected by the Engineer, removed from the Site and replaced by the Contractor at his own expense.

#### 203.3.1 SPECIAL REQUIREMENTS

##### 203.3.1.1 Manufacturer's Certificate

Materials shall be supplied with certificates, in respect of each delivery, stating that products comply with and have been factory tested in accordance with the specified Standards.

##### 203.3.1.2 Special Tests

Whenever required by the Engineer, the Contractor shall supply and transport to an approved testing laboratory samples of materials selected by the Engineer. The number of samples shall not be less than 0.5% of the total supply, with at least one from each class, diameter and manufacturer. Failure of any sample shall be followed by a second and if necessary, a third test from the same batch. A third test failure will result in all material from that manufacturer being rejected and replaced by material from a different manufacturer, subject to approval by the Engineer, after satisfactory testing. Laboratory test reports in an approved form shall be provided.

##### 203.3.1.3 Manufacturer's Instructions

The Contractor shall observe the manufacturer's written instructions and recommendations in respect of handling, protection, stacking, storage, laying, fitting, cutting, repair of the products and materials as applicable.

#### 203.3.1.4 Marking

Unless otherwise specified in the relevant Standard, products shall have legibly cast, stamped or indelibly painted on, the following marks, as appropriate:

- The manufacturer's name, initials and identification mark.
- Nominal diameter.
- Class designation.
- Initials and a number of relevant Standards.
- Length of pipe if shorter than the standard length.
- Angle of bends in degrees.
- The date of manufacture.

#### 203.3.1.5 Samples and storage of materials

Where required by the Engineer, the Contractor shall submit to the Engineer for approval samples of pipes, fittings and materials prior to procurement.

The Contractor shall store pipes, fittings and other materials only at places approved by the Engineer and shall at all times provide adequate supervision and watchmen to prevent theft or damage. Any loss or damage incurred will be the Contractor's responsibility.

Pipes shall not be stacked higher than recommended by the manufacturer. The area on which the pipes are to be stacked shall be free draining, the grass or other vegetation shall be kept cut and suitable timber or cradles shall be provided on which the pipes shall be laid. End stops to all stacks shall be provided.

Fittings and valves shall not be stacked more than one tier high and they shall be supported off the ground by suitable timbers.

Air valves, rubber joint rings, gaskets, bolts and similar fittings and materials shall be kept in approved locked premises and such fittings and materials shall not be distributed to the trench side until immediately prior to laying, fitting, jointing or assembly thereof. All rubber joint rings and gaskets must be stored in a cool damp location and all fittings and materials shall at all times be stored in the shade under cover and protected from the weather to the satisfaction of the Engineer.

#### 203.3.1.6 Flanges

Unless otherwise specified, flanges shall be faced and drilled to conform to the dimensions specified in BS EN 1092-2:1997. Flanges shall be compatible with the pressure rating of the adjacent pipework but not less than 16 bars. Bolts, nuts, and washers (two washers per bolt) shall be to BS 4504 Clause 5 or ISO 898-2:1999 and ISO 4032:2001. No bolt shall project more than two full threads beyond its nut after tightening. In no circumstances shall be shortening of excessively long bolts but cutting be allowed.

Gaskets shall comply with BS EN1514-4:1997, ISO 4633:2015 or BS 2494 Type W.

Flanges shall be painted with two coats of epoxy resin paint or with the same coating as fittings: an epoxy coating in accordance with EN 14901:2014.

#### 203.3.1.7 Mechanical Couplings

Unless otherwise specified or shown on the Drawings pipes and fittings shall be supplied with flexible joints.

Mechanical couplings shall be of the Dresser, Viking Johnson type without a center register.

#### 203.3.1.8 Materials for the assembly of flexible joints

Lubricant shall be of a kind not conducive to the growth of bacteria and shall have no deleterious effects on either the joint rings or pipes. Lubricants for water supply shall not impart to water taste, color, or any effect known to be injurious to health.

### 203.3.2 WORKMANSHIP: OPERATIONS

- 1) Manufacturer's recommendations on handling, repairing, laying, jointing, anchoring, testing and other works for pipes and fittings shall be strictly followed.
- 2) The Contractor shall use cranes, hoists or forklifts as directed by the Engineer. The Contractor shall use hooks, spreader beams, ropes, band or wire slings etc. as recommended by the manufacturer for each type of pipe and as approved by the Engineer.
- 3) The Contractor shall stack pipes on a level surface. Pipes shall not rest on sockets or flanges and end pipes in the bottom row shall be securely chocked. Heights of stacks shall be in accordance with the manufacturer's instructions.
- 4) The Contractor shall handle material with care to avoid damage whenever moved by hand, forklifts or hoists.
- 5) The Contractor shall provide safe storage for all material. The interior of pipes, fittings etc. shall be kept free from dirt and foreign matter. The Contractor shall provide shade for materials as required by manufacturers' instructions and recommendations and to the Engineer's approval.
- 6) Pipe Cutting: The Contractor shall use hacksaws, manually operated wheel cutter or pipe cutting machine in accordance with manufacturers' instructions. If, in the opinion of the Engineer, special precautions are required to eliminate airborne particles, the Contractor shall use methods and equipment as directed by the Engineer. The Contractor shall prepare ends according to type of joint used and follow manufacturers' recommendations. The Contractor shall take care not to damage linings. The Contractor shall repair on site minor damage if so, permitted by the Engineer.
- 7) The Contractor shall repair damaged coatings, sheathings or linings in accordance with the Specification and the manufacturer's instructions. The Contractor shall use material compatible with that originally used. Repairs shall be approved by the Engineer before incorporating the materials into the works.

### 203.3.3 SEQUENCE OF CONSTRUCTION

The Contractor shall adhere to the sequence of construction as set out below unless a justified request for modification is approved by the Engineer at least two weeks prior to commencement of work on the affected section of the network:

- 1) Stake out pipe alignments

- 2) Clear and grade the right of way (wherever required)
- 3) Carry out surveys, including trial pits if necessary, along the alignments to verify the location, depth, size and type of existing utilities.
- 4) Prepare and submit for approval composite Shop Drawings for all utilities showing alignment, ground elevation, trench invert elevation, pipe size, class and length, station and size of fittings, valves as applicable manholes, inlets, appurtenances and structures to be demolished and reinstated (curbstone, rails, culverts, etc.). Cross sections showing location and inverts of existing pipes and those proposed shall be prepared. Pipes, structures and other utilities to be removed or relocated shall be indicated on the Shop Drawings.
- 5) Relocate, demolish and reinstate existing services and utilities interfering with pipeline alignments.
- 6) Remove pavement layers, excavate trenches and place bedding as required
- 7) Lay and join pipes, fittings, appurtenances, manholes, etc.
- 8) Place primary backfill material
- 9) Perform hydrostatic testing
- 10) Complete connections to existing services and curb/gutter inlets as required
- 11) Place final backfill
- 12) Restore or reinstate surfaces and structures as required
- 13) Carry out final surface works road surfacing curb stone, backing walls, sidewalk paving, etc.
- 14) Dispose of surplus materials.

#### **203.3.4 DUCTILE IRON PIPES**

##### **203.3.4.1 General**

- 1) Ductile iron pipes for raw and potable water pipelines shall be of Preferred C-Class unless otherwise specified pipes in conformance to BS EN 545-2010 and ISO 2531:2009. Pipes shall be to pressure rating suitable for the condition of service as denoted on the drawings and according to the allowable operating pressure of C Class. All ductile iron pipes and fittings to be supplied under this Specification shall be obtained from an approved manufacturer having an ISO9001-2015 TOTAL QUALITY ASSURANCE system based on the latest version of the ISO9001 standard.
- 2) Spigot and socket ended pipe joints shall be used for straight runs and adjacent to elbows or fittings. These joints shall be provided with rubber gaskets, and external thrust blocks at elbows or fittings. Anchored joints shall be the push-in, self-anchored type. Concrete thrust blocks are not required for anchored joints. The Contractor shall submit calculations verifying the number of restrained joints required noting that pipe pressure testing will be made when pipes are partially backfilled.

- 3) Prior to the ordering of pipe and fittings materials, the Contractor shall carry out his own calculations of the surge, the maximum allowable pressure and the Test Pressures, using approved parameters to ensure safety of the proposed system under worst working conditions, all to the approval of the Engineer. If the Contractor's approved calculations show that the resulting pipe classes needed are higher than the original Contract Documents, then the Engineer shall instruct the Contractor to adopt them; but if lower classes are needed, then the Contract classes shall prevail.
- 4) Flanges shall be provided in accordance with BS EN 1092-1:2002 and BS EN 1092-2:1997.
- 5) Factory protection for pipes shall be as follows:
  - Internally: cement lined to BS EN 545:2010 with ordinary Portland or sulphate resisting cement (for potable water ) to BS EN 197-1:2011 and ISO 4179:2005.
  - Externally: 200g/m<sup>2</sup> metallic zinc shall be applied in accordance with BS EN 545:2010 and ISO 8179:2017 And a finishing layer (a bituminous varnish or equivalent anticorrosive paint ) shall be uniformly covering the whole surface of the metallic zinc layer, with a minimum thickness not less than 70micron.

- 6) Factory protection for fittings shall be as follows:

Coated internally and externally by dipping, or other method, using hot applied coal tar based material to BS 4164:2002 or hot applied bitumen to BS 3416:1991, Type 1, grade D, minimum thickness 250 microns or with a hot applied epoxy powder coating, minimum thickness 250 microns, over a shot blasted surface. In accordance with EN545:2010 and EN 14901:2006.

#### 203.3.4.2 Joints

Joints of Ductile Iron Pipes and Fittings shall be of the Push in automatic standard type and any axial forces shall be taken by thrust and anchor blocks, where necessary and as shown on drawings.

#### 203.3.4.3 Lubricant paste

The lubricant paste shall be a mixing of Vaseline, non-soluble in accordance with French standard AFNOR T90 M DOC8. The quantities used in the assembly joints shall be as per manufacturer recommendation. The pipes and fittings manufacturer shall supply it.

#### 203.3.4.4 Connecting pieces

All connecting pieces i.e. flexible coupling, flange adaptors, dismantling joint shall be made of ductile iron and shall be supplied from the same pipes and fittings manufacturer.

#### 203.3.4.5 Pipes internal protection (including welded flanged pipes)

Pipes shall be internally lined with sulphate resisting blast furnace slag cement applied by a centrifugal process. The cement mortar lining shall be in accordance with the European Standard EN 545-2010 & with the International Standard ISO 4179-2005 with the thickness given in the following table:



	Thickness of mortar	
	Nominal mean value (mm)	Tolerance (mm)
80 – 300	4	-1.5
350 – 600	5	-2
700 – 1200	6	-2.5
1400 – 2000	9	-3

#### 203.3.4.6 Pipes external protection (including welded flanged pipes)

Pipes shall be externally coated with:

- A metallic zinc coating in accordance with the European Standard EN545 – 2010 and the International Standard ISO 8179:2017. The quantity of zinc shall not be less than 200 g/m<sup>2</sup>.
- A bituminous varnish or equivalent anticorrosive paint which shall be applied over the zinc coating in accordance with the European Standard EN545-2010 and the International Standard ISO 8179:2017, with a minimum thickness of 150 microns.

#### 203.3.4.7 Connecting pieces internal and external protection

The connecting pieces (flexible couplings, flange adaptors, dismantling joint) shall be internally and externally protected with a powder epoxy coating having a minimum thickness of 150 microns or with a Rilsan nylon coating having a minimum thickness of 200 microns.

### 203.3.5 POLYETHYLENE PIPE FOR POTABLE WATER

- 1- Pipes and fittings shall be manufactured in accordance with DIN 8074/8075 or AWWA C906-99. Pipes shall be supplied straight with straight ends suitable for heat fusion, class 16 kg/cm<sup>2</sup>.
- 2- Materials used shall have a minimum hydrostatic design basis of 1600 psi according to AWWA C906-99 Table 1.
- 3- Manufacturers shall provide certification that stress regression testing has been performed on the pipe products. Materials shall also meet elevated temperature requirements as given in Table 2 AWWA C906:99.
- 4- Fittings shall be manufactured in accordance with AWWA C906-99, extruded or injection moulded suitable for the class of pipe required.
- 5- Joints for pipes and fittings shall be made by heat fusion and in strict accordance with the pipe manufacturer's recommendations. Joints shall have a tensile strength equal to that of the pipe. Fusion temperature, interface pressure, alignment and cooling time, shall be according to the manufacturer's recommendations.
- 6- PE compounds in pipes and fittings shall contain no toxic chemicals that can migrate into the water. PE compounds shall be tested and certified suitable for potable water by an accredited testing agency as approved by the Engineer and certificates from an accredited testing agency

proving, that the material compounds used during manufacturing of pipes are suitable for potable water, should be submitted to the Engineer before placing order of purchase. Tests shall be undertaken in accordance with requirements no less restrictive than those in NSF Standard No. 14 (1976), Sections 3 and 4. The seal and mark of the testing laboratory shall be included on pipes and fittings.

#### **203.4 WARNING TAPES**

Warning tapes shall be placed on well compacted backfill at 450mm below the finished level and directly above the center-line of the pipeline.

Warning tapes shall be made of pigmented low-density polyethylene and aluminum foil in a bright color or other approved material not less than 250 mm wide and 0.15 mm thick. When laid, the tapes shall provide a continuous band detectable with a metal detector if the pipe itself is not detectable. The tapes shall be continuously and alternatively labeled in Arabic and English.

Where possible, tapes shall also be laid above ducts and concrete protection slabs as directed by the Engineer.

#### **203.5 MANHOLES**

Manholes shall be constructed as specified in Sub-Sections 202.11.2, 202.14.2 and 202.14.5 of the General Specifications and according to the dimensions specified in the BOQ and the related drawings.

Steel Ladders shall be manufactured in accordance with BS 4211:2005, mild steel, galvanized to BS EN ISO 1461:1999 with 200 grams of zinc per square meter.

All concrete faces in contact with the soil shall receive a waterproofing treatment consisting of two layers of brush-applied bituminous paint, in accordance with Sub-Section 213.2.1 of the General Specifications.

#### **203.6 CHAMBER COVERS AND SURFACE BOXES**

Covers and frames shall be manufactured from ductile iron in accordance with BS EN 124:1994, non-rock, locking and solid tops. The wording on covers shall indicate the nature of the network (water supply). Grades of covers shall be Grade A, heavy duty test load 40 tons.

Manhole covers shall be of a circular pattern unless otherwise indicated on the Drawings. Frames shall be provided with openings for fixing bolts for solid frame embedment into manhole concrete necks. Covers and frames shall be coated with a bitumen-based compound to BS 3416:1991 with a minimum thickness of 200 microns.

#### **203.7 STEP IRONS FOR VALVE CHAMBERS**

Step Irons shall be manufactured in accordance with BS EN 13101: 2002.

## **203.8 TEMPORARY AND/OR PERMANENT RESTORATION OF PAVED ROADS**

In all paved roads, trenches shall be refilled and compacted to the underside of the original road surface.

A sub-base and base layers shall be laid and compacted and shall be carried out in accordance with the Ministry of Public Works decree No. 13495 dated 5/11/98 (Refer to Annex 1 of this volume) and in accordance with related general specifications of Volume 3.

In case of ambiguities or discrepancies between the content of the above-mentioned decree and the general specifications, the decree shall prevail.

For main roads subject to a permit from the Ministry of Public Works and Transport, the Contractor, at his own expenses and sole responsibility, should deal to obtain and receive this permit, and the asphalt reinstatement works should be carried out in accordance with the specifications and conditions (if any) of the permit.

As for narrow roads not exceeding 3m width, asphalt reinstatement should be executed to cover the entire width of the road.

## **203.9 REMARKS**

The Contractor shall lay pipes on one side of the streams and on one side of the roads (even if this is not shown of the drawings) and if possible, outside the carriageway in order to avoid damaging the roads. The Contractor shall coordinate with the Administration and the Engineer and the relevant Authorities in order to obtain official authorization prior to any construction work.

## **204. HYDRAULIC ACCESSORIES**

### **204.1 ELECTRO-MAGNETIC FLOW METERS**

The flowmeters shall be of electro-magnetic inductive type having a DC pulsed field with automatic zero error averaging and low power consumption. They shall have no moving or protruding parts nor cause any restriction in the flow path (Insertion type are not allowed) and be capable of setting adjustments without the need to stop the flow.

Each metering system shall comply with the latest international standard and comprise a flow sensor mounted in the pipework line and a transmitter which degree of protection is IP68; either integrally mounted or remotely located preferably within the main control panel.

Electro-magnetic system shall comply with the latest international standards at least with:

- 2014/35/EU- EN 61010-1:2013 ( LVD)
- 2014/30/EU- EN 61326-1:2013 (EMC)
- OIML R49- 1:2013
- European directive 2014/32/EU (MID)
- 2014/34/UE – IEC 60079- 0, IEC 60079- 18 (ATEX- IECEx) Separate version
- EN ISO 15609-1 and EN ISO 15614-1
- UNI EN ISO 12944-2, painting for C4 class environments ( on request)
- Ebonite conform to the norms WRAS, FDA e DM174
- BS 5792

The flowmeter shall have a maximum accuracy at normal operating conditions.

The uncertainty of the calibration shall be equal to 0.2%  $\pm$  2 mm/s. The repeatability of the measure shall be about 0.1%. Bi-directional measure. The sensors shall be certified under MID01 norms. Every meter shall be delivered with its calibration certificate.

Error range no larger than  $\pm$  0.2% of the reading operating at 30% or less than the meter range, error range shall not exceed  $\pm$  0.5%

The maximum permissible error shall be within the limits indicated in the following graph, for each sensor diameter.

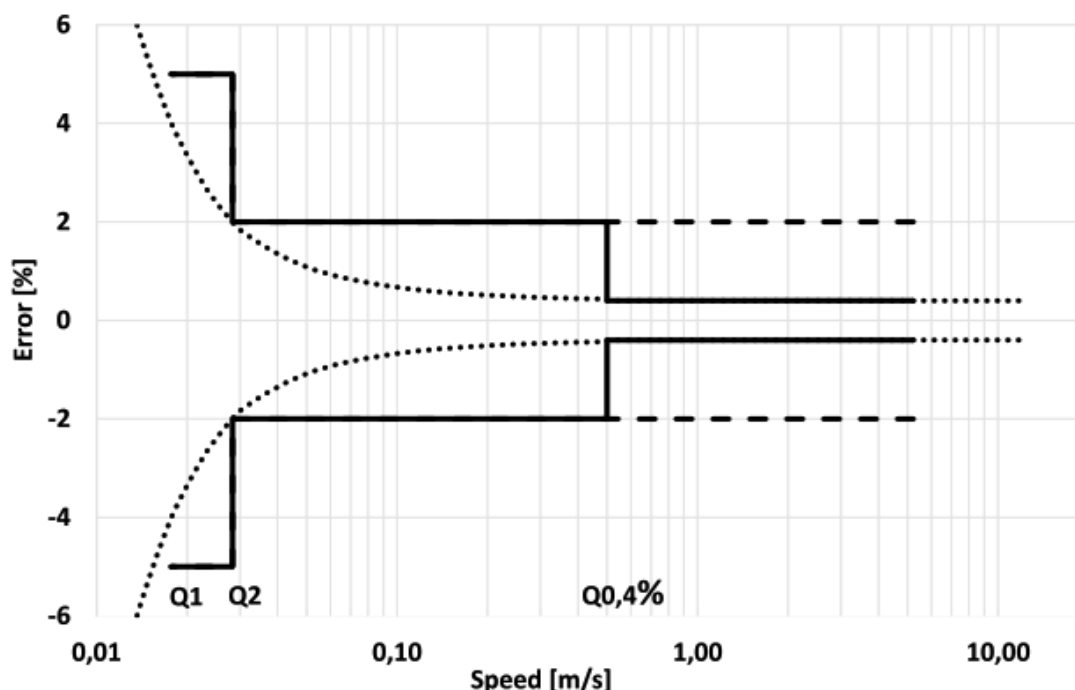


Figure 1: Graph indicating the Maximum Permissible Error

Sensor diameter	Flow [m3/h]					Ratio Q3/Q1
	Min Q1	Trans. Q2	Q0,4%	Perm. Q3	Overl. Q4	
DN50 - 2"	0,125	0,20	3,50	25,00	31,25	200
DN65 - 2"1/2	0,20	0,32	6,00	40,00	50,00	200
DN80 - 3"	0,315	0,50	9,00	63,00	78,75	200
DN100 - 4"	0,50	0,80	14,00	100,00	125,00	200
DN125 - 5"	0,80	1,28	22,00	160,00	200,00	200
DN150 - 6"	1,25	2,00	32,00	250,00	312,50	200
DN200 - 8"	3,15	5,04	57,00	630,00	787,50	200
DN250 - 10"	5,00	8,00	90,00	1000,00	1250,00	200
DN300 - 12"	8,00	12,50	128,00	1000,00	1250,00	125

Table 1: Flow rates table

- a) **Flow sensors** These shall comprise electrodes located in a meter tube which shall be made of watertight construction, suitable for operation without loss of accuracy when totally submerged to a depth of 3 metres or even buried into the ground together with the water pipe. Its degree of protection shall be IP68. They shall not contain any active components such as

amplifiers or memory modules. The flowmeter shall be flanged type and the lining shall cover the external parts of both flanges

The flow tube shall be made of stainless steel AISI 304 or AISI 316, where two coils are installed on its top and lower side. The interior of the flow tube shall be electrically insulated, thus the process liquid shall no longer be in contact neither with the material of the flow tube nor with that of the flanged.

The standard internal insulating lining shall be in compliance with WRAS, FDA and DM174 standards. The flanged materials shall be made of Carbon steel (S235 JR-1.0037), AISI 304 optional, and or AISI 316 optional and shall comply with at least EN 1092-1 and ANSI 150 Standards.

The measuring electrodes shall be continuously cleaned by means which do not interrupt the process flow or the measurement. A sensing electrode shall also be provided to detect when the flow meter is not fully charged with liquid.

Electrodes shall be supplied in Hastelloy B, C, Titanium, Tantalum or Platinum. A partially empty tube detection (fourth electrode) shall be installed and should be enabled or disabled through the software.

The electromagnetic flowmeters shall guarantee a pressure drop less than 250 mbar at velocity of 8 m/s. The pressure drop shall always be less than 10 mbar at velocities lower than 1 m/s.

#### **b) Transmitter**

The converter shall be able to generate the current supplying the coils, acquire the electrodes potential difference, process the signal to calculate the flowrate and manage all the communication.

The transmitter shall have an LCD display with facility to show live flow rate. The display shall be programed to show readings.

The transmitter shall provide the following minimum functions:

- Conversion of its supply voltage 90 to 264 Vac or 12/24 Vac/dc, battery powered supply or 12/24 Vac/dc or battery powered-2 xD Cell 3.6V (Lithium) , Lithium battery life shall be up to 10 years with the possibility of changing the batteries in order to prolong the lifetime of the pressure sensor and the transmitter.
- Supervision of the flow sensor: the transmitter shall be able to generate an alarm signal when the following conditions occur:
  - ◆ water conductivity below a preset level
  - ◆ flow meter empty
  - ◆ reverse flow direction
  - ◆ Excitation failure
  - ◆ Empty pipe on the 4<sup>th</sup> electrode
  - ◆ Empty pipe on measuring electrodes
  - ◆ High temperature
  - ◆ High voltage supply
  - ◆ Pulse overlapped
  - ◆ Wet electronic board

Status icon for alarm shall be displayed and alarm shall be logged in the datalogger.

- Output signals to inform the control/display equipment. Thus, the transmitter shall have as a minimum the following independent output signals:
  - ◆ Standard analogue current signal 4-20 mA fully isolated from input and other outputs, and where the zero and full scale mA - value are configurable as well as the measuring range. The range adjustment shall be continuous, and the units shall be configurable in flow engineering units.
  - ◆ 2 pulses passive outputs (MOS), individual galvanically isolated-clean contact, with a maximum load +/- 35V DC, 100 mA short circuit protected

The Transmitter shall have an LCD display-Index menu, and symbols icon for dedicated information, it shall bear at least 4 Push buttons to access all functions and the totalizer informations shall be displayed with 5 decimal digits. The minimum information displayed shall be as follow:

- ◆ Live Flowrate
- ◆ Total positive Totalizer (t+)
- ◆ Total negative Totalizer (T-)
- ◆ Partial positive Totalizer (P+)
- ◆ Partial negative totalizer (P-)
- ◆ Time & date
- ◆ Converter temperature
- ◆ Parameters corresponding code and value

The convertor shall have an excellent data security given by the internal memory. It shall have a built in datalogger with over 100 000 data lines capacity with a frequency of log between 1 minute and 120 minutes ( default 15 minutes).When full capacity is reached; cycle memory, old data shall be overwritten by new ones. Software shall be supplied with the unit to allow users to communicate with the convertor via port to any pc, laptop, windows tablet. Downloading the data, managing and programming shall be easy.

- Data shall be protected with a password, in addition, automatic firmware check and recovery during the update must be possible. As for the external verification, field vericator shall be available for calibration verification and electronic status.
- The instrument shall have at least 4 totalizers (2 positive and 2 negative)
- Software for communication and programming: Commissioning (equal settings of meters)- Data print for documentation- Data export (CSV file)- Firmware update -Read instant flowrate- Read and write all non volatile parameters- Download internal datalogger- View instrument event logger.

### c) Flowmeter Cabling

Where remote mounted converters are specified, cables shall be provided, installed and terminated between the sensor and converter/ pulse power unit for the following purposes:

- flow signal;

- reference signal;
- coil supply;

Such cables and sealing glands shall be suitable for submersible operation (IP68) of the sensor to the depth specified. The cable length depends on the liquid conductivity. Cable entries shall be 4X PG9 Glands I/O -2X PG20 Glands junction box in remote version.

**d) Spool Piece**

A flanged steel pipe spool piece shall be provided of the same diameter and length as the respective flowmeter and flanged for insertion in the pipe should it be necessary to remove the flowmeter.

**e) Accuracy**

The accuracy of the flowmeter shall be independent of the range which has been selected for the analogue signal and shall be better than 0.2%  $\pm$  2 mm/s, in addition, insertion sensors accuracy shall be 2% of rate  $\pm$  2 mm/s.

The uncertainty of the calibration shall be equal to 0.2%  $\pm$  2 mm/s. The repeatability of the measure shall be about 0.1%. Bi-directional measure. The sensors shall be certified under MID01 norms.

**Note** : the flow test shall be made on a recognised test bench which is traceable to international standards.

## **204.2 WATER METERS FOR SERVICE CONNECTIONS**

### **204.2.1 OVERVIEW**

Contractor is requested to supply, transport, and install DN15, DN20, and DN25 class B mechanical type water meters and accessories including installation and connection of boxes to the network.

The water meters are to be compliant with:

- EU Measuring Instruments Directive (MID) – 2004/22/EC
- The water meters should be compliant to the ISO 4064-1:2014|OIML R49 (International Organization for Legal Metrology)
- EN 14154:2005+A2:2011
- Only Water meters manufacturers with a quality assurance system complying with ISO 9001:2008 or ISO 9001:2015 with certification for design, whereas ISO 9001:2015 is required for manufacturing functions.

Unless otherwise stated, all flow meters shall be of the mechanical type.

### **204.2.2 WATER METER LIFESPAN AND TESTING**

The water meters to be installed shall have a minimum operational lifespan (continuous operation) of 10 years or better (at  $t_{Bat} < 30^{\circ}C$  based on one emission per 30 sec).

The water meters shall be operational with no impact on accuracy or performance regardless of orientation of the water meter.

The water meters are to undergo metrological verifications and tests in accordance with the Measuring Instruments Directive requirements.

Contractor shall include a typical metrological curve of the meters they would be using.

Contractor to guarantee the dispersion of the meter accuracy curve, with the dispersion of accuracy to average metrological curve not to exceed +/- 5% between Q1 and Q2, and +/- 2% between Q2 and Q4.

The definitions for Qi being as follow:

- Q1 : Minimum readable flow
- Q2 : Transitional flow
- Q3: Nominal flow
- Q4 : Maximum readable flow

#### DN15 Class B water meters

The meters shall be of the Multi-jet Class B, dry dial.

The meter shall have an operational performance of OIML R49:2013 Class B or better.

DN15 meters that has a Permanent Flow Rate (Q3) of 2.5 m<sup>3</sup>/hr and an 'R' Ratio (Q3/Q1) of 400 or better. This will guarantee a low Q1. Moreover, meters having a starting flow greater than 2 litres/hour shall not be considered.

#### DN 20 Class B water meters

The meters shall be Multi-jet Class B, dry dial.

The meter shall have an operational performance of OIML R49:2013 Class B or better.

DN20 meters that has a Permanent Flow Rate (Q3) 4 m<sup>3</sup>/hr, and an 'R' Ratio (Q3/Q1) of 400 or better. This will guarantee a Q1 lower than 10 l/h.

Meters having a starting flow greater than 3 litres/hour shall not be considered.

#### DN 25 Class B water meters.

The meters shall be Multi-jet Class B, dry dial.

The meter shall have an operational performance of OIML R49:2013 Class B or better.

DN 25 meters that has a Permanent flow rate (Q3) of 6.3m<sup>3</sup>/h and an 'R' ratio (Q3/Q1) of 400 or better. This will guarantee a Q1 of 16 l/h or lower.

Meters having a starting flow greater than 5 liters/hour shall not be considered.

### 204.2.3 IDENTIFICATION AND LEGIBLE COMPONENTS

Contractor to ensure that all meters have an arrow cast on their body to indicate the direction of the flow. The following markings shall be clearly visible and preferably located on the dial of the water meter:

- Water meter type/model
- Nominal/permanent flow rate Q3
- Metrological class: Class B
- Trade mark and/or name of the manufacturer
- Year of manufacture
- Serial number in numeric format
- Approval marking and No. of approval certificate



Contractor to ensure that markings are easily legible and permanent. The markings are not to be affected by normal storage, weather, handling or use. If print markings are used, the color of the print markings is to differ from the color of the water meter.

The totalizer shall be designed in such a way that if the totalizer protective glass is broken for a reason or another the totalizer cannot be removed from its place.

- The totalizer shall be of straight reading type
- The totalizer shall register in cubic meter units
- The totalizer shall consist of a row of minimum five on-line consecutive digits to read at least 99,999 m<sup>3</sup>
- Another three digits or pointers shall register flows in liters and be of a different color.
- The totalizer or any part of it shall be capable of being repaired
- The totalizer should be of open type
- The totalizer must be suitable for test on an electronic test bench
- The protection class of the totalizer should be IP 68

#### **204.2.4 METER CONSTRUCTION AND COMPOSITION**

All meter materials that are to be in direct contact with water need to be suitable for contact with potable water and shall withstand 2 ppm of chlorine residual and be resistant to corrosion.

The materials, which come in contact with the potable water, shall not create a toxic hazard, shall not support microbiological growth, and shall not give rise to unpleasant taste or discoloration in the water supply.

The acceptable water meter body material is either brass (low lead EnviroBrass suitable for potable water), bronze, stainless steel or composite material such as fiber reinforced polymers or copolymers and shall be NSF 61 certified.

The meter upper and lower cases and any other exposed parts must be made of brass or bronze alloy. However, the spindle and bearings inside the hydraulic chamber shall be made of polished stainless steel with tungsten carbide tip and sapphire or similar material ensuring a longlife operational period.

The internal pressure cup must overlap the meter body. The lower case of the meter shall be painted with thermal painting internally and externally. The painting materials should be safe for human health.

Water meter moving components and working surfaces must be composed of durable materials that are resistant to wear, tear, and abrasion scenarios.

In the case of mechanical meters, pistons shall be designed to reduce the risk of blockage by particulate matter that was not stopped by the strainer.

The meter ends are to be threaded to ¾ inch BSP male thread which shall conform to BS21 for the threaded end. The connecting end threads shall be robust in construction. The threaded ends shall be protected with plastic covers. The plastic cover for the inlet will be removed when connecting the water meter to the network, whereas the plastic cover for the outlet will be kept until the subscriber decides to connect.

## 204.2.5 WATER RESILIENCE

Meters should be able to operate normally in waters with different parameters with no impact on performance or accuracy. The following water parameter ranges can be considered:

pH	6 – 8
Total Alkalinity as CaCO <sub>3</sub>	Between 200 and 300 mg/l
Total hardness as CaCO <sub>3</sub>	Between 200 and 250 mg/l
Chlorides as Cl	Between 15 and 25 mg/l
Total Dissolved Solids (TDS)	Between 200 and 400 mg/l
Sulphates (SO <sub>4</sub> )	Between 30 and 40 mg/l
Free Chlorine Cl <sub>2</sub>	Between 0.3 and 0.9 mg/l

## 204.2.6 HUMIDITY AND IMMERSION

Meters have to withstand total and continuous immersion in waters up to 1 meter of depth with no impact to operation or readability.

The hermetical seals of the dry dial meters in particular are to prevent water from entering. Water meters are to remain compliant with the maximum permissible errors (MPEs) following conclusion of test. Any indication of moisture or intrusion of water under these conditions shall be considered a non-compliance of specifications rendering meters ineligible for use.

## 204.2.7 ANTI-TAMPERING

Contractor is to ensure that water meters are supplied and transported to worksite in adequate sealing that prevents meter tampering to take place. Contractor is to ensure that the installation of the meters and associated accessories is to be done in a way to prevent tampering without causing any damage to the meters.

Contractor is to provide a detailed explanation of the anti-tampering capabilities of the water meters being installed. The protective cover of the dial is to be made of transparent glass to eliminate the risk of deliberate damage or tampering.

## 204.2.8 PRESSURE

Water meter used by contractor are to withstand a minimum continuous working pressure of 16 bars and shall conform to the testing in accordance with ISO 4064. Meters shall be tested for continuous operation at a minimum of 1.5 working pressure and is to remain compliant with the maximum permissible errors following the pressure test. The meters must also be able to withstand any adverse effect related to water hammers.

The meter shall be capable to operate in an ambient temperature of up to 40°.

## 204.2.9 HEAD LOSS

Head losses inside the meter and strainer/filter are not to exceed 0.15 bars of pressure at Q<sub>3</sub> and 0.6 bar of pressure at Q<sub>4</sub>.

## 204.2.10 LITERATURE AND SAMPLES

The contractor is required to submit the following list of documents:

- Technical specifications of items being offered
- Quality assurance documentation
- Detailed drawings and construction materials
- Water meter typical metrological curve
- Description of water meter anti-tampering specifications
- EU entity sanitary conformity certification

### **204.3 WATER METER ACCESSORIES**

A typical arrangement for water meters installation consists of a Quarter turn valve followed by an air valve before distributing into the different house pipes. All house pipes shall be equipped with two ball valves and a subscriber meter.

The pipe arrangement shall force air trapped in the service pipe to exit from the air valve. Therefore, the air valve must be located at a high point that provides at least 5 cm head room above the air valve. Supply pipes may need to be re-arranged to allow for the installation of all fittings and valves required for the installation of subscriber meters in a given location. All pipes above ground until the new water meters shall be executed with galvanized iron pipes.

The Contractor shall provide and install all pipes, fittings, bends, reducers and materials required for the installation of the new pipe arrangement.

#### **204.3.1 STRAINERS AND NON-RETURN VALVES**

Contractor shall ensure that water meter bodies are fitted with a tubular strainer made of stainless steel in addition to a non-return valve for meters. The strainer shall have at least at least 18 holes/cm<sup>2</sup> and is to be fitted at the inlet of the water meter, both the strainer and non-return valve are to be fitted in such a way that they can be removed.

#### **204.3.2 UNION JOINTS AND WASHERS**

Contractor is required to supply transport and install union joints and washers. The joints are to be used for the installation of the water meters. The union joints shall be of brass, stainless steel or composite material (for plastic bodies) and shall be supplied in separate packaging than the meters.

The nut of the union joint shall have two 1 mm diameter holes drilled on its side diagonally and opposite to each other. This will allow a 0.8 mm seal wire to pass through it while the meter is being installed.

#### **204.3.3 AIR VALVES**

The contractor shall install one air valve before every individual water meter. The air valve is to be installed on the upper part of the pipe arrangement prior to the entry of the water meter. The pipe arrangement shall be designed in such a way to force any trapped air to exit from the air valve. The air valve shall therefore be located at a high point that provides a minimum of 5 cm of headroom above the air valve.

#### **204.3.4 QUARTER TURN VALVES**

The contractor is required to supply, transport, and install one quarter turn valve before the water meter. The quarter turn valve must allow locking/plumbing.

#### **204.3.5 METER PROTECTION BOXES**

The contractor is required to supply transport and install meter protection boxes. The meter boxes are installed in order to prevent and mitigate the risk of vandalism and tampering and therefore should be solid and are to be secured with locks in order to avoid unwanted access to water meters. A sample of water meter boxes is to be provided to the Supervising engineer for approval.

##### **204.3.5.1 CABINET MATERIAL AND DIMENSIONS**

The meter protection boxes are to be made of steel; the box shall be of off-white color and the profile of the boxes' door should be at least 1 cm curved (90 degrees), to prevent the entrance of heavy waste or rain water.

The contractor is required to ensure that the box is tested for:

- High temperature resistivity
- Electrical insulation (paint)
- Dust and weather
- Impact resistance

The box should be designed in such a way to allow for easy mounting on walls and surfaces: it should have a minimum of 4 wall mounting holes at the back, each one to be located in one of the corners.

There should be at least five sizes of water meter protection boxes:

- Box able to fit 1 water meter (15,20,25 mm)
- Box able to fit 2 water meters (15,20,25mm)
- Box able to fit 4 water meters (15,20,25 mm)
- Box able to fit 6 water meters (15,20 25 mm)
- Box able to fit 8 water meters (15,20 25 mm)

In these four latter cases, a collector linked to the downstream end of the service line shall distribute water to each house connection. For pricing purposes, this collector shall be considered an integral part of the water meter boxes it is supplying. The dimensions of the boxes will vary based on the water meter dimensions, and should allow for a minimum of 5 cm space in between water meters themselves and in between the water meter and the walls of the box.

The contractor shall ensure that the water meter cabinets have built-in 20 mm incoming/outgoing water pipes opening. The number of outgoing openings will vary on the number of water meters the cabinet holds.

Boxes must be equipped with built-in locks that can be locked with a triangular Allen key.

These locks shall be identical for a given number of boxes. For each group of similar locks, shall be provided a corresponding set of 5 identical keys.

#### **204.4 INSTALLATION OF WATER METERS**

The contractor is to follow the instructions of the manufacturer when installing the new water meters and related accessories. In particular, for mechanical domestic meters, the orientation of installation has to be horizontal because any tilting will affect the accuracy. The contractor needs to ensure that the water meters are installed in such a way as to allow easy legibility of water meter reading.

When installing a new water meter in place of an already existing domestic connection, the contractor is required to dismantle the existing water meter/gauge and hand them over to the water establishment. The contractor is to ensure that the subscriber's access to water is not interrupted for more than 6 hours when dismantling old water meters/gauges and installing new water meters and water meter cabinets.

The contractor is required to modify the supply pipe after installing the water meters in order to fit the available space conditions.

The contractor is to strive to carry out works carefully in order to avoid sand or dirt entering water meters and water meter boxes. For aesthetic reasons, pipes shall either be installed horizontally or vertically. Inclined pipes will not be accepted.

#### **204.5 AIR RELEASE VALVES**

For all transmission pipelines, air release valves should be exclusively double air release valves three functions types.

### **205. SHOP DRAWINGS, AS-BUILT DRAWINGS**

Shop Drawings and all necessary material technical specification shall be submitted to the Engineer for approval at least 21 days before starting the work.

As-built drawings shall be prepared and submitted successively during the execution of works and shall be also submitted completely to the Engineer for approval one month maximum after the completion of the work.

It is the duty of the Contractor to undertake all the Engineer's recommendations, modifications and corrections at his own expense until complete satisfaction of the Engineer.

All the modifications to the design drawings coming out during execution of the works, or after ordering the relating materials (especially for pumping stations building dimensions) should be done by the contractor and approved by the Engineer.

**PART 3**

**MECHANICAL WORKS**

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## **300. MECHANICAL WORKS: COMMON PARTICULAR SPECIFICATIONS - PUMPING STATIONS**

### **300.1 PUMPING SYSTEM**

#### **300.1.1 SUBMERSIBLE MOTOPUMPSET (DEEP BOREHOLE)**

- Pumps shall be semi-axial or radial multicellular.
- Motor pump sets shall have vertical axis, flooded, installed vertically in metallic casing (deep borehole/ barrels).
- Pumps rotating speed shall be that of the electrical driving motor.

### **300.2 PIPING AND ACCESSORIES**

- All pipes, valves, and hydraulic accessories shall have flanged and or mechanical joints.
- All piping of suction and discharge headers, and Motopumpsets inlet and outlet sections shall be internally and externally coated with epoxy (300 microns).
- All valves shall be coated internally and externally with epoxy (150 microns).
- The installation of piping and valves is deemed to include all the necessary miscellaneous hydraulic accessories required for the assembly of the complete system such as flanges, gaskets, coupling, adaptors, tees, bends, pipe supports, nuts and bolts, etc...
- All pressure reducing valves shall be supplied with a strainer installed before the valve.

### **300.3 DRAINAGE INSTALLATION**

Drainage works for the pumping stations, reservoirs and valve chambers shall include but not limited to: drain outlets, floor drains, clean outs, gully traps, above and below ground pipe works and fittings, drain, overflow, and rainwater installations from roofs, reservoirs, and surfaces inside and outside the pumping stations and reservoir sites as shown on the drawings, diagrams, and as per the specifications.

### **300.4 LIQUID CHLORINATION SYSTEM**

All water shall be chlorinated before going into public supply.

Chlorination facilities will normally be provided at sources of supply including boreholes and springs or at surface (booster) pumping stations. Where multiple sources feed into a reservoir the Chlorination facilities may be sited at the reservoir or a wet well. Care must be taken to allow maximum possible time/distance before any pump intakes.

Unless otherwise specified, the chlorine source will be of powder Calcium Hypochlorite granules, which shall be mixed with water in the PVC mixing tank. In



some cases, direct injection of concentrated Calcium Hypochlorite may be necessary and in other cases injection of hypochlorite solution with dosing pump may be used.

Chlorine dosing shall always have manually adjustable pre-set rate facility, with a maximum dose rate of 5 mg/l.

In all cases chlorine control shall be by flow detection facilities, vacuum switch and where chlorine dosing is undertaken at a borehole or at a surface (booster) pumping station chlorine dosing shall be linked to pump operation, unless otherwise stated it shall be assumed that pump output is constant. At other locations, such as at a reservoir, Chlorination shall be controlled on flow and the Contractor shall include for the installation of the appropriate flow measurement and control facilities.

Unless otherwise specified, sufficient Calcium Hypochlorite granules shall be provided for two weeks usage at a dose rate of 5 mg/L. Above the two weeks usage, requirement for chlorinating substances for a duration of 2 days shall be provided.

The Contractor shall supply and install all necessary safety equipment. This shall include and not limited to, Chlorine leak detector, Gas masks, mechanical ventilation, alarm facilities and shower system with 1 m<sup>3</sup> water tank as per chlorine schematic drawing. The chlorinator shall also be fitted with vacuum alarm switch to detect high and low vacuum for control and signalling purposes

The Contractor shall also provide training and detailed procedures for normal and emergency situations including literature and wall charts in English and Arabic.

### 301. MECHANICAL WORKS: BEINO PUMPING STATION

- Reference: Well head Schematic No: 477W-PS-01EM01  
 Chlorination Schematic No: 477W-PS-01EM02  
 Mechanical drawing for wellhead No: 477W-PS-01EM03

#### 301.1 PUMPING SYSTEM

##### 301.1.1 ELECTRIC MOTOR

Minimum Power Factor at 75% to 100% Output	Efficiency at 75% to 100% Output	No. of Starts/Hour	Quantity	Motor Diameter	Remarks
$\geq 0.85$	$\geq 85\%$	$\geq 10$	1	8 in	Submersible motor in borehole

N.B: Electric motors should be suitable and compatible with the connection to solar variable frequency drive starter control panels.

##### 301.1.2 PUMP

Type: - Submersible Motopumpset

Flow (l/s)	Head (m)	N.P.S.H. (m)	Efficiency at Duty Point	Quantity	Remarks
16.5	150	$\leq 3$	$\geq 75\%$	1	Submersible motopumpset in borehole

#### 301.2 PIPING AND ACCESSORIES

##### 301.2.1 SCOPE OF WORKS

The hydraulic system of WELL is composed of the following:

1. One (1) off submersible Motopumpsets with discharge check valve.
2. One (1) off rising column 125 mm diameters.
3. One (1) off wellhead and hydraulic accessories 125 mm diameter.
4. One (1) off well wash out pipe 100 mm diameter.

5. Level, pressure, flow and temperature measurements as specified in “Instrumentation, Control Equipment and accessories” section.

### 301.2.2 PIPING

Piping	Type	Material	DN (mm)	PN (bars)
Rising column	Seamless	Black Steel	125	Schedule 40
Well head piece, pipe and outlet	Seamless	Carbon Steel	125	16
Well wash out pipe	Seamless	Carbon Steel	100	16

### 301.2.3 VALVES

Valves	Type	Material	DN (mm)	PN (bars)	Qty (No)
Well sampling Valve	Ball	Cast Iron	13	16	1
Well regulating valve	Globe	Cast Iron	125	16	1
Well isolating	Butterfly	Cast Iron	125	16	1
Well wash-out valve	Gate	Cast Iron	100	16	1
Well check valve	Anti-Slam	Cast Iron	125	16	1
Well air release valve	3 functions	Cast Iron	65	16	1

### 301.3 PLUMBING AND DRAINAGE INSTALLATIONS

Refer to Common Particular Specifications.

### 301.4 FIRE FIGHTING

#### 301.4.1 PORTABLE FIRE EXTINGUISHERS

Location	“G” Type (6 Kg)	“P” Type (8 Kg)
Electrical Room	2	-
Chlorination Room	1	1

### 301.5 LIQUID CHLORINATION SYSTEM

One manual liquid Chlorination system, serving the well water system, shall be supplied and installed on the discharge of the well as shown on the chlorine circuit schematic diagram and as described in the General Specifications. The operation of the Chlorination system circulation pump shall be interlocked with that of the submersible pump. A chlorine gas detection system shall also be supplied and installed. The minimum required distance between the intake and chlorine injection points should be not less than 80 cm.

- Capacity of chlorinator: 4.5 l/hr. (Qty=1)
- Injector back pressure: 4 bars
- Calcium Hypochlorite granules: 100 Kg

## 302. DEIR NBOUH PUMPING STATION

- Reference: Hydraulic Schematic drawing N° 477W-PS-02EM01  
Chlorination Schematic drawings N° 477W-PS-02EM02  
Mechanical drawing for wellhead N° 477W-PS-02EM03

### 302.1 PUMPING SYSTEM

#### 302.1.1 Electric Motor

Minimum Power Factor at 75% to 100% Output	Efficiency at 75% to 100% Output	No. of Starts/Hour	Quantity	Remarks
$\geq 0.85$	$\geq 85\%$	$\geq 8$	1	Pump in borehole

#### 302.1.2 Pump

Type: - Submersible Motopumpset (Deep Borehole).

Flow (l/s)	Head (m)	N.P.S.H. (m)	Efficiency at Duty Point	Quantity	Remarks
6	697	$\leq 3$	$\geq 70\%$	1	Pump in borehole

## 302.2 PIPING AND ACCESSORIES

### 302.2.1 Scope of Works

The hydraulic system of the well is composed of the following:

6. One (1) off submersible Motopumpsets with discharge check valve.
7. One (1) off rising column 80 mm diameters.
8. One (1) off wellhead and hydraulic accessories 80 mm diameter.
9. One (1) off well wash out pipe 80 mm diameter.
10. Level, pressure, flow and temperature measurements as specified in “Instrumentation, Control Equipment and accessories” section.

### 302.2.2 Piping

Piping	Type	Material	DN (mm)	PN (bars)
Rising column	Seamless	Black Steel	80	Schedule 40
Well head piece, pipe and outlet	Seamless	Carbon Steel	80	40
Well wash out pipe	Seamless	Carbon Steel	80	40

### 302.2.3 Valves

Valves	Type	Material	DN (mm)	PN (bars)	Qty (No)
Well sampling Valve with PRV 40-16	Ball	Cast Iron	13	16	1
Well regulating valve	Globe	Cast Iron	80	40	1
Well isolating	Butterfly	Cast Iron	80	40	1
Well wash-out valve	Gate	Cast Iron	80	40	1
Well check valve	Anti-Slam	Cast Iron	80	40	1
Well air release valve	3 functions	Cast Iron	65	40	1

## 302.3 FIRE FIGHTING

### 302.3.1 Portable Fire Extinguishers

Location	"G" Type	"P" Type
Electrical room	2	-
Pumping room	1	1

## 302.4 SURGE SUPPRESSION EQUIPMENT

The Contractor shall submit detailed sizing calculation for the vessel capacity based on the pumping line profile and characteristics.

Type: Ductile iron., DN 100, PN40.

Flow: 6 l/sec. Length: 2630 m. Delta H =275 m.

### **302.5 PLUMBING AND DRAINAGE INSTALLATIONS**

Refer to Common Particular Specifications.

### **302.6 LIQUID CHLORINATION SYSTEM**

One manual liquid Chlorination system, serving the well water system, shall be supplied and installed on the discharge of the well as shown on the chlorine circuit schematic diagram and as described in the General Specifications. The operation of the Chlorination system circulation pump shall be interlocked with that of the submersible pump. A chlorine gas detection system shall also be supplied and installed. The minimum required distance between the intake and chlorine injection points should be not less than 80 cm.

- Capacity of chlorinator: 2.5 l/hr. (Qty=1)
- Injector back pressure: 31 bars
- Calcium Hypochlorite granules: 100 Kg

**PART 4**  
**ELECTRICAL WORKS**



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## **400. ELECTRICAL EQUIPMENT AND ACCESSORIES: COMMON PARTICULAR SPECIFICATIONS - PUMPING STATIONS**

### **400.1 EDL TRANSFORMER**

The Contractor shall coordinate with EDL after gathering all necessary information, supply, install test and commission a High Voltage/Low Voltage, pole or ground mounted power transformer as follows:

- Dual primary voltage: 15/20kV
- Secondary voltage: 400 V.
- Rated Power: as specified in the Contract's drawings and BOQ.

The transformer shall be supplied along with subscription to EDL and power meter and all necessary materials as per EDL requirements and recommendations. (Medium voltage power lines are not included).

NB: If the electrical load of the pumping station is much less than the capacity of the lowest power transformer in the market, the contractor shall provide an electrical subscription to the local electrical grid (EDL, Qadisha, ...). This shall include but is not limited to low voltage cables, AC circuit breaker, power meter, electrical enclosure and all necessary accessories to ensure proper and safe system operation.

### **400.2 GENERATOR SET**

One standby diesel operated generated set with associated accessories, cooling air flow system, fuel water separator filter, start up, daily tank, fuel system, batteries & Charger, Instrumentation, protection and control equipment shall be installed to supply the pumping station equipment.

The primary distribution board shall include an incoming section with facilities for connection of a standby generator. An adequately sized opening with a hinged steel door shall be provided at low level in the external wall of the room of the building housing the primary distribution board. The incoming section shall incorporate an interlocked mains/standby supply, manually operated, change over switch. "Mains supply available" and "standby supply on" indicator lights shall be provided on the panel face.

### **400.3 MOTOPUMPSET SWITCHGEAR**

Distribution board: A primary distribution board shall be provided at each installation. The board shall have, as applicable, feeds to:

1. Each motor starter/control panel.
2. Chlorination panel.
3. Instrumentation and control equipment.
4. Building services electrical distribution board.
5. Other as particularly specified.

The primary distribution panel shall be located in the control room. It may be either wall mounted or free standing as appropriate to its rating power factor meter and size. The board

shall incorporate door mounted ammeters, voltmeter with a phase-phase and phase-neutral selector switch, frequency meter and power factor meter.

Where the EDL transformer is not in a building or where the incoming EDL supply to the site is at 380 V, an earth fault relay shall be incorporated in the main distribution board to trip out the incoming supply under earth fault conditions.

#### **400.3.1 GENERAL CIRCUIT BREAKERS (G.C.B.)**

- G.C.B. shall be a moulded case circuit breaker of type “A” as described in the general specifications.
- G.C.B. shall be installed upstream the Automatic-Transfer Switch, one for network supply and another for emergency supply.

#### **400.3.2 CIRCUIT BREAKERS FOR MOTOPUMPSSETS (C.B.P.)**

- C.B.P. shall be a moulded case circuit breaker of type “B” as described in the general specifications.
- C.B.P. shall be installed upstream the starters that control the motopumpsets.

#### **400.3.3 AUXILIARIES SWITCHGEAR**

- Shall include all outgoing feeders and corresponding protection for the auxiliaries of the site.
- The circuit breakers, shall be supplied and installed to supply all Auxiliary equipment of the site.
- The circuit breaker shall be a moulded case circuit breaker of type “B” as described in the general specifications.

#### **400.3.4 AUTOMATIC TRANSFER SWITCH (A.T.S.) (MAIN/STANDBY SUPPLY CHANGEOVER)**

- A.T.S complete with mechanical inter-lock shall be installed for the pumping station.
- This Automatic Transfer Switch shall be supplied with auxiliary contacts for monitoring and control.

#### **400.3.5 STARTER**

A combined starter/control panel shall generally be provided at each installation. The panel shall incorporate a suitably screened section for instrumentation and PLC. Panels shall be arranged for front and back access.

The panel shall be fed from the primary distribution board and shall incorporate a main incoming section with door interlocked isolator, “supply on” indicator lamp, voltmeter and ammeters on the panel face.

The panel shall incorporate phase failure, phase reversal and under voltage protection. It shall not be possible for unauthorised personnel to adjust the voltage protection devices.

Starter/control panels shall be fully compartmentalised with each motor starter enclosed within its own cubicle with a door interlocked isolator. Unless instrumentation is specific to a particular motor separate instrumentation compartment(s) shall be provided, isolated as necessary to prevent pick up from the motor starters induced spurious signals.

All starters shall incorporate, mounted on the outside of the door, in addition to the features stated in the General Specification, the following:

1. Hand/off/auto selector switch.
2. Motor start and stop push buttons for use in hand control of the pump.
3. Emergency Stop push button, shall be of the mushroom headed push to stop/twist to reset type.
4. Motor “running”, “stopped”, “fault” indicator lights.
5. Cyclometer type running hour’s indicator.
6. PLC for control, monitoring and transmission purposes used to control:
  - The motopumpset operation.
  - The motopumpset protection and signalling.
  - The motopumpset discharge motorized valve with “local/remote/off” selector.

All panels shall have an audible alarm to sound under fault condition, together with a panel mounted mute push button to silence the alarm when acknowledged. This shall not clear the fault light which shall only be cleared when the fault is cleared.

Lamp test facilities with lamp test push button shall be provided.

In the event of multiple pump installations the panel face shall incorporate a duty selector.

Flow indication, integration and recording shall be provided at the station control panel.

**N.B.:** - A calculation sheet for design justification of all electrical switchgear shall be submitted.

#### **400.4 UNINTERRUPTIBLE POWER SUPPLY (U.P.S)**

Set of one U.P.S. system of adequate power output operating in redundancy shall be installed to supply the control, protection, measuring, signalling, ... circuits of the pump station and suction reservoir.

#### **400.5 GROUNDING SYSTEM - LIGHTNING & SURGE PROTECTIONS**

- The Contractor shall supply and install a lightning protection system, covering all the pumping stations and reservoir or chlorination sites, and using early streamer emission type lightning conductors which number and type will be determined according to the site protection demand and in compliance with general specifications and latest standards.
- The lightning protection down conductors shall be flat conductors.
- The Contractor shall implement also an earthing circuit for the site, independent from the lightning ground network.
- The Contractor shall supply and install as well, a lightning current arrester at the point of entry of each power supply line into the stations and reservoir sites.
- The Contractor shall supply and install over-voltage protection systems for all power, data and communication networks in the station.

- The Contractor shall also connect to the grounding system all electromechanical equipment such as piping, electrical panels, H.V.A.C. system, switches, instruments, power outlets, luminaire chassis, etc...
- The maximum allowable resistance of the earthing pits is 5 ohms.
- The maximum allowable resistance of the lightning pits is 3 ohms.

#### **400.6 PROTECTION OF MOTOPUMPSETS**

The automatic shut off of the motopumpset shall occur in case of the following:

- Minimum water level in suction reservoir for motopumpsets fed from reservoirs.
- Minimum water level in borehole for well motopumpsets.
- High flow at the discharge of the motopumpset (with delay).
- Insufficient flow at the discharge of the motopumpset (with delay).
- High pressure at the discharge of the motopumpset (with delay).
- Low pressure at the discharge of the motopumpset (with delay).
- Unauthorized starting when main circuit-breakers are open.
- High water temperature at the suction of motopumpsets inside barrels (where applicable).
- High pressure at the suction of motopumpsets inside barrels.
- Low pressure at the suction of motopumpsets inside barrels.
- Minimum water level in barrels.

#### **400.7 ALARMS & SIGNALLING**

A visual indication and sound alarm shall be foreseen, in the electrical room with the switchgear, for the following faults (where applicable):

- Tripping of medium voltage circuit-breaker.
- Voltage fault.
- Minimum level in the suction and discharge reservoirs.
- Maximum level in the suction and discharge reservoirs.
- High pressure at the suction of motopumpsets.
- Low pressure at the suction of motopumpsets.
- Minimum water level in boreholes.
- Minimum water level in barrels.
- High pressure at the discharge of motopumpsets.
- Low pressure at the discharge of motopumpsets.
- Excessive flow at the discharge of motopumpsets.
- Insufficient flow at the discharge of motopumpsets.
- Motorized valve fault for each valve.
- Extreme levels in surge protection vessel (for each level).
- Emergency stop.
- Overheating of cooling air.
- Chlorine leakage.
- Fire alarm.

These defects shall be signalled on a luminous panel, constituted of labels of translucent material specific for each fault, and comprising two associated push-buttons: lamp test and reset (acknowledge).

A visual signalling (independent) of the state of each set shall be provided: RUN, STOP.

## **400.8 ELECTRICAL INSTALLATION FOR BUILDINGS**

### **400.8.1 ELECTRICAL PANEL BOARDS**

Including signalling lamps, measuring instruments, selectors, bus bars, glands, cables, wiring, connections, to incoming and outgoing feeders, installations, connection, labelling, accessories, identification, etc... These panels shall be installed where shown on drawings.

### **400.8.2 CIRCUIT BREAKERS**

The ratings and types of circuit breakers shall be as indicated on the respective panel drawings including installation, connections, labelling, accessories, etc...

### **400.8.3 ELECTRICAL CABLES**

Including conduits, cable trays, connections, supports, installation, accessories, identification, etc...

### **400.8.4 CONDUITS**

Including clamps, flexible, fittings, connections, installation, accessories, etc...

### **400.8.5 JUNCTION AND DISTRIBUTION BOXES**

Including glands, installation, connections, labelling, accessories, covers, etc...

### **400.8.6 SWITCHES**

Including boxes, covers, installation, accessories, cables, conduits, wiring, connections to panel boards, etc...

### **400.8.7 POWER OUTLET SOCKETS AND PLUGS**

Including plugs, boxes, covers, installation, cables, conduits, wiring, connections to panel boards, labelling, accessories, etc...

### **400.8.8 LIGHTING FIXTURES**

Including lamps, supports, poles, installation as and where shown on drawings, accessories, cables, conduits, wiring, connections to switches, etc...

### **400.8.9 EMERGENCY LIGHTING SYSTEM**

Including luminaires where shown on drawings, lamps, conduits, installation, labelling, accessories, cables, wiring, connections to power supply, etc...

### **400.8.10 TESTING AND COMMISSIONING**

Including measuring of resistances of the grounding and the lightning protection systems, luminaires, power, continuity and insulation meggering of cables installation, etc...

#### **N.B.:**

- All conduits used for domestic electrical installation shall be imbedded in walls or in floor.
- All outlet sockets and switches shall be flush mounted.

## 400. ELECTRICAL EQUIPMENT AND ACCESSORIES: BEINO PS

- |   |                    |
|---|--------------------|
| – Reference: Electrical Schematic                                 | No: 477W-PS-01EM04 |
| Electrical Details drawing  | No: 477W-PS-01EM06 |
| Standard drawing for the earthing and lightning protection system | No: 477W-PS-01EM07 |
| Domestic electrical installation schematic                        | No: 477W-PS-01EM05 |

### 400.1 EDL TRANSFORMER

The Contractor shall coordinate with EDL after gathering all necessary information, supply, install test and commission a High Voltage/Low Voltage ground mounted power transformer as follows:

- Dual primary voltage: 15/20 kV
- Secondary voltage: 400 V.
- Rated Power: 100 KVA.

The transformer shall be supplied along with subscription to EDL and power meter and all necessary materials as per EDL requirements and recommendations. (Medium voltage power lines are not included).

### 400.2 GENERATOR SET

One standby generator set with connecting cables and accessories shall be installed on a concrete pad, inside sound proof canopy, to supply the plant with the following main characteristics:

- Rated Power (Continuous Rating): P = 80 kVA
- Class of Protection: IP 23
- Switch Gear: include monitoring, control protection and displays.
- Fuel Storage Tank: Volume: V = 2,000 liters, carbon steel sheets 4 mm minimum thickness, fabricated with level indication, filling pipe and washout valve.

### 400.3 MOTOPUMPSET SWITCHGEAR

#### 400.3.1 GENERAL CIRCUIT BREAKERS (G.C.B.)

No. of Poles	Rating (A) at 380 V	Qty (No)
4	150	2



#### 400.3.2 CIRCUIT BREAKERS FOR MOTOPUMPSETS (C.B.P.)

- C.B.P. shall be a Molded Case Circuit Breaker of type “B” as described in the general specification.
- C.B.P. shall be installed upstream the starters that control the Motopumpsets.

No. of Poles	Rating (A) at 380 V	Qty (No)
3	100	1

#### 400.3.3 AUXILIARIES SWITCH-GEAR

- Shall include all outgoing feeders and corresponding protection for the auxiliaries of the site.
- The circuit breakers, shall be supplied and installed to supply all Auxiliary equipment of the site.
- The circuit breaker shall be a Molded Case Circuit Breaker of type “B” as described in the general specification.

No. of Poles	Rating (A) at 380 V	Qty (No)
4	32	1

#### 400.3.4 AUTOMATIC TRANSFER SWITCH (A.T.S.) (MAIN/STANDBY SUPPLY CHANGEOVER)

No. of Poles	Rating (A) at 380 V	Qty (No)
4	150	1

#### 400.3.5 STARTER

Type	Rating (kW) at 380V	Qty (No)
Solar Variable Frequency Drive	≥ 50	1

Solar Variable Frequency Drive control panel Should Have the following features:

- Vin: 800 – 1000 V
- Voltage AC output: 3 x 380
- Max Efficiency: 98%
- Enclosure: IP 65
- Permissible harmonics order as per as per IEC 61000-3
- Ambient Temp Range: -10C to 50C
- Frequency: 0 - 50 Hz
- Built-In data logging and a simple management interface.
- Ability to be remotely monitored and managed via a web application service

- Maximum Power Point Tracking (MPPT)
- Highly efficient maximum power point tracking with pump system specific algorithms.
- Active power management for temperature
- Automatic and active power management to ensure the system continues to run in even the most extreme temperature conditions.
- Digital inputs for connection of well probe, tank full, pressure switches and remote switches
- Analogue inputs for sensors. Applications included for pressure and level monitoring and pump control.
- Sun-Sensor function allowing controller to block pump operation once solar irradiation levels drop below a minimum threshold for optimizing operation.
- Water meter input Pulse water meter input for accurate collection of flow data.
- Variable frequency output to allow maximum water to be pumped based on available power.
- Soft start and infinite control of motor speeds for long life and low generator loads.
- Signal output for controlling externally connected devices.
- Low voltage DC input to allow bench / field configuration when 3 phase power is not available.
- Constant pressure and flow built in applications to limit or to provide minimum pressure and flow.
- Control of pump system using pressure sensors for remote control applications and pressure depended processes.
- Built in system timers for providing time of day or interval timing control.
- Power choice control giving the ability to prioritize water delivery or power type (cost) in hybrid applications
- Automatic data logging of all running pump data. Recording frequency is configurable with capacity for up to 10 years.
- Simple LED display to indicate system status.
- Simple configuration with remote application
- Local and remote monitoring and management with a well-developed web interface
- Configurable set points for minimal frequency power drive to ensure optimized commissioning settings for pump switch off at low power values
- Integrated filter ensuring a sinusoidal phase to phase voltage transmission to the motor.
- Integrated dV/dt filter ensuring a controlled voltage rise rate and slower peaking when connected at shorter runs.
- 5 years warranty
- Enclosure 200 x 80 x 40 cm.
- Sine Wave Filter

#### 400.4 ELECTRICAL INSTRUMENTATION

Local electrical instrumentation	Quantity (set)
Set of three digital Ammeters with current transformers	3
Digital hour-meters	1
Signalling lamps (Set of three)	5

- Current, voltage, power factor and frequency measurements shall also be transmitted, via the relevant Programmable Logical Controller (PLC) and the main PLCs, to the supervisor program for calculation, remote display or any other application.

#### 400.5 UNINTERRUPTIBLE POWER SUPPLY (U.P.S)

Shall be as described in the Common Particular Specifications.

#### 400.6 GROUNDING SYSTEM - LIGHTNING & SURGE PROTECTIONS

Shall be as described in the Common Particular Specifications.

#### 400.7 PROTECTION OF MOTOPUMPSETS

The automatic shut off of the motopumpsets shall be as described in the Common Particular Specifications.

#### 400.8 ALARMS & SIGNALING

Shall be as described in the Common Particular Specifications.

#### 400.9 ELECTRICAL INSTALLATION FOR BUILDING

Shall be as described in the Common Particular Specifications.

## 401. DEIR NBOUH WELL PUMPING STATION

- Reference: Electrical schematic drawing No: 477W-PS-02EM04  
Domestic electrical installation drawing No: 477W-PS-02EM05  
Electrical details drawing No: 477W-PS-02EM06  
Standard drawing for the earthing and lightning protection system  
No: 477W-PS-02EM07

### 401.1 MOTOPUMPSET SWITCHGEAR

#### 401.1.1 General Circuit Breakers (G.C.B.)

No. of Poles	Rating (A) at 380 V	Qty (No)
4	240	1
4	220	1

#### 401.1.2 Circuit Breakers for Motopumpsets (C.B.P.)

No. of Poles	Rating (A) at 380 V	Qty (No)
3	150	1

#### 401.1.3 Auxiliaries Switchgear

No. of Poles	Rating (A) at 380 V	Qty (No)
3	32	1

#### 401.1.4 Automatic Transfer Switch (A.T.S.) (Main/Standby Supply Changeover)

No. of Poles	Rating (A) at 380 V	Qty (No)
4	240	1

#### 401.1.5 Starter

Type	Rating (KW) at 380 V	Contactors Mechanical Life (Cycles)	Contactors Switching Frequency (Cycles/Hour)	Qty (No)
Solar Variable Frequency driver	≥ 85	≥ 10 million	≥ 2400	1

Solar Variable Frequency Drive control panel Should Have the following features:

- Vin: 800 – 1000 V
- Voltage AC output: 3 x 380
- Max Efficiency: 98%
- Enclosure: IP 65
- Permissible harmonics order as per IEC 61000-3
- Ambient Temp Range: -10C to 50C
- Frequency: 0 - 50 Hz
- Built-In data logging and a simple management interface.
- Ability to be remotely monitored and managed via a web application service
- Maximum Power Point Tracking (MPPT)
- Highly efficient maximum power point tracking with pump system specific algorithms.
- Active power management for temperature
- Automatic and active power management to ensure the system continues to run in even the most extreme temperature conditions.
- Digital inputs for connection of well probe, tank full, pressure switches and remote switches
- Analogue inputs for sensors. Applications included for pressure and level monitoring and pump control.
- Sun-Sensor function allowing controller to block pump operation once solar irradiation levels drop below a minimum threshold for optimizing operation.
- Water meter input Pulse water meter input for accurate collection of flow data.
- Variable frequency output to allow maximum water to be pumped based on available power.
- Soft start and infinite control of motor speeds for long life and low generator loads.
- Signal output for controlling externally connected devices.
- Low voltage DC input to allow bench / field configuration when 3 phase power is not available.
- Constant pressure and flow built in applications to limit or to provide minimum pressure and flow.
- Control of pump system using pressure sensors for remote control applications and pressure depended processes.
- Built in system timers for providing time of day or interval timing control.
- Power choice control giving the ability to prioritize water delivery or power type (cost) in hybrid applications
- Automatic data logging of all running pump data. Recording frequency is configurable with capacity for up to 10 years.
- Simple LED display to indicate system status.
- Simple configuration with remote application
- Local and remote monitoring and management with a well-developed web interface
- Configurable set points for minimal frequency power drive to ensure optimized commissioning settings for pump switch off at low power values
- Integrated filter ensuring a sinusoidal phase to phase voltage transmission to the motor.
- Integrated dV/dt filter ensuring a controlled voltage rise rate and slower peaking when connected at shorter runs.
- 5 years warranty
- Enclosure 200 x 80 x 40 cm.

- Sine Wave Filter

#### **401.2 LOCAL ELECTRICAL INSTRUMENTATION**

<b>Local Electrical Instrumentation</b>	<b>Quantity (set)</b>
Set of three digital Ammeters with current transformers	3
Set of digital voltmeters with selector switches	1
Digital hour meters	1
Digital frequency meters	1
Digital power factor measurement (Response time $\leq 1$ s)	1
Signalling lamps (Set of three)	5

- Current, voltage, power factor and frequency measurements shall also be transmitted, via the relevant Programmable Logical Controller (PLC) and the main PLCs, to the supervisor program for calculation, remote display or any other application.

#### **401.3 UNINTERRUPTIBLE POWER SUPPLY (U.P.S)**

Set of two U.P.S. systems each.

#### **401.4 GROUNDING SYSTEM - LIGHTNING & SURGE PROTECTIONS**

Shall be as described in the Common Particular Specifications.

#### **401.5 PROTECTION OF MOTOPUMPSETS**

The automatic shut off of the motopumpsets shall be as described in the Common Particular Specifications.

#### **401.6 ALARMS & SIGNALLING**

Shall be as described in the Common Particular Specifications.

#### **401.7 ELECTRICAL INSTALLATION FOR BUILDING**

Shall be as described in the Common Particular Specifications.

**PART 5**  
**INSTRUMENTATION AND CONTROL**

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## **500. INSTRUMENTATION AND CONTROL: COMMON PARTICULAR SPECIFICATIONS - PUMPING STATIONS**

### **500.1 PUMPING SYSTEM**

The control system shall be designed and implemented on the following basis:

- All general circuit breakers (GCB), the corresponding MTS system, the circuit breaker for auxiliaries, the relevant signalling and electric parameters (voltage, current, frequency, power factor) shall be connected and/or controlled by one PLC unit adequately sized (PATS).
- For each motopumpset system, the circuit breaker (CBP), the starter, the suction and discharge motorized valves, where applicable, the discharge pressure, the discharge flow, the motor temperature measuring instruments, the relevant signalling and electric parameters (voltage, current, frequency, power factor) shall be all connected and/or controlled by one PLC unit adequately sized (PSC).
- One main P.L.C. unit (MPLC), shall be installed and connected to all PLC units through a communication bus, and shall be responsible for the automation and control of the pumping station/system according to the relevant parameters and variables.
- For each group of surface motopumpsets, and unless otherwise specified, the motopumpsets shall be operated cyclically and the maximum number of pumps simultaneously running is the total number of pumps less one pump.
- Where the pumping station consists of only one motopumpset system (borehole or surface), then this system and the electric ATS shall be controlled by the main PLC (MPLC) of the station.
- The Contractor shall supply one portable programming unit for the above PLC unit(s).
- The proposed equipment and add-in options shall offer and support cable redundancy on the network components.
- Where specified to lay down telemetry cables, they shall be drawn into ducts laid in the pipe trenches. Ducts shall be 63 mm Polyethylene (PE) pipe laid with 750 mm cover with draw pits at the ends and intermediately such that no length of continuous duct exceeds 100 m. Draw pits shall be installed at all changes of direction in excess of 22°.
- Cable route markers shall be installed at bends and along the cable length.
- Where the Contractor does not have a pipeline to install, he shall provide for the execution of all necessary civil works, trenches, etc... as described in the general specifications.
- In addition to the control and indication equipment (measurements display, alarms, push buttons, etc...) installed in the control room of the pumping station, this latter shall be designed to house a mimic panel representing the pumping system.

## **500.2 RESERVOIR**

Each location of reservoir(s) shall be equipped with a remote terminal unit (RTU), adequately sized for the control of the water levels in the reservoir, motorized valves and flowmeter, etc ...

## **500.3 PLC SPECIFICATIONS**

### **500.3.1 GENERAL SPECIFICATION**

The PLC shall be installed withing a self-Standing Enclosure IP 54 made by steel sheet of thickness not less than 2 mm thick, modular in construction, properly reinforced, powder coated and having rigid frame structure; and internal mounting plate including the gland plate shall be 3 mm thick. The control panel shall have dimensions as per system requirement. However, the control panel height shall not exceed 2000 mm. Front door with lock.

The PLC Controller shall be equipped with Plug-in Memory Card 2GB max and built-in ethernet and communication ports (RS485, RS232). The Control panel shall include necessary component to insure proper functioning, Modbus Module for Peripherals. The 24 VDC Power supply for connection 124 master or slave units. The PLC shall support DNP3 Protocol and data logging.

Digital inputs shall be 24VDC input level, galvanic isolated, with led indication.

Analogue inputs Module with minimum resolution 16-bit, external power supply 24VDC. the Input-output module shall secure 10% spare for future extensions.

88 DI

32 AI

28 DO

58 Point Modbus communication

### **500.3.2 SYSTEM ARCHITECTURE**

The system architecture for PLC / SCADA System has been designed using the automation and information levels commonly used in standards, such as ISA-95. These levels define the interfaces between enterprise activities, plant, and control activities. Automation operations will be performed at the lowest level possible within the architecture. Presenting the Integrated Architecture using these levels assists in understanding the functionality and roles of system elements.

### **500.3.3 LEVEL 0 - FIELD DEVICES**

This level includes instruments, actuators, drives, and safety equipment. Interface to the components is either hardwired or via a communication network such Ethernet/IP, Modbus, Process measurements and control actions take place at this level, as well as local instrumentation and device diagnostics.

### **500.3.4 LEVEL 1-MONITORING AND CONTROL OF FIELD INSTRUMENTATION AND DEVICES**

This level includes PLC, I/O modules, and control network communication interfaces and all related protection devices and accessories to allow proper functioning of the system.

In each Pumping station, Reservoir the contractor shall install a PLC that support DNP3 Protocol and has an Ethernet Port. This port will be connected to DNP3 gateway capable to transmit data thru

3G/4G data using M2M package. the PLC shall be equipped with memory cards up to store data up to two weeks in case of Communication failure.

In critical pumping station or reservoirs powers a redundant power supply shall be provided.

The PLC shall have at least the following Inputs/Outputs and this list may be extended to allow proper monitoring and functioning of the system in each location.

Equipment ID	Equipment	IO description	Input Type
RC-1	PUMP	ON/OFF Status	Digital Input
		FAULT	Digital Input
		Power meter	Ethernet
		Power ON	Digital Input
		Run Order	Digital Output
		Soft starter register	Modbus or Ethernet
		VFD registers	Modbus or Ethernet
RC-2	Level sensor	Reading	Analogue input
RC-3	Level electrode	Low Low level	Digital Input
		Pump enable level	Digital Input
	Flow Meter	reading	Analogue input
RC-4	Water Meter	Reading	Digital Input (pulse)
	Pressure Sensor	reading	Analogue input
RC-5	Temperature sensor	reading	Analogue input
		Auto/Manual	Digital Input
		Flow switch	Digital Input
		pressure switch	Digital Input
		Reset	Digital Input

Equipment ID	Equipment	IO description	Input Type
		PLC Enable	Digital Input
<b>RC-6</b>	Chlorination system	ON/OFF Status	Digital Input
		Power ON	Digital Input
		Pump on off status	Digital Input
		Residual Analyzer	Modbus or Analogue Input
		Chlorine Leakage	RS-232 Digital Communication or Analogue Input and digital output
		Automatic feed of Chlorine (Omni Valve)	RS-232 Digital Communication or Analogue Input
<b>RC-8</b>	Generator	Fuel tank level	Analogue Input
		Control panel of GEN	Modbus
		Generator ON/OFF Status	Digital Input
<b>RC-9</b>	Utility	EDL Available	Digital Input
		Power meter	Ethernet or Modbus

List of events to be transmitted to the main station:

<b>Devices</b>	<b>Events</b>	<b>Total Events per day</b>	<b>Comments</b>
<b>Pumps</b>	<b>Pump Status</b>	<b>720</b>	<b>Every 2 minutes</b>
	<b>Running Hour</b>	<b>24</b>	<b>once per Hour</b>
<b>Pressure sensor</b>	<b>Pressure</b>	<b>2880</b>	<b>Every 30 second</b>
<b>Level sensor</b>	<b>Water Level in well</b>	<b>720</b>	<b>Every 2 minutes</b>
<b>Level sensor</b>	<b>Water level In resevoir</b>	<b>720</b>	<b>Every 2 minutes</b>
<b>PT-100</b>	<b>Temperature</b>	<b>2880</b>	<b>Every 30 second</b>
<b>Flow meter</b>	<b>Flow measurement</b>	<b>720</b>	<b>Every 2 minutes</b>
<b>Power Meter</b>	<b>Pump Amperage</b>	<b>4320</b>	<b>every 10 second when running assuming 12 hour running</b>
<b>Power Meter</b>	<b>Pump Voltage</b>	<b>720</b>	<b>Every 2 minutes</b>
<b>Power Meter</b>	<b>Power usage per Hour</b>	<b>24</b>	<b>once per Hour</b>
<b>Power Meter</b>	<b>Max volt per Hour</b>	<b>24</b>	<b>once per Hour</b>
<b>Power Meter</b>	<b>Min voltage Per Hour</b>	<b>24</b>	<b>once per Hour</b>
<b>Pressure sensor</b>	<b>Water system discharge Pressure</b>	<b>8640</b>	<b>Every 10 second</b>
<b>Chlorine MCC</b>	<b>Chlorine Status</b>	<b>720</b>	<b>Every 2 minutes</b>
	<b>Chlorine Residual</b>	<b>720</b>	<b>Every 2 minutes</b>
	<b>Chlorine dosage</b>	<b>2880</b>	<b>Every 30 second</b>
	<b>Chlorine Pump Status</b>	<b>720</b>	<b>Every 2 minutes</b>
	<b>Chlorine Pump Running Hour</b>	<b>24</b>	<b>once per Hour</b>
<b>Actuators MCC</b>	<b>Actuators Status</b>	<b>720</b>	<b>Every 2 minutes</b>

<b>Energy Meter</b>	<b>Total Electricity consumption</b>	<b>1</b>	<b>Once per day</b>
<b>Fuel level</b>	<b>Fuel Level in Reservoir</b>	<b>720</b>	<b>Every 2 minutes</b>
<b>Generator</b>	<b>GEN Running Hours</b>	<b>1</b>	<b>Once per day</b>
	<b>GEN Amperage</b>	<b>4320</b>	<b>every 10 second when running assuming 12 hour running</b>
	<b>Faults &amp; Alarms</b>		
<b>Level Electrode</b>	<b>Low level in well</b>	<b>3</b>	<b>When Occur</b>
<b>Level in reservoir</b>	<b>Elevated level in reservoir and pumps are running</b>	<b>3</b>	<b>When Occur</b>
<b>Pump MCC</b>	<b>Pump Fault</b>	<b>3</b>	<b>When Occur</b>
<b>Chlorine MCC</b>	<b>Chlorine Fault</b>	<b>3</b>	<b>When Occur</b>
<b>Chlorine MCC</b>	<b>Chlorine leakage</b>	<b>1</b>	<b>When Occur</b>
<b>Actuators MCC</b>	<b>Actuators Fault</b>	<b>3</b>	<b>When Occur</b>
<b>Generators</b>	<b>Generator failure in utility Absence</b>	<b>3</b>	<b>When Occur</b>
<b>Fuel</b>	<b>Low level in fuel tank</b>	<b>3</b>	<b>When Occur</b>

#### 500.4 PLC PANELS GENERAL SPECIFICATION

##### 500.4.1 PROGRAMMABLE LOGIC CONTROLLER (PLC) PANELS

Programmable Logic Controllers (PLC) Panels shall be provided with control and monitoring configuration to perform combinational and sequential logic functions, status monitoring and reporting functions with counter and timer facilities.

PLC shall comprise of necessary processors, Simplex input/output (I/O) modules of the same series of the PLC CPU, communication interface modules and Human-Machine Interface (HMI) required to perform the desired functions. PLC shall have the following attributes as a Controller.

- carry out sequential logic implementation for operations of plant;



- carry out computation and interfacing for data acquisition, data storage and retrieval
- it shall accept downloaded program from a programmer;
- it shall have different functional modules to perform the desired functions;
- it shall scan the inputs in time cycles and update the status of its outputs.
- The PLC system shall support OPC (Open protocol) compliant.
- The PLC system shall be expandable and shall be modular in construction, so as to be capable of future expansion without hardware modifications. PLC's shall be microprocessor based. PLC's shall use standard known protocols and structures for communication outside the system.

To communicate with the HMI/MMI no external OPC server shall be considered.

In case of system failure or power supply failure the outputs shall attain a predetermined fail-safe condition (this shall normally be 'off') that could be achieved via a relays where the coil is connected to the output and the normally open or normally close contact is connected to the actuator.

The PLC used shall have a proven record in the type of application concerned and in the prevailing environmental conditions. Refer approved vendor list. PLC System (Panel) should be housed in a dust free environment.

#### 500.4.2 REFERENCE VENDOR LIST FOR AUTOMATION

No.	Description	Manufactures/Makes
1	Programmable Logic Controllers	Rockwell Automation, Siemens PLC, Schneider Electric (Premium – M340 Quantum Series),
3	Industrial Cellular Gateway from Ethernet or Modbus to DNP3 Support 2G/3G/4G	Prosoft, Westermo

#### 500.5 PLC PANELS PARTICULAR SPECIFICATION

##### 500.5.1 PARTICULARS FOR PROGRAMMABLE LOGIC CONTROLLERS

According to the project requirements and different numbers of inputs/outputs there shall be two to three different size of the PLC for master station which shall be built in PLC Panels. There shall be master station with build in Basic type of PLC Controller and master station with build in advanced type of PLC Controller.

Both shall be provided with central processors unit (CPU) configured such that they operate in hard environment condition. CPU should have the memory expansion capability with plug in memory card.

The CPU's should have separate associated support hardware and built in WEB server.

SCADA connectivity with the CPU will be on Ethernet network (10/100 Mbps with open Ethernet IP or DNP3, Profibus/Modbus or Profinet,) either through embedded port or communication modules or communication gateways. There shall be dual connectivity based on minimum two different communication systems. On the event of hardware failure in primary system the standby system would provide dual connectivity with the SCADA.

Redundancy of switch for SCADA (industrial grade managed switch) connectivity is to be provided.

Contractor should take note on the importance of this obligation.

The both PLC systems shall be expandable (OPC compatible) and shall be modular in construction, to capable of future expansion without hardware modifications. The communication to the HMI/MMI should not require external OPC servers.

The system hardware, application software and database shall be sized to accommodate a total of 50% increase in signal capacity and up to 100% increase in an individual zone.

Sufficient plug in modules shall be provided and wired to terminals ready to accept future signals of up to 15 % for each 6 cards

Each 6 cards shall be able to accept at least one more I/O cards without requiring replacement of, or additions to, the original equipment.

PLC's shall be microprocessor based. PLC's shall use standard known protocols and structures for communication outside the system. In case of system failure or power supply failure the outputs shall attain a predetermined fail-safe condition (this shall normally be 'off') by configuration or through relays.

The PLC used shall have a proven record in the type of application concerned and in the prevailing environmental conditions. PLC shall be of an approved type from a major international manufacturer.

Refer Vendor list. The PLC shall be open systems standard for all elements of communications and programming and shall be designed for ease of use and minimum configuration. Application logic programs shall be fully compliant with all most used logic development methods detailed in IEC 63331-3 (Instruction list, FBD, Ladder or AWL at least).

The PLC shall be powered by the UPS system with 8 hours backup time and all internal operating supplies shall be derived from the UPS. The power supplies, I/O, CPU and communication modules and battery backup rates shall be monitored by the PLC and shall be available by report.

During the times of the battery discharge, the PLC shall initiate an orderly self-shutdown and automatically restart on the main power restoration without the need

for reloading or initiation of any kind. The PLC shall comply with the specification specified elsewhere in this specification.

Each PLC shall have built in web server capability allowing system information to be stored in a format that allows for easy access and viewing with standard Windows™ based browser. Each unit shall be furnished with built in O & M data associated with its specific site including; as a minimum, basic system information, panel layouts, wiring diagrams, material lists w/part numbers, and operational summary. This information shall be accessible locally or remotely.

The sites should have at least 3 types of PLC each of them addressing several size of sites. The Medium and big size should support if required by the site insertion and removal of I/O module under power.

For the small or medium size sites the CPU should embed one or two Ethernet port that support modern protocol such as Ethernet/IP belonging to the OVDA, Profinet or Modbus TCP.

### **500.5.2 PLC CENTRAL PROCESSING UNITS**

The central processing units (CPU) shall be a high performance processor with modular configuration suitable for real time process applications. The CPU with a large program and data memory in the for failsafe applications with high requirements regarding program scope and networking.

For the medium and big size site the CPU should a real time multi task operating system done for industrial automation and RTU.

Shall be possible to select CPU that include failsafe functions according to IEC 61508 where conventional automation control application with safety application will be able to be together, but only when required.

The following features shall be provided on a minimum

- Communication between CPU and peripherals shall be by an I/O bus. And if extension I/O modules required the individual device, interfaces shall be capable of being plugged into the I/O bus.
- On resumption of power following a power failure the PLC shall automatically restart its controlling function.
- High processing speed for binary and floating-point arithmetic
- CPU shall have a real time clock capability to accept a time synchronization pulse and adjust its internal clock with the pulse.
- CPU shall have extensive self-diagnostic facilities and watch dog timers to identify fault at card levels

The CPU for Basic type of PLC Controller type shall have can have integrated I/O's where the number will be directly related to the size of controller required that will comply with the specifications requirements, an example is that for a medium size site the CPU can embed 20DI and 12DO and 4AI and 2AO, but the CPU should allow expansion of I/O modules as well as gateway depending of the technology chosen and the type of PLC required. The limitation in number will be directly linked to the size of site and the availability required for it.

Note: Advance PLC could embed 16 DI and 16 DO.

The CPU for Advanced type of PLC controller type shall have number of connectable 10 devices,

- Modern Ethernet communication connection nodes like Ethernet IP or similar with a support several 1000 I/O's for the big sites.
- Possibility of DEVICENET to connect existing devices that support it.
- Possibility of Modbus TCP to connect existing devices that support it.
- Possibility of Modbus Serial to connect existing devices that support it.
- PROFINET IO Controller Services with number of connectable IO devices, up to max.
- 512; In total, up to 1000 distributed I/O devices can be connected via PROFIBUS or PROFINET
- PROFIBUS DP master Services with number of DP slaves up to 125; In total, up to 1000 distributed I/O devices can be connected via PROFIBUS , PROFINET or DP3

This connection could be either done vial inrack modules or gateway depending of the network and type of site.

The I/O network would be for the high availability site preferently Ethernet ring or similar such as Ethernet/IP DLR ring form OVDA.

The CPIU should allow online changes of the application without any impact in the running application.

### **500.5.3 PLC MEMORY UNIT**

Memory unit shall comprise of highly reliable memory chips which are industry standard, proven design with fast random access and suitable for operation in process environments. Main memory shall be modular and facility shall be provided for the upgrading and expansion of memory to meet future demands. Not less than 50 % spare program memory and data memory space shall be provided. System initialization and application software shall be stored in flash memory or EEPROM or EPROM. Operating data shall be stored in a RAM fitted with an internal battery backup or capacitor that allows to store the data into internal flash memory and will be stored back to running ram memory when the power get back. The battery backup or mechanism of storing the ram data provided shall support the memory on loss of power for at least one month. In the vent of battery, it life shall be at least 2 years.

The CPU for Basic type of PLC Controller type shall have Working memory of up to 32MB or greater for the advance PLC and 20kbytes with 128K bytes for data-logging for the small size PLC/RTU. Some solution but not limited to will require Load memory as Plug-in Memory Card with capacity from 4MB, 12 MB, 24MB, 256MB up to 2GB capacity.

The CPU for Advanced type PLC controller type shall have Working memory of up to from 756KB to 4MB or greater with a possibility if required of load memory as Plug-in Memory Card shall be up to 2 GB capacity or greater.

Preferently the medium and big size site, the application memory and data memory should be common in order to simplify the data sharing between communication task and process task as well as simplify the online changes.

#### **500.5.4 PLC I/O MODULES**

For small application and sites in number of I/O the PLC will allow extension modules.

For the application or sites that require rack mounted I/O, rack mounted plug in I/O modules shall be provided.

For the sites we can identify medium or big size that will require I/O extension rack mounted I/O with modules that can be inserted or removed under power.

In the event that the I/O modules are located in the same rack as the CPU, the I/O Modules should be of the same series as the PLC CPU.

Deviation from this would be treated as a non-responsive bid and lead to technical disqualification.

Contractor should take note on the importance of this obligation.

Field wiring shall be terminated in screwed terminal blocks and interconnected to the processor I/O system with prefabricated cables and plug in card type connectors.

The application should have 20% extra modules of installed capacity for each type of module shall be provided as spare.

Provision shall be made for future expansion of additional 20% extra I/O modules of the installed capacity.

All I/O module should be rack mounted type I/O modules shall be as follows:

- Inputs shall be opto isolated;
- filters shall be provided for noise rejection;
- output status shall be indicated by an LED;
- all outputs shall be fuse protected and have fuse failure indication the fuses may be mounted externally from the output module;
- all the modules shall be of addressable type.

#### **500.5.5 PLC ETHERNET SWITCH MODULE**

Ethernet I/O modules shall be connected to the PLC by on board Ethernet 10/100 Base T connection port. Ethernet switch for implementing local Ethernet network shall be built in PLC Panel.

The site that will require High availability or redundancy the I/O will be connected via Ethernet ring supporting modern ring protocol such as CIP or other Ethernet/IP DLR or Profinet or similar in order to provide high availability for the RIO network. The Ethernet modules or adapters shall preferably embed manageable integrated switch with 2 ports ring enable.

In the event of the panel will require additional switch, the switch shall be unmanageable switch if no cybersecurity required or layer 2 or layer 3 manageable switch when cybersecurity required.

It shall do the multiplication of Ethernet interfaces on RTU unit for additional connection of up to three programming devices, operator controls, and further Ethernet nodes if required.

It shall have connection without any problems using RJ45 standard connectors. There shall be integral autocross over function permits use of uncrossed connecting cables

The connection to devices that will support third party Ethernet protocol or serial protocol such as Modbus Serial or ASCII or Profibus will be achieved either via in rack modules or gateway depending of the size of the site as well as the type of protocol. In some cases, the communication between protocol will be done through the backplane a and via CPU.

#### **500.5.6 PLC ANALOGUE INPUT MODULES**

They shall consist of an input isolation unit, signal conditioning unit and an analogue to digital converter (ADC). In addition, the following features shall be provided.

- cross talk attenuation
- provision for monitoring of the ADC for overflow detection
- gain amplifier with high common mode rejection ratio
- accuracy for analogue signals shall be 0.5%
- With extremely short conversion times
- For connecting analog sensors without additional amplifiers

#### **500.5.7 PLC ANALOGUE OUTPUT MODULES**

They shall consist of signal conditioning unit and a digital to analogue converter (DAC). In addition, the following features shall be provided.

- 12 to 16 bits resolution minimum
- provision for monitoring of the DAC for overflow detection
- accuracy for analogue signals shall be 0.5%

#### **500.5.8 PLC DIGITAL INPUT MODULES**

The following design features shall be provided.

- contact bounce protection;
- choice of type of contacts.

#### **500.5.9 PLC DIGITAL OUTPUT MODULES**

The digital output module shall provide contact closure output by driving relays. The features to be provided are as follows:

- contact bounce protection shall be provided
- relay output shall be provided to operate pump motors and motorized valve actuators
- fail safe position in case of output module failure and fault indication

PLC's provided under this specification shall be capable of performing the necessary logic to control the system as previously defined. These capabilities shall include, but not be limited to the following:

1. Discrete input / output	6. Pump Alternation	11. Counters	16. Time of Day Control w/lockout
2. Analog input	7. Mathematical Function Blocks	12. Comparators	17. Ramp Blocks
3. Analog output	8. Stage Blocks	13. FBD logic only for advance	18. Data Logging
4. Timers	9. Trending	14. Flow Totalization/Integration	
5. Pump Controller	10. Latch/unlatch relays	15. Intrusion Detection	

#### 500.5.10 PLC ETHERNET IP INTERFACE MODULE OR EMBEDDED PORT

This shall be Communication module for connecting a PLC to internet IP network (CIP over Ethernet IP OVDA Protocol) networks as RIO Network.

In the event redundancy / High availability the protocol has got a built in ring capabilities DLR as per OVDA specifications.

ODVA International have recently introduced the newest member of the CIP family – EtherNet/IP ("IP" stands for "IndustrialProtocol"). This implements the full suite of control, configuration, and data collection data services on an Ethernet network, and can thus be used for both the information and control levels.

EtherNet/IP provides the capability to collect data from devices directly on the Ethernet network and to configure those devices in real-time, it cannot be assumed that a single network will supply all needs. Individual vendors may not have an EtherNet/IP connection available for their device.

EtherNet/IP is a connection-based network. A CIP connection defines a packet that will be produced on the network. When a connection is established, the transmissions associated with that connections are assigned a Connection ID (CID). If the connection involves a bi-directional exchange, then two Connection ID values are assigned. Since most messaging on a CIP network is done through connections, a process has been defined to establish such connections between devices that are not "connected" yet. Once a connection has been established, then all communication resources needed in the devices including any intermediate CIP bridges/routers are reserved. And the overall network loading and bandwidth required for that data exchange is minimized.

The embedded switch technology shall have the following features. Exceptions can exist in which a product that has embedded switch technology does not support **all** of the following features:

- Support for the management of network traffic to ensure timely delivery of critical data, that is, QoS and IGMP protocols, are supported
- Product design that meets the ODVA specification for EtherNet/IP Because of this design, third-party products can be designed, according to the ODVA specification, to operate on a DLR or linear network.

The communication interface can go up to 250 nodes depending of the interface and CPU.

The number of nodes on a DLR network shall a maximum of 50. If in some circumstances the number shall exceed 50, the manufacturer should validated the network.

Provide rack type I/O modules in the base bid. Alternative system designs may use different mounting configurations. The I/O will have the ability to sit on an Ethernet ring topology and must selfheal within 3mS (ie Device Level Ring-DLR). Flex and Point I/O will also be available for installations that have tight space requirements and or small amount of I/O at an area.

#### **500.5.11 PLC DNP3 COMMUNICATION PROTOCOL INTERFACE MODULE/GATEWAY**

The DNP3 communications processor shall be used to connect a PLC to a control center system via the DNP3 protocol and has the following characteristics:

- Support for the established DNP3 tele control protocol for standardized linking of the available control center systems
- Data transfer of measured values, control variables, or alarms optimized for tele control systems
- Automatic sending of alert emails
- Clearly laid out LED signaling for fast and easy diagnostics
- Compact industrial enclosure for mounting on a standard mounting rail
- Fast commissioning thanks to easy configuration using PLC vendor software
- Data buffering of up to 64,000 values ensures a secure database even with temporary connection failures (For advance solution).
- Transfer rate at the 1<sup>st</sup> interface 10 ... 100 Mbit/s
- Type of electrical connection at the 1<sup>st</sup> interface acc. to Industrial Ethernet RJ45 port
- Supply voltage 1 from backplane bus.

#### **500.5.12 PLC 3G/4G COMMUNICATION MODULE**

PLC Panel shall be equipped with 3G/4G Communication router for connection to the globally available 2G/3G/4G mobile radio network with data transmission supported by the communication provider. 2G/3G/4G mode shall be with fixed IP addresses and dynamic IP addresses with standard mobile phone contract. This unit shall allowed transparent data tunneling using mobile network, remote



configuration by 2G/3G/4G, upload data via 3G/4G on Schedule or event occurs. For detail specification please refer to paragraph no. 5.2.5 -RTU 3G/4G.

#### **500.5.13 PLC POWER SUPPLY MODULE**

Power supply Module Accessories shall be single-phase load power supply (PM = power module) with automatic range selection of the input voltage is an optimal match e.g. power supply. The input voltage shall be 230VAC. It provides the supply to CPUs with 24 V input as well as to signal modules, and to 24 V loads connected to the modules.

#### **500.5.14 PLC UPS MODULE**

The PLC Controller shall be powered by the UPS system with 8 hours backup time and all internal operating supplies shall be derived from the UPS. The PLC UPS module shall be build inside of the PLC Panel. There shall be two sizes of UPS, one for Basic type of PLC Controller with active power of 1000W and second one for advanced type PLC controller type with active power of 2000W. The technical specification shall be same as other bigger UPS Modules for SCADA Center.

- On Line Double Conversion
- Apparent power - 1000/2000 VA
- Active Power - 900/1800W
- Input voltage - 220 VAC (range 115 VAC to 300VAC)
- Input frequency - 50 Hz (range 46 Hz to 54 Hz)
- Input Power factor - 0.98
- Output voltage - 220VAC (+- 2%) "pure sinewave"
- Output frequency - 50 Hz (+- 0.05 Hz)
- Output power factor - 0.9
- Build in bypass switch
- Insulation transformer

PLC-UPS shall be manageable & configured remotely (should contain Ethernet port)

#### **500.5.15 COMMUNICATION MODEMS AND ROUTERS**

All parts of SCADA system, RTU's, PLC's and SCADA Centers shall be equipped with communication units for control the communication subsystem which shall combines, modifies and transmits information over the chosen media. The communication hardware shall comprise of transmitters to convert the data signals to suit the transmission media, cabling or wireless like modems and routers, to combine and transmit the signals to a receiving station and vice- versa.

#### **500.5.16 3G/4G ROUTER**

The 3G router shall be industrial mobile broadband router uses the Internet to cost effectively interconnect systems, allowing PLCs to communicate with each other and with SCADA Centers.

The unit shall feature an onboard two port switch and a serial port providing the unit with versatile connection options. Together with the rugged enclosure, DIN-rail mounting for PLC and RTU Panels or rack mounting type for SCADA Center and an operating voltage range spanning from 10 VDC to 60 VDC, the unit shall be designed for industrial applications in harsh environments.

#### **500.5.17 CONNECTIVITY**

The 3G router shall supports a wide variety of wireless standards, GSM, GPRS, 3G/4G UMTS, HSDPA, and HSUPA, thus providing connectivity in as many applications as possible. With the built-in two port 10/100 Ethernet switch the 3G router shall easily allows devices to seamlessly connect over a vast geographical distance. Typical 3G router shall be include SCADA telemetry systems and remote access to machines and devices.

Securely connect everywhere using a Virtual Private Network (VPN)

3G router shall create VPNs secure tunnels over insecure networks, such as the Internet. With the straightforward on-board web interface, the VPN tunnel, running between sites shall be set. The 3G router shall offers network protection from malicious eavesdroppers via encrypted communication tunnels (VPN), and features a simple, yet powerful, packet inspection firewall. The unit shall support IPSec, SSL, PPTP and L2TP encryption and certificate management to secure the tunnel.

- Tri-Band UMTS/HSDPA/HSUPA: 900/2100 MHz .....
- Quad-Band GSM/GPRS/EDGE: 850/900/1800/1900 MHz ....
- HSUPA/HSDPA downlink data rates of up to 7.2 Mbit/s, uplink data rates currently at 2 Mbit/s
- Operating voltage range of 10 VDC - 60 VDC.....
- Two 10/100 Ethernet switch ports with a built-in DHCP server. ....
- Virtual Private Network (VPN) with IPSec, SSL, PPTP or L2TP encryption.....
- Web and SNMP based configuration
- Simply insert a 3G data SIM card inside to create a 3G wireless network
- Network status indicator
- The connection manager shall be features to 3G router in order to ensure constant connectivity and stability of mobile connections.

### **500.6 THE OPERATION PHILOSOPHY**

#### **500.6.1 FUNCTIONAL OPERATION OF THE MAIN EXECUTION UNITS CONNECTED TO THE SCADA SYSTEM**

Functional operation of the main execution units like Pumps and Automatic Valves shall have four modes of operations: System should run in two modes locally and remotely.

### **500.6.2 LOCAL**

When the selector is on the Local position, PLC should read all the digital inputs, alarms and indication of all equipment and instruments. The run output is disabled in this case. The sensors alarm output such the temperature, pressure, and dry running shall remain active and it shall be in series with local protections.

On the Local mode, operator in site can have the control and decision to Start/Stop the pump or any equipment if the pump is healthy.

The alarms output of sensors will prevent the operator to run the pump in local mode.

In case of Maintenance, the operator must put the selector in Local mode for safety reasons.

### **500.6.3 REMOTE**

When the selector is on the Remote position PLC will have full control and the pump will operate according to the logic incorporated in the PLC which is related to the water level in the Well/Reservoir and pump healthy conditions.

Remote mode will have two selections, Auto mode and Manual mode and can be selected in the SCADA system.

### **500.6.4 MANUAL MODE:**

Operator from SCADA room can Start/Stop the pump or any equipment manually taking into consideration the safe operation conditions.

### **500.6.5 AUTOMATIC MODE**

In the normal case the pump should be running according to a schedule can be modified in the HMI or SCADA, also the automatic system mode will be applied as the following condition:

### **500.6.6 PUMP RUN:**

- The pump must be healthy to start and not having any fault including:
  - Pump Fault (Thermal Protection)
  - Long start
  - Low Level in Well
  - High motor Temperature
  - High and Low Pressure
  - Low Flow Level

The level has a set points value to consider that when the Pump should be running.

#### 500.6.7 PUMP STOP

- The pump will stop for any fault condition mentioned above. The PLC will send order to stop the pump immediately once receiving any fault feedback.
- Once the fault disappear and the pump are healthy again, the PLC will consider the 6 times of pump running per hour before sending the start order again.
- The level will have a set point value to consider that when the Pump should be stopped.
- The Low Flow or Low Pressure shall be bypassed for few second at pump startup. Later they will be active.

#### 500.6.8 EDL/GENERATOR/SOLAR

Scada system shall only monitor the power supply quality and energy consumption for every source based on power meter readings.

For the generator we must as minimum read the status of faults as digital inputs but it's better if the PLC can communicate all protection registers from the DEEP SEA or Similar thru Modbus or Ethernet

#### 500.6.9 UPS

UPS is available when EDL fail. The PLC should always collect the availability data from the station and monitor the UPS availability and the battery health.

#### 500.6.10 ALARMS

Operator should monitor all the system and have indications of all alarms in case of any fault appear in the system.

List of Alarms

#	Alarm	Severity	Effect	Remedy
1	Pump Long start alarm	High	Emergency Stop	Reset
2	Pump Soft starter alarm	High	Emergency Stop	Reset
4	Pump high temperature	High	Emergency Stop	Reset
6	Water high pressure	High	Emergency Stop	Reset
7	Water low pressure	High	Emergency Stop	Reset

#	Alarm	Severity	Effect	Remedy
8	Water Low or no flow	High	Emergency Stop	Reset
9	Pump Fault	Medium	Normal Stop	N/A
11	EDL Fault	Medium	Normal Stop	N/A
12	Well low level - Electrode	Medium	Normal Stop	N/A
13	Well low level - Level Transmitter	Medium	Normal Stop	N/A
14	No Connection to SCADA	Low	Switch pump to remote auto mode	N/A
16	UPS Low Battery	Low	Display Only	N/A

#### 500.6.11 EVENTS

Events and transmission time and size.

#	Event	Type	Reporting Frequency	Hysteresis
1	Pump Local	Digital (True/False)	immediate upon change	N/A
2	Pump Remote	Digital (True/False)	immediate upon change	N/A
3	Pump Auto	Digital (True/False)	immediate upon change	N/A
4	Pump Manual	Digital (True/False)	immediate upon change	N/A
5	Pump Running	Digital (True/False)	immediate upon change	N/A
6	Pump Long Start Alarm	Digital (True/False)	immediate upon change	N/A
9	Pump Fault	Digital (True/False)	immediate upon change	N/A
14	Well Low Level - Transmitter	Digital (True/False)	immediate upon change	N/A
15	Well Low Level - Electrode	Digital (True/False)	immediate upon change	N/A
16	Pump High Temperature	Digital (True/False)	immediate upon change	N/A

KUWAIT FUND FOR ARAB ECONOMIC DEVELOPMENT  
CONSTRUCTION OF DRILLING WATER WELLS, PUMPING STATIONS AND LIFT LINES  
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#	Event	Type	Reporting Frequency	Hysteresis
17	Water Pressure High	Digital (True/False)	immediate upon change	N/A
18	Water Pressure Low	Digital (True/False)	immediate upon change	N/A
19	Water Low or No Flow	Digital (True/False)	immediate upon change	N/A
23	EDL ON	Digital (True/False)	immediate upon change	N/A
24	EDL Fault	Digital (True/False)	immediate upon change	N/A
29	UPS ON Battery	Digital (True/False)	immediate upon change	N/A
30	UPS Low Battery	Digital (True/False)	immediate upon change	N/A
31	Pump Output Safety	Digital (True/False)	immediate upon change	N/A
32	Pump Command Run	Digital (True/False)	immediate upon change	N/A
34	Masking Active	Digital (True/False)	immediate upon change	N/A
35	Masking Completed	Digital (True/False)	immediate upon change	N/A
36	Reset	Digital (True/False)	immediate upon change	N/A
37	Cleaning Active	Digital (True/False)	immediate upon change	N/A
38	Pump Running hour	Analog	Daily	N/A
39	Water pressure	Analog	upon change	5%
40	Water level in well	Analog	upon change	5%
41	Water level in reservoir	Analog	upon change	5%
43	Water flow measurement	Analog	upon change	5%
44	Pump current on L1, L2, L3	Analog	upon change	5%

#	Event	Type	Reporting Frequency	Hysteresis
45	Pump voltage on L1, L2, L3	Analog	upon change	5%
46	Pump kWh	Analog	Daily	N/A
47	Max volt	Analog	upon change	5%
48	Min volt	Analog	upon change	5%
49	Water discharge pressure	Analog	upon change	5%

#### 500.6.12 POWER METER

The power meter installed must read the indication bellow. All the reading mentioned must be viewed in the SCADA

<b>Pump Power meter</b>	CURRENT 1
	CURRENT 2
	CURRENT 3
	VOLTAGE 12
	VOLTAGE 23
	VOLTAGE 31
	ACTIVE POWER
	REACTIVE POWER
	FREQUENCY
	KWH
	POWER FACTOR

#### 500.6.13 HMI

The HMI shall show the PID diagram of the station and all related readings, alarms and indications.

HMI shall be user friendly and the schedule update shall be easy for basic operator. HMI Panel of size 10", 24VDC, with Built-in ethernet port for communication with PLC.

#### 500.6.14 SYSTEM FAILURE

System will consider failure once the connection between the PLC and the equipment's are lost and once sending order to run the pump in normal situation but system are not responding. Operator should know about this operation fail by indication on the screen.

PLC should know about the communication lost between the station and the SCADA. If connection is interrupted in remote manual mode, the pump switches

automatically to remote auto (as the schedule). As communication back, PLC should send all the data and alarms collected during the lost communication.



## **501. INSTRUMENTATION, CONTROL EQUIPMENT AND ACCESSORIES: BEINO PUMPING STATION**

Control system schematic  
Electrical schematic  
Well head schematic

No.: 477W-PS-01EM08  
No.: 477W-PS-01EM04  
No.: 477W-PS-01EM01

### **501.1 INSTRUMENTATION**

The Contractor shall supply and install the following system for the measurement of the operation parameters of the pumping installation and of their local display.

#### **501.1.1 LEVEL MEASUREMENTS**

Location	Type	Qty (No)
Well (L1)	Piezoresistive	1
Well (LE)	Electrode	1 (set of 3 electrodes)
Reservoir (L2)	Piezoresistive	1

The water level shall be monitored by a system providing the necessary duty set points, each being adjustable over the full range of control required.

To achieve performance stability under all environmental conditions and variations, all necessary signal compensation devices shall be included.

The monitoring system shall be dampened to prevent spurious switching due to transient wave motion but shall respond sufficiently to allow adequate time for plant reaction to stabilize in order to prevent hunting.

The system shall include a duplicate back-up monitoring device or have built-in self-monitoring circuitry with alarm facilities.

Any high-level settings which may be provided as part of a level control system may be linked with the independent high level alarm sensors specified.

#### **501.1.2 PRESSURE MEASUREMENTS**

Location	Type	Qty (No)
Well Discharge Pipe	Manometer	2
Well Discharge Pipe (P)	Piezoresistive	1

#### **501.1.3 TEMPERATURE MEASUREMENTS**

Location	Type	Qty (No)
Submersible Motopumpset Electric motor (T)	PT 100	1

#### **501.1.4 FLOW MEASUREMENT**

Location	Type	DN (mm)	PN (bars)	Qty (No)
Well Discharge pipe (F)	Electromagnetic	125	16	1
Well Drain pipe (FS)	Flow switch	13	16	1

### 501.2 CONTROL EQUIPMENT

- The main PLC shall have a provision for the connection to the RTU of the reservoir.
- The control system of the well pumping station shall use a cable link for the communication between the main PLC (MPLC) of the pumping station and the RTU of the reservoir.
- The Contractor shall supply and install telemetry cables from the well pumping station to the location of reservoir.
- The Contractor shall supply and install an HMI (Human Machine Interface) panel showing the entire pumping system.
- The anti-water hammer system shall be connected to the MPLC of the well pumping station for control and protection.

### 501.3 PLC SPECIFICATIONS

As described in the common particular specification.

## 502. DEIR NBOUH WELL PUMPING STATION

- Reference: Control schematic No: 477W-PS-02EM08
- Electrical schematic No: 476W-PS-02EM04
- Hydraulic schematic No: 476W-PS-02EM01
- Chlorination schematic No: 476W-PS-02EM02

### 502.1 INSTRUMENTATION

The Contractor shall supply and install the following systems for the measurement of the operation parameters of the pumping installation, their local display and remote transmission.

#### 502.1.1 Level Measurements

Location	Type	Qty (No)
Well (L1)	Piezoresistive	1
Well (LE)	Electrode	1 (set of 3 electrodes)
Reservoir (L2)	Piezoresistive	1

The water level shall be monitored by a system providing the necessary duty set points, each being adjustable over the full range of control required.

To achieve performance stability under all environmental conditions and variations, all necessary signal compensation devices shall be included.

The monitoring system shall be dampened to prevent spurious switching due to transient wave motion but shall respond sufficiently to allow adequate time for plant reaction to stabilize in order to prevent hunting.

The system shall include a duplicate back-up monitoring device or have built-in self-monitoring circuitry with alarm facilities.

Any high-level settings which may be provided as part of a level control system may be linked with the independent high level alarm sensors specified.

#### 502.1.2 Pressure Measurements

Location	Type	Qty (No)
Well Motopumpset outlet	Manometer	2
Well Motopumpset outlet (P)	Piezoresistive	1

#### 502.1.3 Flow Measurements

Location	Type	DN (mm)	PN (bars)	Qty (No)
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Well Motopumpset outlet (F)	Electromagnetic	80	40	1
Well Drain (FS)	Flow Switch	13	40	1

#### 502.1.4 Temperature Measurements

Location	Type	Qty (No)
Well Motopumpset electric motor	PT 100	1 (1 per motor)

#### 502.1.5 FLOW MEASUREMENT

Location	Type	DN (mm)	PN (bars)	Qty (No)
Well Discharge pipe (F)	Electromagnetic	80	40	1
Well Drain pipe (FS)	Flow switch	13	40	1

#### 502.2 CONTROL EQUIPMENT

- The main PLC shall have a provision for the connection to the RTU of reservoir.
- The control system of well pumping station shall use a cable link for the communication between the main PLC (MPLC) of well pumping station and the (RTU) of reservoir.
- The Contractor shall supply and install telemetry cables from well pumping station to the location of reservoir.
- The Contractor shall supply and install a mimic panel showing the entire pumping system.
- The chlorine parameters (Vacuum switch, leakage detection, flow switch and or measurement, modulating valve...) shall be connected to the MPLC of well pumping station for control and protection.
- The anti-water hammer system shall be connected to the MPLC of the well pumping station for control and protection.

#### 502.3 PLC SPECIFICATIONS

As described in the common particular specification.

## **PART 6**

### **TRAINING, TESTING AND COMMISSIONING**

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## **601. PUMPING STATIONS**

### **601.1 TRAINING, TESTING AND COMMISSIONING**

Refer to General Specifications, Volume 3, Part 6.

- 1) Testing and Commissioning of all Mechanical Equipment and installations.
- 2) Testing and Commissioning of all Electrical Equipment and installations.
- 3) Testing and Commissioning of all Controls/Instrumentation Equipment and installations.
- 4) Training of personnel.

### **601.2 WATER ANALYSIS**

Reference : Pumping Station

Number of Analysis: 3 analysis

Type of Analysis : C3 + B2

## **PART 7**

### **BOREHOLES**



### **3.2.1 – GENERAL REQUIREMENTS**

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### **3.2.1 GENERAL REQUIREMENTS**

#### **3.2.1.1 APPLICATION OF PARTICULAR SPECIFICATION**

This Particular Specification is to be read and construed together with the General Specification contained in Volume 3 of the Contract Documents for this Tender. In case of ambiguities or discrepancies between this Particular Specification and the General Specification, the Particular Specification shall prevail, except if and to the extent otherwise provided by the Contract or directed by the Supervisor.

Whenever the term "Specification" without further qualification is used in the Contract Documents, it shall mean the General Specification together with the Particular Specification.

#### **3.2.1.2 LOCATION OF WORKS**

The Works cover the deepening, drilling, casing, screening and pump testing of an existing borehole in the village of Beino at Akkar Caza, and the drilling, casing, and pump testing of a new borehole in the village of Deir Nbough at Miniyeh Danniyeh Caza in North Lebanon.

#### **3.2.1.3 THE SITE**

For work within public lands and tracks, the limits of the Site shall be the limits of land in public ownership which shall be taken to be any boundary fence or wall or if there is no such clearly identified boundary the width shall be taken as one meter beyond the edge of the carriageway.

In some areas the width of the Site will be physically restricted by physical boundaries such as boundary wall or by natural topographic features. The Contractor shall have inspected the Site and shall have included for the provision of any additional working area that he may require outside the limits of the Site.

#### **3.2.1.4 SCOPE OF WORK**

The works covered by this contract are summarized as follows:

##### In Beino Village:

- Deepening the well by rotary machine using 9.88" diameter drilling bit.
- Installing 8" black steel slotted liner screens 6 mm thick including conical adaptor (L= 100m).
- Development and pumping test of the well with a flow of 15 l/sec with the installing pump at a depth of 180m.

##### In Deir Nbough Village:

- Drilling by rotary machine with drilling bit diameters 22", 17.5" and 14.75" to the total depth of 350 m.
- Installing 18", 15.5" and 12" final casings and screens to the total depth of 350 m.
- Development and pumping test of the well with a flow of 40 l/sec with the installing pump at a depth of 330 m.

### **3.2.1.5 CONDITIONS PREVAILING AT SITE OF WORKS**

The Contractor's attention is drawn to his obligation to satisfy himself, before submitting his Tender, as to the conditions prevailing at the Site of Works and its surroundings and relevant sections of the General Specification for Borehole Drilling Works.

### **3.2.1.6 PRIVATE LANDS**

The Contractor shall not enter upon or occupy with men, tools, or materials of any nature, any lands other than the working areas shown on the Drawings, except after consent shall have been received by him from the proper parties and a certified copy of such consent shall have been furnished to the Supervisor. Any rentals or damages paid for occupying private lands shall be at the Contractor's expense.

### **3.2.1.7 EXISTING SERVICES**

In the course of works, the Contractor will encounter within the limits of the working areas and in the vicinity, miscellaneous above ground and underground services such as drains, pipes, cables, telephone and electric poles and lines, water supply and similar existing services.

### **3.2.1.8 ACCESS ROADS**

#### **3.2.1.8.1 TEMPORARY ACCESS ROADS**

The necessity of construction of Access Roads and/or temporary roads may arise, in which case such temporary roads shall be executed at the contractor responsibility and expenses in coordination with the concerned Authorities and according to the Supervisor requirements.

### **3.2.1.9 PROGRAM AND MONITORING**

It is a primary requirement of the Contracting Authority that a comprehensive knowledge of the status of progress to date, predicted progress, costs and cash flow forecasts is available at all times. The Contractor shall be responsible of the requisite information and shall be responsible for programming the Works, preparation of cash flow estimates and measuring and reporting the progress of the works in an approved format. In order that programming, progress measurements and reporting is executed in a timely and efficient manner, the Contractor shall program the Works, monitor progress and generate cost reports and cash flow projections by utilizing a recognized industry standard approved P.C. based Project Management software package.

The Contractor's master program and cash flow estimates and subsequent updates, submitted, as a minimum, detail the sequence of procurement, for each of the works items including each item described in the Bill of Quantities.

At least 21 days prior to taking possession of any portion of the Site and starting of work, the Contractor shall submit a detailed construction program for that portion of the Site. The detailed construction program shall be to a level to adequately identify the intended sequence of working on each individual item of work. The minimum level of detail shall not be less than that needed to identify each individual payment item included in the Bill of Quantities.

The Supervisor's obligation to measure the Works shall be dependent on the Work being programmed and progress being monitored and reported in accordance with the requirements of the Contract.

### 3.2.1.10 LIST OF ABBREVIATIONS

In the Contract Documents, the following abbreviations have been employed :

A	The slope of the curve
$\alpha$	The slope of the curve (Gosselin method)
B	The intercept of the best fit line with the ordinate axis
C	The intercept of the best fit line with the ordinate axis (Gosselin method)
CEE	Communauté Economique Européenne
CCTV	Downhole video camera
BH	Borehole
DWL	Dynamic water level
$\Delta s$	Drawdown variations in one logarithmic cycle
I.D.	Internal diameter
L/sec	Litres per second
MHER	Ministry of Hydraulic and Electrical Resources
m <sup>3</sup> /hr	Cubic meters per hour
m <sup>3</sup> /d	Cubic meters per day
O.D.	Outside diameter
O.M.S.	Organisation Mondiale de la Santé
POH	Pulled out of hole
Q	Discharge rate
R	The effective borehole radius
r	The distance to the piezometer at the well location
S	Aquifer storativity
s	Drawdown inside the borehole
s/Q	Specific drawdown
SWL	Static water level
T	Transmissivity
t	Time
t <sub>c</sub>	Well capacity effect

### 3.2.1.11 OR EQUAL CLAUSE

Wherever reference to Standard Specifications, such as British Standards are made they shall not be construed to restrict materials to British products. Materials from other scheduled countries will be considered provided that the producer of the material certifies its conformity to the appropriate Standard Specification.

Similarly whenever a material or article required is specified or shown in the plans by using the name of the proprietary product or of a particular manufacturer or vendor; any material or article which will perform adequately the duties imposed by the general design will be considered equal and satisfactory provided the material or article so proposed is of equal substance and function in the Supervisor's opinion. It shall not be purchased or installed without his written approval.

### **3.2.1.12 GOVERNMENT REGULATIONS**

The Contractor shall comply with all provisions of the rules, regulations and orders of Government and Municipal agencies, such as the Public Works Department, Electricity of LEBANON, and Telecommunications Authority.

The Contractor shall co-operate with the Contracting Authority in promptly furnishing any information that may be required by such governmental agencies. It shall be the obligation of the Contractor to keep himself informed of these governmental rules, regulations, and orders and the Contractor shall make the requirements of this article a part of any sub-contract he may enter into.

### **3.2.1.13 FACILITIES FOR THE SUPERVISOR'S REPRESENTATIVE**

Not applicable.

### **3.2.1.14 ACCESS TO WORK**

The Supervisor and his duly appointed representatives and the Contracting Authority or his representatives or agents may at any time and for any purpose whatsoever enter into and upon the work and the premises used by the Contractor. The Contractor shall provide free, proper, and safe facilities therefore.

### **3.2.1.15 SURVEY AND SETTING OUT**

Not applicable.

### **3.2.1.16 NOTICE BOARDS**

The Contractor shall provide and erect sign boards at the sites where works are being executed, giving information to the public on the Project and the Contracting Authority and further details as will be prescribed by the Contracting Authority. The location and number of the sign boards at the sites will be indicated by the Supervisor. The Contractor shall maintain, alter, move and adapt the sign boards from time to time as instructed by the Supervisor. The display of any named Subcontractors or any other information associated with the Works shall be to the approval of the Supervisor.

### **3.2.1.17 MANUFACTURE'S CERTIFICATES**

The Contractor shall furnish the Supervisor with a manufactures certificate confirming compliance to the specification in respect of all items of equipment.

The original and one copy of the manufacturer's certificate shall be delivered to the Supervisor not later than 14 days prior to the intended date of delivery of the Item to site.

### **3.2.1.18 PRECAUTIONS AGAINST CONTAMINATION OF THE WORK**

The Contractor shall at all times take every possible precaution against contamination of the works. The site and all permanent and temporary works shall be kept in a clean, tidy and sanitary

condition. The Contractor shall at all times take measures to avoid contamination of the existing water courses and drains by petrol, oil or other harmful materials.

#### **3.2.1.19 ACCESS TO PROPERTIES**

The Contractor shall not disrupt any private or public access way without first providing alternative arrangements.

#### **3.2.1.20 TOPOGRAPHIC SURVEY**

Where the Contractor get the approval of the Supervisor to execute topographical survey, mapping shall be at 1:200 with contour lines at an interval of 1 meter. A ground profile along the centerline of the pipe route shall be provided and shall be at the same scale of the construction drawings relatives to the contract.

The extent of mapping shall be the width of roads or dual carriage ways up to the property lines on either side of the public land, or one meter from the edge of road which ever is nearer to the road centerline.

In open areas and along water courses the mapping corridor shall be 20 meters. The mapping shall be supplied on film plotted from digital data.

All control points, and heights shall be related to the National Height Datum in meters. Station Descriptions with distances to reference objects and a list of coordinates and heights shall be submitted to the Supervisor.

Permanent bench marks shall be constructed from steel pins, road nails or painted marks on existing stable features. A minimum of two site bench marks shall be established on existing stable features.

All man-made hand detail features, road edges, kerbs, existing manholes, inspection covers, culverts, and underground service pipeline shall be surveyed in their true position and shown by conventional symbols. The detection of the existing services will be paid separately and must be approved by the Supervisor.

All surveyor which will subcontract the Contractor for the topographicals works shall be approved by the Supervisor and the responsibility still on the Contractor to satisfy the Supervisor by the accuracy of the survey.

#### **3.2.1.21 DRAWINGS AND DOCUMENTS**

Not applicable.

#### **3.2.1.22 MEASUREMENT AND PAYMENT**

Unless otherwise provided for in the B.O.Q, all costs incurred in complying with the requirements shall be deemed to be included by the Contractor in his unit rates in Bill of Quantities and shall not be paid for separately.

### **3.2.2 BEINO BOREHOLE**

#### **3.2.2.1 BOREHOLE LOCATION**

The well is located at El Aayoun area near existing reservoir, to the south west of Beino Village, at the following coordinates (Fig. 1):

X = -272.548 km  
Y = +40.541 km  
Z = 557 m  
(Beino map, 1/20.000)

#### **3.2.2.2 ACCESS TO BOREHOLE**

Access to the site is easy on main road, but some cleaning and excavating of the drilling site is necessary

#### **3.2.2.3 EXPECTED DEPTH**

200 m

#### **3.2.2.4 EXPECTED DISCHARGE**

1,296 m<sup>3</sup>/day (or 15 l/s).

#### **3.2.2.5 STATIC WATER LEVEL**

20 m below ground level.

#### **3.2.2.6 GEOLOGY**

The drilling of the water well will start in the sands and sandstones of the Lower Cretaceous (C1) Formation to reach the limestones and dolomitic limestones of the Middle Jurassic (J4) Formation.

#### **3.2.2.7 SCHEDULE OF DRILLING, CASING AND GROUTING**

The Contractor shall present the schedule for deepening the well from 100-200m.b.g.l in order to install 8" diameter screen liner (L= 100m). The well is to be drilled with a rotary rig and provide for all additional equipment such as water and fuel, as well as treating collapsing rocks at his own expense.

Nevertheless, the schedule of the proposed works could be as follows (Fig. 2):

- Drilling by rotary methods with a 9.88" bit from 100 to 200m , with samples collection as described in the general specifications from this depth and onwards.
- Installing 8" I.D. screen liner having 8-10% opening area, with conical adaptor (black steel, thickness 6mm total length 100m)



### 3.2.2.8 VERTICALITY AND ALIGNMENT THE TESTS

The Contractor should ensure the verticality of the well by Plumbness Method, as mentioned in the general specifications. The Contractor shall also ensure the alignment of the borehole by the Dummy Method, as mentioned in general specifications. No borehole shall be accepted when its deviation exceeds 0.5% and/or when the 12m Dummy does not reach the bottom of the well. The Client representative should give his final approval to the verticality and alignment of the borehole.

### 3.2.2.9 WELL DEVELOPMENT

The well development shall be executed by pumping through variable pumping rates equal to 6, 9, 12 and 15 l/s. Each pumping rate will not stop until reaching 20 mg/l of sediments in the water, as mentioned in the general specifications. In both cases, the development pump, shall be installed at a depth of 180 m, and shall have a manometric head of 150 m with a maximum flow of 15 l/sec.

For the above-mentioned development and the pumping tests (mentioned below), the installation system of the pipes, the flowmeters, and the piezometric tube should adhere to what is mentioned in the general specifications (pipes diameters, valve diameters, flow meters types and diameters should be approved by the Client representative prior to their installation). The Contractor should select the area toward which the disposed pumping water should be conveyed, and its distance should not be less than 100m from the borehole.

### 3.2.2.10 PUMPING TESTS

Pumping tests should be performed only in dry period of the year (between June and October).

#### A) Well Test (Step drawdown test)

The Contractor shall carry out a pumping test at different rates: 6, 9, 12 and 15 l/s. Each step shall be of 4 hours duration and shall be followed by a period of recovery of not less than 4 hours.

#### B) Aquifer Test (Constant rate pumping test)

The constant rate discharge test shall be of 72 hours duration, and followed by a period of recovery not less than 24 hours. The lift flow shall be of maximum 15 l/s and shall be clearly defined upon the results of the step drawdown testing.

The submersible pump should be installed at a depth of 180 m, and should have a max head of 150 m and should be able to lift a max flow of 15 l/sec.

### 3.2.2.11 PUMPING MEASUREMENTS AND EQUIPMENT

All measurements, such as Flow Measurements, Time Measurements and Water Level Measurements in the main well and the observation boreholes (piezometers), are recorded according to a preset plant. The details of which can be seen in the general specifications. All the details concerning the pumping and the accompanying measurements (during the development or all pumping tests) are recorded in the general specifications. The water recovery measurements are duly noted following the end of the pumping stage, as mentioned on the general specifications.

The Contractor shall provide all the necessary measuring devices that should be approved by the Consultant prior to the pump testing, in order to ensure the collection of accurate data by experienced number of technicians.

The Contractor shall also provide the necessary pump that would discharge the required amounts of water as well as a suitable electrical generator and fuel reservoir. A flexible polyethylene dip tube with a diameter of 1.5 inches shall be installed along with the pumps from 0.5m above ground level to the level of the pump assembly in order to measure the water levels inside the well. All the necessary maintenance of the generator should be done ahead of the pumping notably the Constant Rate Pumping Tests, which will be undertaken for 72 continuous hours without interruption.

### **3.2.2.12 CONTROLS THROUGHOUT EXECUTION**

Throughout the works execution, the following should be controlled as per Borehole General Specifications.

- Verticality and alignment.
- Well development
- Water quality (sand content).

### **3.2.2.13 WATER SAMPLES AND ANALYSES**

Three water samples shall be collected for physico-chemical analyses and three other samples for bacteriological analyses.

The required analyses shall be as mentioned in the general specifications item 104.12.8.

The samples shall be taken during the constant rate pumping test after 24, 48 & 72 hours from the beginning of the pumping test.

### **3.2.2.14 REPORTS AND DOCUMENTS**

The Contractor shall record all the details concerning the works “Driller’s Report” detailing all the operations in a continuous time, sequence to form a “Daily Report”. This can be seen in Table 1 of the general specifications as well as all the information and tables concerning the pumping tests. All these data are submitted as “Detailed Daily Reports” and presented to the Consultant and Management for approval.

Moreover, at the end of the operations, a separate “Final Well Report” should be submitted by the Contractor. It will include everything (as mentioned in the general specifications) and especially the well construction, pump tests and interpretation in order to properly exploit the borehole, the discharge rate and the proper equipping, the final depth of the pump, as well as the chemical and bacteriological characteristics of the water. This report should be submitted not later than one month after ending all the works on the well.

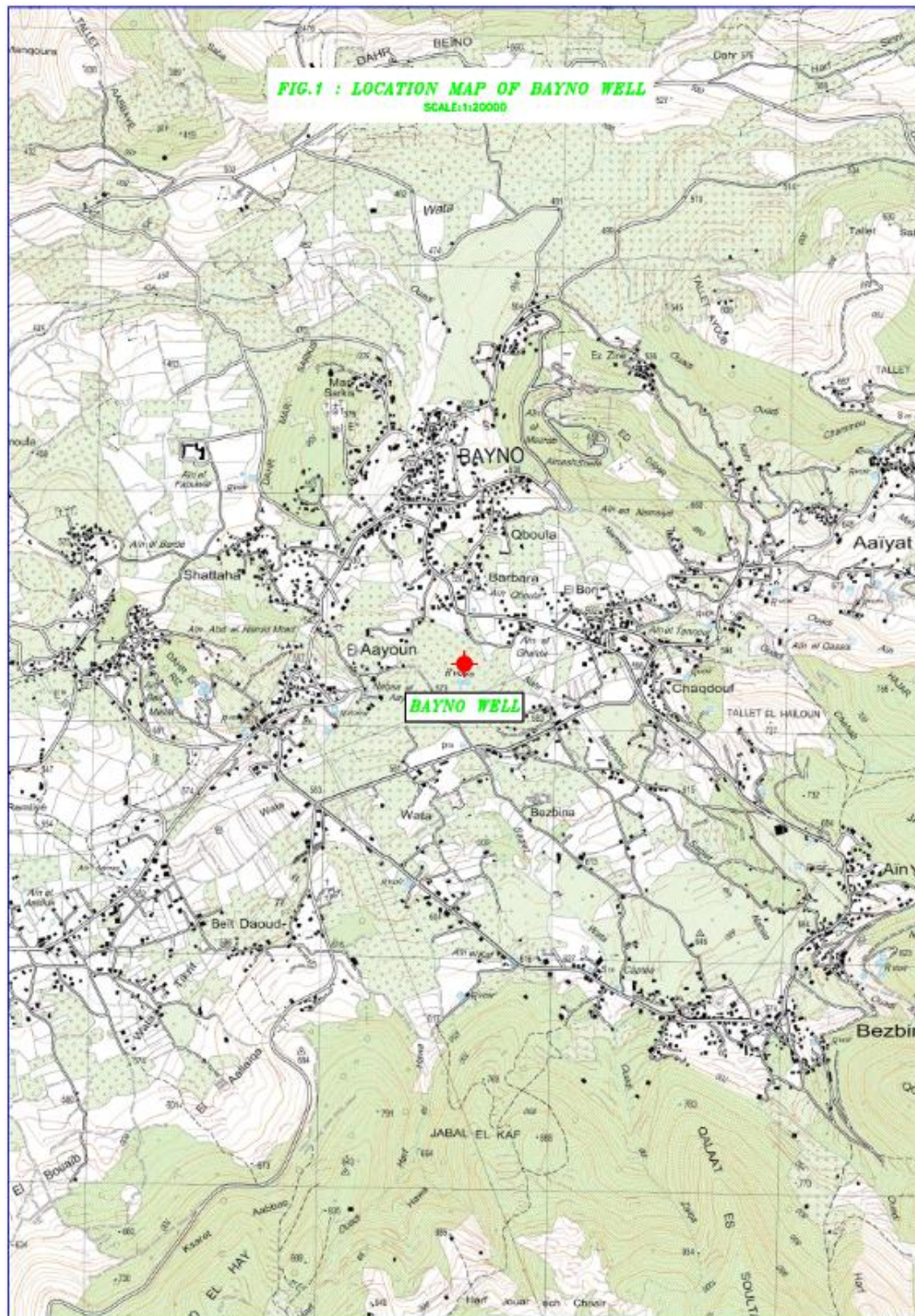
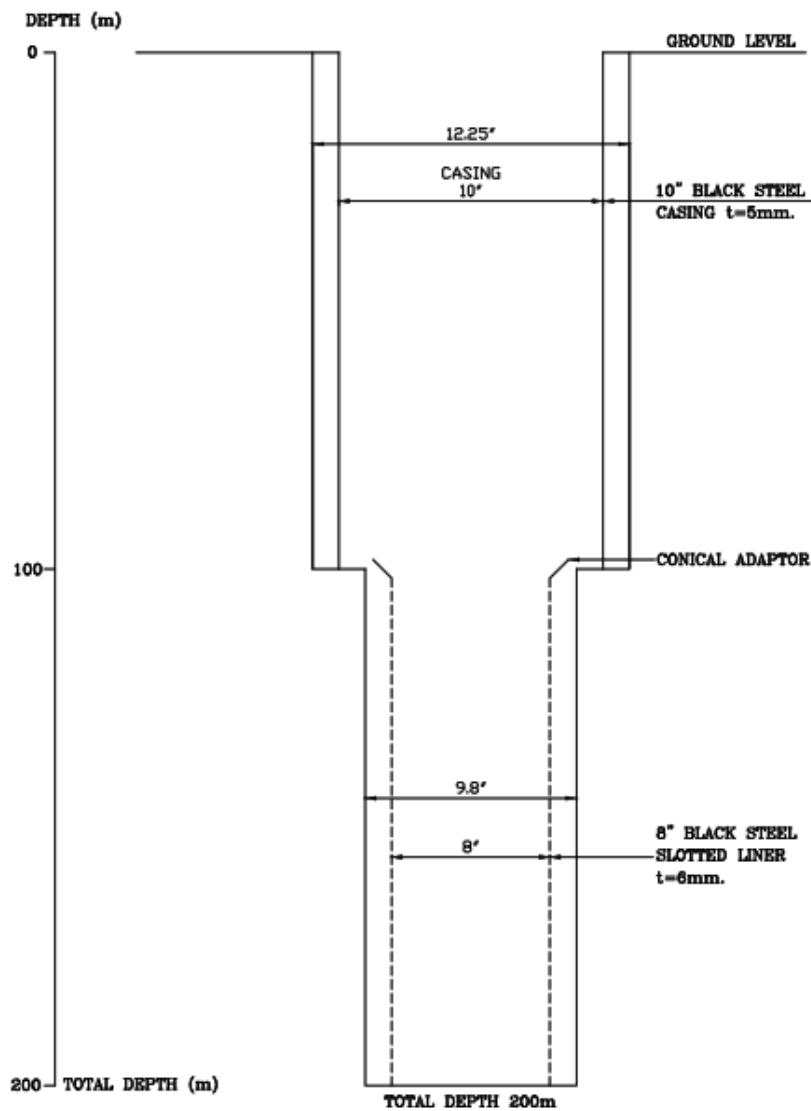


FIG. 2 : VERTICAL CROSS SECTION OF BEINO WELL



### **3.2.3 DEIR NBOUH BOREHOLE**

#### **3.2.3.1 BOREHOLE LOCATION**

The well is located in plot No 99, at Zaroub Abou Khodor locality to the north of Deir Nbouh Village, at the following coordinates (Fig. 1):

X = -296087.3 km  
Y = +24320.5 km  
Z = 225.28 m  
(Zgharta map, 1/20.000)

#### **3.2.3.2 ACCESS TO BOREHOLE**

Access to the site is easy on dirt road, but some cleaning and excavating of the drilling site is necessary

#### **3.2.3.3 DEPTH**

500 m

#### **3.2.3.4 EXPECTED DISCHARGE**

518 - 691 m<sup>3</sup>/day (or 6-8 l/s).

#### **3.2.3.5 STATIC WATER LEVEL**

200 m below ground level.

#### **3.2.3.6 GEOLOGY**

The drilling of the water well will start in the limestone and dolomitic limestone of the Upper Cenomanian Formation (C4c) to reach the limestone's and dolomitic limestone of the Lower Cenomanian Formation (C4a) through the marly layers of the Middle Cenomanian Formation (C4b).

#### **3.2.3.7 SCHEDULE OF DRILLING, CASING AND GROUTING**

The Contractor shall present the schedule for drilling in order to have a final casing and screen diameter of 10". The well is to be drilled with a rotary rig and provide for all additional equipment such as water and fuel, as well as treating collapsing rocks at his own expense.

Nevertheless, the schedule of the proposed works could be as follows (Fig. 2):

- Drilling by rotary methods with a 22" bit from 0 to 20m to avoid contamination from surface water that is mixed with wastewater, with samples collected as described in the general specifications from this depth and onwards.

- Installing 18” I.D. casing (black steel, thickness 5mm total length 20m)
- Grouting the annular space as described in the general specifications, from the bottom to the surface, then waiting between 36 to 48 hours for the cement to set, and then continue the works.
- Drilling with 17.5” bit from 20 to 150 m.
- Installing 15.5” temporary casing if necessary (black steel, thickness 5 mm, total length 150 m).
- Drilling with a 14.75” bit from 150 to the depth of 350 m.
- Installing 12.5” temporary casing if necessary (carbon steel, thickness 6 mm, total length 350 m).
- Drilling with a 12.25” bit from 350 to the total depth of 500 m.
- Installing 10” casing and screens as shown below:
  - a) Casing:
    - Diameter: 10” ID
    - Type: Carbon steel
    - Thickness: 6 mm
    - Total length: 400 m
  - b) Screens:
    - Diameter: 10” OD
    - Type: Carbon steel, bridge slotted 12.2% void, 1.5-2mm slots.
    - Thickness: 6 mm
    - Total length: 100 m.

The installation of the casing and screens will be in accordance with the general specifications, and in particular, the welding and closure of all openings such that the water only enters the well through the screen openings, in order to minimize the pollution from zones above the SWL.

### **3.2.3.8 VERTICALITY AND ALIGNMENT THE TESTS**

The Contractor should ensure the verticality of the well by the Plumbness Method, as mentioned in the general specifications. The Contractor shall also ensure the alignment of the borehole by the Dummy Method, as mentioned in general specifications. No borehole shall be accepted when its deviation exceeds 0.5% and/or when the 10m Dummy does not reach the bottom of the well. The Client representative should give his final approval to the verticality and alignment of the borehole.

### **3.2.3.9 WELL DEVELOPMENT**

The well development shall be executed by pumping through variable pumping rates equal to 3, 5, 7 and 8 l/s. Each pumping rate will not stop until reaching 20 mg/l of sediments in the water, as mentioned in the general specifications. In both cases, the development pump shall be installed at a depth of 480 m, and shall have a manometric head of 450 m with a maximum flow of 8 l/sec.

For the above-mentioned development and the pumping tests (mentioned below), the installation system of the pipes, the flowmeters, and the piezometric tube should adhere to what is mentioned in the general specifications (pipes diameters, valve diameters, flow meters types and diameters should be approved by the Client representative prior to their installation). The Contractor should select the area toward which the disposed pumping water should be conveyed, and its distance should not be less than 100m from the borehole.

### 3.2.3.10 PUMPING TESTS

Pumping tests should be performed only in dry period of the year (between June and October).

#### C) Well Test (Step drawdown test)

The Contractor shall carry out a pumping test at different rates: 3, 5, 7 and 8 l/s.

Each step shall be of 4 hours duration and shall be followed by a period of recovery of not less than 4 hours.

#### D) Aquifer Test (Constant rate pumping test)

The constant rate discharge test shall be of 72 hours duration, and followed by a period of recovery not less than 24 hours. The lift flow shall be of maximum 8 l/s and shall be clearly defined upon the results of the step drawdown testing.

The submersible pump should be installed at a depth of 480 m, and should have a max head of 450 m and should be able to lift a max flow of 8 l/sec.

### 3.2.3.11 PUMPING MEASUREMENTS AND EQUIPMENT

All measurements, such as Flow Measurements, Time Measurements and Water Level Measurements in the main well and the observation boreholes (piezometers), are recorded according to a preset plant. The details of which can be seen in the general specifications. All the details concerning the pumping and the accompanying measurements (during the development or all pumping tests) are recorded in the general specifications. The water recovery measurements are duly noted following the end of the pumping stage, as mentioned on the general specifications.

The Contractor shall provide all the necessary measuring devices that should be approved by the Consultant prior to the pump testing, in order to ensure the collection of accurate data by experienced number of technicians.

The Contractor shall also provide the necessary pump that would discharge the required amounts of water as well as a suitable electrical generator and fuel reservoir. A flexible polyethylene dip tube with a diameter of 1.5 inches shall be installed along with the pumps from 0.5m above ground level to the level of the pump assembly in order to measure the water levels inside the well. All the necessary maintenance of the generator should be done ahead of the pumping notably the Constant Rate Pumping Tests, which will be undertaken for 72 continuous hours without interruption.

### 3.2.3.12 CONTROLS THROUGHOUT EXECUTION

Throughout the works execution, the following should be controlled as per Borehole General Specifications.

- Verticality and alignment.



- Grouting
- Well development
- Water quality (sand content).

### **3.2.3.13 WATER SAMPLES AND ANALYSES**

Three water samples shall be collected for physico-chemical analyses and three other samples for bacteriological analyses.

The required analyses shall be as mentioned in the general specifications item 104.12.8.

The samples shall be taken during the constant rate pumping test after 24, 48 & 72 hours from the beginning of the pumping test.

### **3.2.3.14 REPORTS AND DOCUMENTS**

The Contractor shall record all the details concerning the works “Driller’s Report” detailing all the operations in a continuous time, sequence to form a “Daily Report”. This can be seen in Table 1 of the general specifications as well as all the information and tables concerning the pumping tests. All these data are submitted as “Detailed Daily Reports” and presented to the Consultant and Management for approval.

Moreover, at the end of the operations, a separate “Final Well Report” should be submitted by the Contractor. It will include everything (as mentioned in the general specifications) and especially the well construction, pump tests and interpretation in order to properly exploit the borehole, the discharge rate and the proper equipping, the final depth of the pump, as well as the chemical and bacteriological characteristics of the water. This report should be submitted not later than one month after ending all the works on the well.



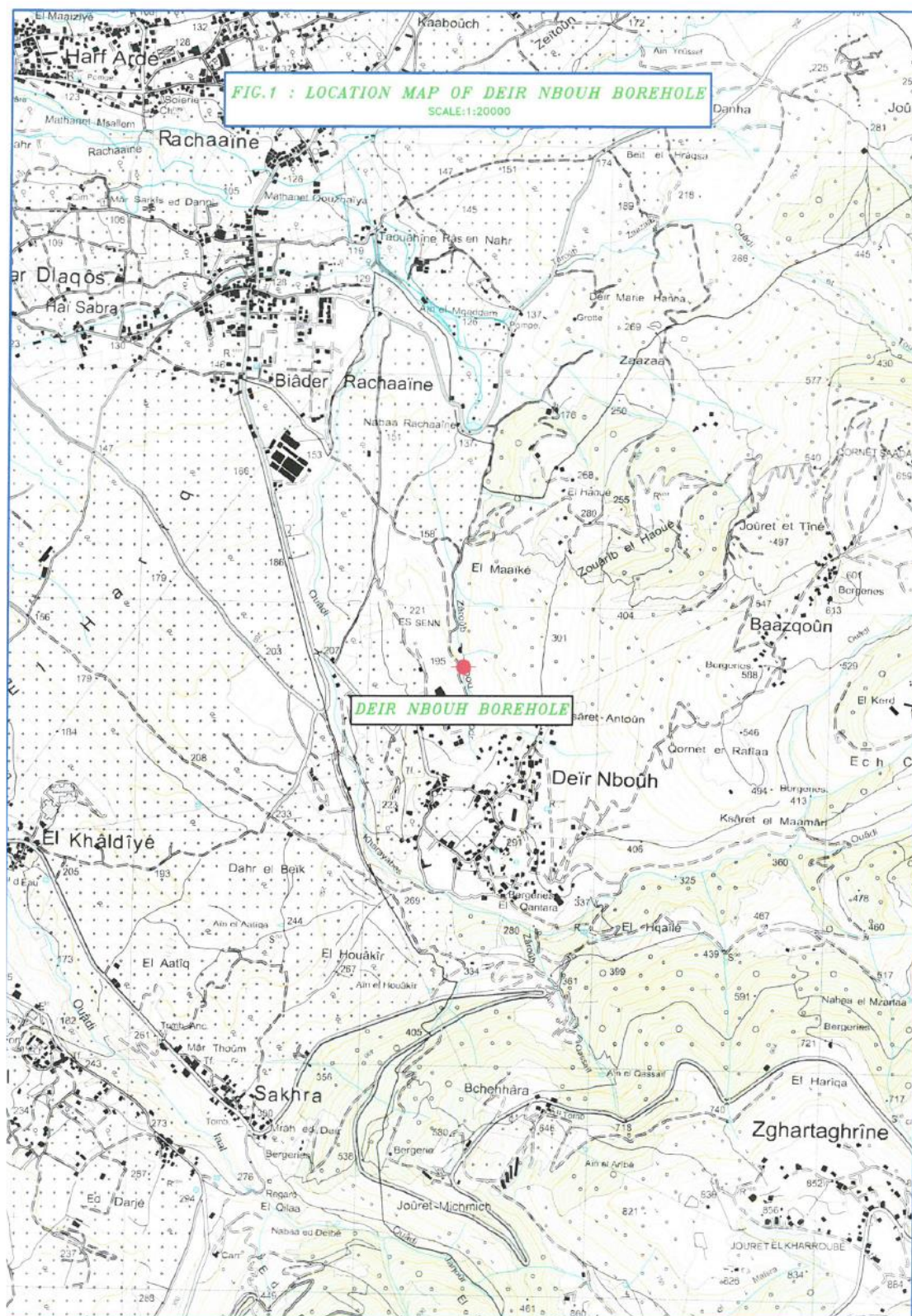
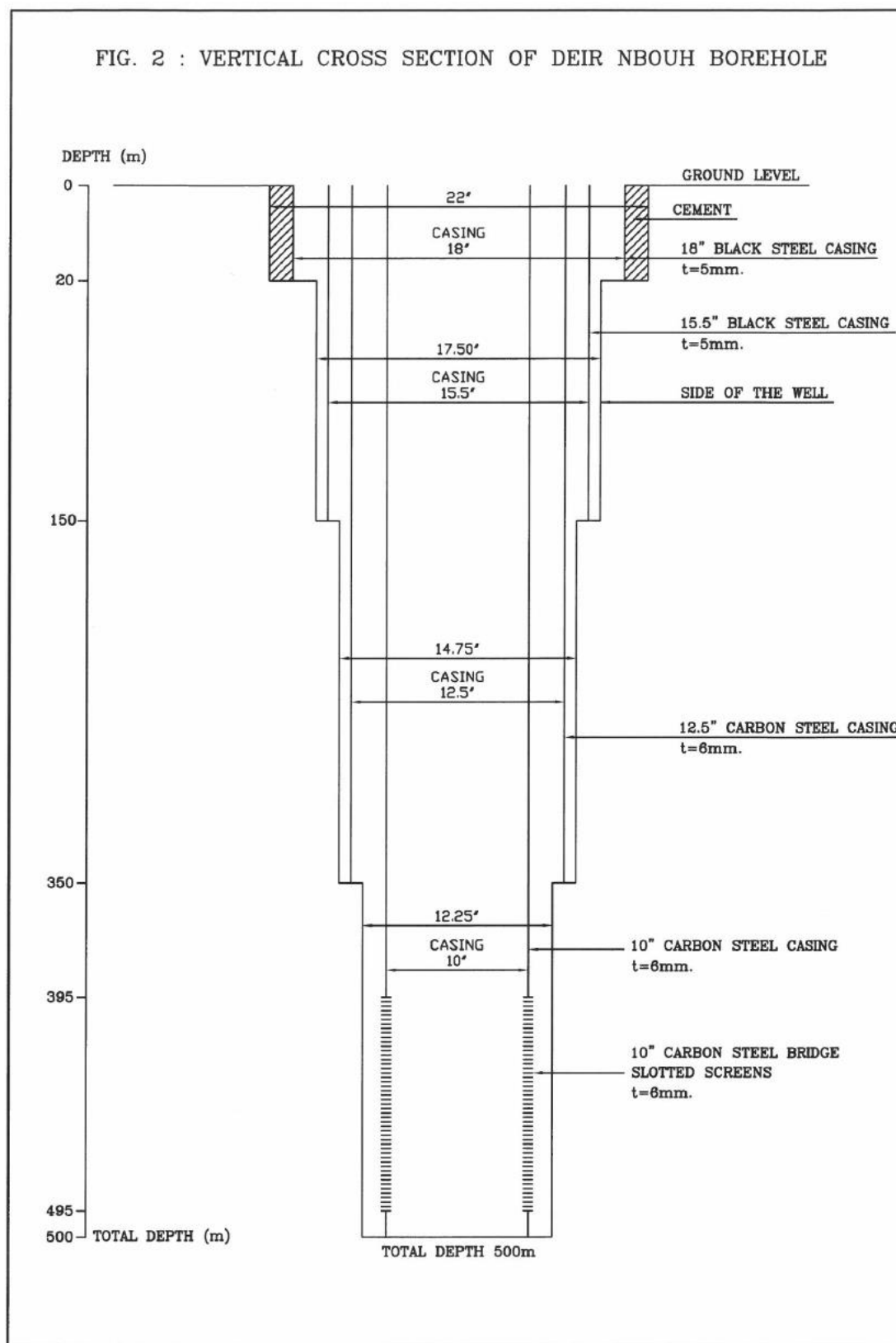


FIG. 2 : VERTICAL CROSS SECTION OF DEIR NBOUH BOREHOLE



**PART 8**  
**SOLAR ENERGY**

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## **800.1 TECHNICAL DESIGN**

### **800.1.1 SYSTEM DESCRIPTION**

The solution shall compose of a high efficiency photovoltaic system, installed in the free land area. The complete PV field shall be 83.4 kWp constituting of 139 modules 600 W each.

The mentioned PV field shall have 128 modules out of the 139 supplying the main well pump.

In addition, 4 PV panels of the field shall be dedicated to the chlorination pump that is too be equipped as well with a variable drive to allow solar operation.

The final 7 PV modules of the field are to be dedicated for the control system via a hybrid off-grid solution with a 10 kWh Li battery bank.

All mentioned pump controllers shall allow auxiliary input AC sources and power blending such that when auxiliary AC sources are available on site the controller shall be able to combine this power, if and when needed, with the available DC solar power and hence to supply additional power to the pumps. Of course, the primary operation of the system shall be via PV power only with no need of any additional external sources which is possible via the installed pump drives.

The off-grid inverter should have as well a dedicated AC auxiliary input to allow charging the batteries and supplying loads with auxiliary power when available and case needed.

The solution shall be built to utilize the existing AC pumps (well and chlorination) however the pumps shall be upgraded to allow operation with variable speed levels.

Whenever solar irradiation exceeds a minimum threshold, the solar controller should operate the pump with the available PV power and achieve relevant flow rate levels.

The implemented solution should be equipped with all hydraulic and control features that allow optimizing the system efficiency and facilitating operator usage at the same time. Decent monitoring and data collection shall be provided thus to allow operator to read generation values, system status and all other essential log values.

The PV modules shall be installed on aluminium profiles. PV module clamping shall be made using aluminium middle and end clamps. All mounting profiles and accessories should have wind load certification to ensure integrity of mounting system. Supplier certifications and wind load test results shall be provided and all mounting components shall be from 1 supplier to ensure perfect compatibility.

The PV modules shall be installed on structures with a tilt of approx. 15 degrees due south. Exact orientation and allocation is provided in the site layout drawings.

The PV modules are to be distributed into suitable strings following DC connectivity model provided.

The PV system shall be equipped with a DC combiner box, DC surge protection and DC disconnect switching. Cabling used should have UV resistant coating to ensure durability and safe operations.

The system shall be provided with all needed hydraulic and electric safety features.

### **800.1.2 SYSTEM TOPOLOGY**

The project shall compose of 3 independent scopes providing together the complete solution.

The 1<sup>st</sup> scope shall compose of 128 PV modules of the field and shall feed the main well pump.

The 2<sup>nd</sup> scope shall compose of a dedicated power supply for the chlorination pump onsite. Again, the pump shall be equipped with a hybrid controller allowing both PV DC input (4 panels 600W each) and Auxiliary AC supply while providing the chlorination pump with variable AC output. The chlorination pump shall operate solely on PV power and is to use auxiliary power optionally and when needed based on demand or operator desire.

The final scope includes the hybrid off-grid part which shall be fed by 7 dedicated PV panels and optional auxiliary power sources. This scope shall supply the control systems via a hybrid inverter and Li storage battery bank.

The solutions shall be equipped with all electric and hydraulic safety accessories to ensure optimal and safe system operation. Furthermore, the solution should include all features and requirements mentioned in the tender specifications and design drawings.

### **800.1.3 SOLUTION FEATURES**

The solution to be implemented shall provide all the following system features related to the PV pumping system.

#### **Integrated Maximum Power Point Tracking:**

The controller shall include the very essential feature of MPPT as it allows the PV system to operate at optimal regions of the IV curve and hence maximizes the efficiency of the PV plant.

#### **Data logging and system monitoring:**

The Solar Controller shall be capable of performing data collection and logging. Information logged by the controller shall be used by the operator to assess operation conditions and system functionality.

The logged information shall be displayed over a convenient platform and via a user-friendly GUI (Graphical User Interface).

#### **Pressure Switching or float switching:**

The controller shall be able to stop water pumping once water in reservoir reaches maximum levels.

This shall be either achieved via pressure sensors and switching installed along the pipeline or via a floating sensor and switch to be located in the main water tank.

### **Irradiance Controlled Switching**

The controller should be able to block pump operation once solar irradiation levels drop below a minimum threshold. This shall allow avoiding system operation at times of low solar power when the efficiency values are not optimal.

### **PV Surge Protection**

System shall be protected by convenient surge protection devices to ensure safe and prolonged operation. Surge protection devices mentioned here shall not replace main surge protection components that are to be installed on the main electric network as well.

### **DC Disconnect Switch**

The PV subsystem shall be equipped with a suitable DC disconnect switch which shall allow disconnecting the DC side from the controller in case of emergency or system maintenance.

### **PV Combiner Box**

The PV subsystem shall be equipped with a suitable PV Combiner Box which is required for combining the PV strings

### **Power Blending**

The solution shall allow the introduction of external power sources case available. The controllers shall be able to simultaneously combine the available solar power with any external sources so that they both feed the load at a time.

### **Automatic Diesel Generator Signalling**

The system shall be equipped with an auto start relay that could signal the input terminal of the site generator to initiate generator operation. Signal shall be provided by the Pump Controller algorithm when backup power sources are required for pumping.

### **Automatic Transfer switching**

An ATS shall allow switching between grid and generator power case backup power is required. An ATS is already available on site, however contractor shall ensure compatibility and connectivity with the PV pumping system, hence shall carry all necessary modifications to achieve that.

## **800.2 ELECTRIC AND CIVIL WORKS**

### **800.2.1 SURGE PROTECTION**

PV System protection requirements shall include the following:

#### **Earthing system**

- A new dedicated earthing system shall be installed for the implemented project. The earthing system should have a resistance value  $R < 5\Omega$ .
- The earthing system should be annually maintained to ensure the resistance value remains below this mentioned threshold. The earthing rods are to be created in the PV lot area and closest possible to the main distribution board. Main PE bar shall be installed at the earthing point.

#### **Equipotential Bonding**

- All structures and conductive instrumentation shall have equipotential bonding.
- Bonding shall be made to all critical and downstream components including but not limited to inverters, modules, electric boards, MDB, etc...

#### **Surge protection**

- System shall be equipped with Type 2 Surge protection on DC side. The system shall further have Type 1 and 2 protection on AC side.
- Operator shall be advised to install relevant surge protection devices at main ATS as well and that to ensure protection at level of incoming power supply.

#### **Residual protection**

- The system shall be equipped with residual breaker on Ac side. Breaker type shall have 300 mA threshold.

### **800.2.2 STRUCTURE FOUNDATIONS**

The site's natural ground shall be adjusted as deemed necessary to allow for the steel structure erection and PV module mounting,

Obstruction that might hinder or negatively affect the function of the PV modules shall be avoided.

Site survey shall be carried out to locate and excavate the exact locations and sizes of the foundations for the steel structure.



The foundation design shall be verified based on contractor installation topology through a calculation note. Adjustments may be made on condition that the concrete strength and total volume of concrete are equal or more than the provided design.

### **800.2.3 STRUCTURE DESIGN**

The steel structures shall be erected using hollow black steel profiles and by means of welding.

The steel design shall be verified based on contractor installation topology through a calculation note. Adjustments may be made on condition that the steel strength and total weight of steel are equal or more than the initial design. All parameters considered in any variations shall be specified including safety factors and combinations.

The steel structure shall be coated with one layer of primer and two layers of protective top coating. The type of coating is also defined in the aforementioned drawings, along with the steel strength and section profiles.

### **800.2.4 SITE FENCING**

The whole PV structure shall be protected by a skirting security fence.

The fence shall allow access for heavy vehicles into the site area such as trucks and cranes for future maintenance.

The fence shall be protected by barbed razor wire to prevent unauthorized access to site and possible vandalism.

The fence skeleton shall be made of black hollow steel sections, and shall be coated similar to the module steel structures; i.e. one layer of primer followed by two layers of protective top coating.

## **800.3 TECHNICAL SPECIFICATIONS**

This section elaborates the technical requirements requested for the products comprising the system. Contractor shall abide by these specifications and mention any deviations clearly within his submittal.

### **800.3.1 PV PANELS**

PV modules in the entire plant shall be procured from the same manufacturer and shall be of the same model number with identical specifications in terms of nominal power rating, nominal I-V characteristics and coefficients.

The PV panels provided for this project shall comply with the below specifications:

- Mono Crystalline Half Cut Technology

- Peak Power: 600Wp
- 10-year product warranty
- 25 years Power warranty (12 years: 90%, 25 years 80%)
- Positive power tolerance: -0/+5 Wp
- Bypass diodes and bus bars
- High efficiency and absorption of light with anti reflection coated (ARC-glass) solar glass.
- Low-iron solar glass (thickness 3,2 mm) and sturdy hollow-chamber frame
- Tested according IEC 61215 for snow loads up to 5400 Pa (ca. 550 kg/m<sup>2</sup>)
- IEC 61730, application class A for system voltages up to 1000 V, protection class II
- Produced in ISO 9001 and ISO 14001 certified factory
- 100% end control with individual registration of the electrical characteristics
- Quality tested by Accredited Laboratories with climate chambers and flasher with integrated electroluminescence measurement. Certifications to be presented.
- IP65 rating for module junctions: IP65 or more
- Power warranty should also ensure that the first year degradation in modules' power doesn't exceed 2.5% with linear annual degradation afterwards (12 years 90%, 25 years 80%).
- Brands: Sharp modules or equivalent
- Min Efficiency at STC: 19.9%
- Module frame: Anodized Aluminum, sturdy- hollow chamber frame
- Environmental conditions type as per IEC: 60364-5-5
- PV Connectors: MC4

### **800.3.2 PV COMBINER BOX**

Suitable to connect and combine the PV strings as per design

- Enclosure class IP 65
- Meets the requirements for CE
- Resistance to Impacts: IK10
- Warranty: 5 years
- Resistance to abnormal heat: up to 750 C
- Rated service DC voltage 1000 V DC.
- DC Combiner components: PV Combiner box for combination of PV strings and connection to inverter. Optional fuses for optimal operation.

### **800.3.3 MOUNTING RAILS & CLAMPS**

The mounting rails & clamps provided for this project shall comply with the below specifications:

- Mounting system is designed based on International standards and regulations especially DIN 1055-4 and DIN 1055-5.
- Rails & Accessories to be specifically developed for PV applications, withstanding wind and stress loads (with valid certifications)
- Rails to be of aluminum
- Clamps to be of stainless steel
- Corrosion resistant, withstanding near-Sea installations
- Bolts & Screws shall be galvanized
- Warranty 10 years
- Mounting Rails and Clamps to be supplied from same manufacturer to ensure mounting system integrity.

### **800.3.4 DC CABLES**

The cables provided for this project shall comply with the below specifications:

- Can be laid underground
- VDE Tested and TUV certified (or equivalent)
- Free of pollutants & halogen
- Resistance against UV, ozone & ammonia
- Acid & Base Resistance
- Improved fire resistance performance confirming to IEC 6033-1-2
- Protected against short circuits and ground leakages
- Ambient temperature: -40 to 90°C
- IP65 or more
- PVC UV resistant coating. Cross-linked HEPR 120 C
- Rated Voltage 1000V
- Conductor type: Electrolytic copper, fine wired Class 5 \_ According to IEC 60228
- Minimum aluminum DC cable section shall not be less than 6mm<sup>2</sup>.

### **800.3.5 SOLAR PUMP CONTROLLER**

- Vin: 800 – 1000 V
- Minimum rated power: Specific to individual pumps. As per Design Drawing SLDs.
- Motor Voltage: 3 x 380/400/415
- Max Efficiency: 98%
- Enclosure: IP 65
- Permissible harmonics order as per as per IEC 61000-3

- Ambient Temp Range: -10C to 50C
- Frequency: 0 - 50 Hz
- Built-In data logging and a simple management interface.
- Ability to be remotely monitored and managed via a web application service
- Maximum Power Point Tracking (MPPT)
- Highly efficient maximum power point tracking with pump system specific algorithms.
- Active power management for temperature
- Automatic and active power management to ensure the system continues to run in even the most extreme temperature conditions.
- Digital inputs for connection of well probe, tank full, pressure switches and remote switches
- Analogue inputs for sensors. Applications included for pressure and level monitoring and pump control.
- Sun-Sensor function allowing controller to block pump operation once solar irradiation levels drop below a minimum threshold for optimizing operation.
- Water meter input Pulse water meter input for accurate collection of flow data.
- Variable frequency output to allow maximum water to be pumped based on available power.
- Soft start and infinite control of motor speeds for long life and low generator loads.
- Signal output for controlling externally connected devices.
- Low voltage DC input to allow bench / field configuration when 3 phase power is not available.
- Constant pressure and flow built in applications to limit or to provide minimum pressure and flow.
- Control of pump system using pressure sensors for remote control applications and pressure depended processes.
- Built in system timers for providing time of day or interval timing control.
- Power choice control giving the ability to prioritize water delivery or power type (cost) in hybrid applications
- Automatic data logging of all running pump data. Recording frequency is configurable with capacity for up to 10 years.
- Simple LED display to indicate system status.
- Simple configuration with remote application
- Local and remote monitoring and management with a well-developed web interface
- Configurable set points for minimal frequency power drive to ensure optimized commissioning settings for pump switch off at low power values
- Integrated filter ensuring a sinusoidal phase to phase voltage transmission to the motor.
- Integrated dV/dt filter ensuring a controlled voltage rise rate and slower peaking when connected at shorter runs.
- 5 years warranty

### **800.3.6 CHLORINATION PUMP CONTROLLER**

- Vin: 150 – 300 V
- Minimum rated power: 2 kW
- Motor Voltage: Single Phase 220/230
- Max Efficiency: 98%
- Enclosure: IP 65
- Permissible harmonics order as per as per IEC 61000-3
- Ambient Temp Range: -10C to 50C
- Frequency: 0 - 50 Hz
- Soft start and infinite control of motor speeds for long life and low generator loads.
- Simple LED display to indicate system status.
- Configurable set points for minimal frequency power drive to ensure optimized commissioning settings for pump switch off at low power values
- Integrated filter ensuring a sinusoidal phase to phase voltage transmission to the motor and all other needed accessories to deliver an optimally operational pump solution.
- Integrated dV/dt filter ensuring a controlled voltage rise rate and slower peaking when connected at shorter runs.
- 5 years warranty

### **800.3.7 COMMUNICATION MODULE FOR REMOTE MONITORING AND MANAGEMENT**

To enable remote monitoring and control for the stored data in the Solar Pump Controller

- Self-contained controller with 2G/3G cellular terminal
- Automatically pairs with pump controller within Bluetooth range
- Ability to transmit current running data and status via mobile Internet to a central server
- Ensures secure and encrypted data
- Active reporting of any alerts or problems
- Ability to switch on, switch off, monitor external sensors and control pump speed remotely
- Includes the needed battery and PV module to run independently and reliably
- PV panels to be of same specifications as in 600.3.1
- Battery to be Lithium Ion and completely compatible with module voltage and power requirements.
- Battery shall allow an autonomy of 8 hours

### **800.3.8 AUTOMATIC REMOTE DIESEL GENERATOR SWITCHING DEVICE**

This device shall automatically and remotely start and stop the diesel generator, and shall connect to the pump controller and to the remote switch input of the diesel generator.

- Automatically switches on/off diesel engines equipped with remote start input (NO)
- Provides power to the controller for night time
- Provides logic operation such as early morning pump starting
- Device shall have independent powering
- Enclosure class: IP65
- PV panels to be of same specifications as in 600.3.1
- Battery to be Lithium Ion and completely compatible with module voltage and power requirements.
- Battery shall allow an autonomy of 8 hours

### **800.3.9 IRRADIATION CONTROLLED SWITCH**

To be used for controlling switching depending on the solar intensity. It should be an autonomous working unit that supplies itself with power from a dedicated PV module and battery.

Shall be compatible with the Solar Pump Controller

Pump will only run when minimum flow rates or pressure levels which are required can be achieved

Reduced wear on the pump and motor since the pump only starts when it will continue to run

- Max. voltage 250 VAC / 220 VDC
- Enclosure class: IP65
- Mounted close to the solar array
- Meets the requirements for CE

### **800.3.10 PV DISCONNECT BOX**

String connection box with DC disconnect switch and surge protection

- Shall include an appropriate DC rated disconnect switch and string fuses (20 A)
- Shall include surge protection
- Compatible with Pump Controller
- DC rated disconnect switch enclosed

- Enclosure class IP 65
- Meets the requirements for CE
- Max. voltage 1,000 V DC (Uoc) 880 V DC (Ump)
- Max. current per string 15 A
- Max. total current allowed 300 A

### **800.3.11 HYBRID OFFGRID INVERTER**

- Output AC Rated power @ 230 V, 50 Hz: 2000 W
- Allows auxiliary AC power input via dedicated terminal
- Minimal DC input: 5 kW
- AC auxiliary frequency range: 48 Hz to 52 Hz
- Rated power frequency / rated grid voltage 50 Hz / 230 V
- Output phases: 3
- Supports LI Battery Bank
- Integrated DC polarity detection
- Integrated ground fault monitoring / grid monitoring
- Integrated residual-current monitoring.
- IEC 62109-1 Protection Class: I
- IEC 62109-1 Overvoltage Category: AC: III; DC: II
- Operating temperature range: -15 °C to +55 °C
- Data interface with remote control and monitoring system
- Guarantee: 5 years
- IP65 or higher

### **800.3.12 BATTERY BANK**

The battery bank provided for this project shall comply with the below specifications:

- Lithium Ion LiFePO4
- Maintenance free Battery bank
- Built in BMS integrated into battery
- Battery Bank Capacity 10 kWh
- Maximum DoD > 95%
- Operating ambient Temperatures: Discharging: -30 to 50 °C \_ Charging: 0 to 50 °C
- Equipped with battery connectors
- Allows both indoor and outdoor installation

- IP55 rating or higher
- Equipped with HVAC module
- IEC 62619 certified
- IEC 62040 certified
- VDE2510-50 certified
- Battery Warranty: 10 years

### **800.3.13 SURGE PROTECTOR DEVICE FOR SENSORS AND SWITCHES**

Device to Protect Controller and Pump Accessories from Voltage Spikes (installed between controller and sensors)

- Reliable surge protection device for switched, pulse or analogue (4-20 mA) inputs sensors
- Meets the requirements for CE

### **800.3.14 SURGE PROTECTION DEVICES FOR PV**

Type II DC SPD to protect the DC side

Connects between PV Generator and Controller

- Operating frequency: 50/60
- Hz Rated operating voltage:  $U_o$  230 V AC
- Maximum continuous operating voltage:  $U_c$  350 V
- Maximum discharge current  $I_{max}$ : 120kA
- Nominal discharge current: 60kA
- Degree of protection: IP20
- Response time: 25 ns
- Working temperature:  $-25^{\circ}\text{C} \sim +60^{\circ}\text{C}$
- Storage temperature:  $-40^{\circ}\text{C} \sim +70^{\circ}\text{C}$
- $I_{ie}$  ( $0.75U_1mA$ )  $< 20 \mu A$
- Brands: Schneider or equivalent

AC SPD Type I + II

- Surge arrester class type Type 1 + 2
- Rated operational voltage 230/400 V AC (+/- 10 %) at 50/60 Hz
- Nominal discharge current Common mode: 100 kA (N/PE); Differential mode: 25 kA (L/N)
- Impulse current Common mode: 100 kA N/PE 50 A.s; Differential mode: 25 kA L/N 12.5 A.s Maximum continuous operating voltage Differential mode: 350 V L/N; Common mode: 350 V N/PE Maximum
- Follow current 25 kA Differential mode L/N 0.1 kA; Common mode N/PE



- Case SPD to be installed outside panel board then should be within 1 m of panel board.

### **800.3.15 PV ENCLOSURES**

- External PV enclosures shall be metallic and IP 65 rated
- External enclosures shall not be installed facing south direction
- Ground area below enclosures shall not be of conductive material to ensure user safety
- Metallic enclosures shall be potentially bonded to ensure user safety.
- Internal control enclosures can be nonmetallic however should be IP 65 rated.
- Brands: Legrand or equivalent.

### **800.3.16 CIRCUIT BREAKERS/ DISCONNECTS**

- UL 489 listed
- UL 1077 recognized
- CSA C22.2 No. 235 certified or equivalent
- CSA C22.2 No. 5-02 certified or equivalent
- IEC 60947-2
- CE marked
- Schneider or equivalent

### **800.3.17 ELECTRIC CONDUITS**

- Rigid non-metallic raceway for wires and cables in accordance with the NEC
- Sunlight resistant per UL 651
- NEMA TC-2
- Listed for 90° C conductors or cable
- All wiring shall be installed in conduit shall be secured by means of proper fittings.
- Exposed conduits shall be securely supported by means of straps with recommended spacing as specified in the National Electrical Code (NEC)
- All wiring/cabling installed outdoors should be buried to minimize the visual intrusiveness of the landscape of the area per the ERAC

### **800.3.18 GROUNDING**

Ground probe and system shall be conducted according to best practices and ensure a resistance of < 5 Ohms.

### **800.3.19 SECURITY FENCE**

- Vertical supports of the fence shall be embedded in ground to a depth not less than 50 cm, and a cylindrical concrete footing base shall be cast having a diameter not less than 50cm
- All hollow section steel profiles used (vertical supports, connecting rods, inclined supports, etc.) shall be cold-formed black steel and shall conform with ASTM A36 Grade (having a yield strength of 250 MPa)
- The wire mesh shall be galvanized and have 2.5mm thickness
- The Barbed razor wire shall be galvanized and have a diameter of 50cm, and shall skirt the top of the whole fence
- The fence shall include at least 2 access points (hinge doors integrated in the fence)
- Steel coating works shall be of high-quality brand (Tinol or equivalent)
  - Epoxy Zinc-phosphate primer coat shall be applied in one layer of thickness not less than 90 microns
  - Aliphatic polyurethane top coat shall be applied in two layers of combined thickness not less than 120 microns
  - Welded points shall be treated and coated afresh to yield same thicknesses of primer and top coat as the rest of the steel fence profiles

### **800.4 SYSTEM HANDOVER AND MONITORING**

#### **800.4.1 TRAINING AND HANDOVER**

The implementation activity shall be terminated with a comprehensive training and handover.

Once system installation is complete the contractor shall train the operator on all details of the system to ensure proper operation and system management once project is handed over.

The training activity conducted shall include the below:

- Detailed site observation tour conducted with the operator where contractor shall introduce all system components and describe functionality and interconnectivity.
- Description of system operation methodology starting from PV modules till pumping subsystem.

- System constraints and thresholds that the operator should pay attention to during system functionality.
- Training on how to operate the embedded monitoring topology. The operator should become comfortable with the user interface and be able to comprehend all notions and displayed values.
- Detailed listing of all critical system logs including warnings, faults and alarms.
- System start-up and shut-off procedures
- Emergency shut-down procedure that would be used in cases of emergency onsite, for example fire, where operator has to instantly shut off all system components to protect lives and property.
- Basic system trouble shooting skills which will allow the operator to assess basic system faults or events such as faulty SPDs, tripped breakers, module excessive soiling, etc.
- Basic maintenance skills such as cleaning and routine check-ups
- Sharing of all relevant product documentation including data sheets, operation manuals, supplier warranties, etc.
- Sharing with operator contact of service hotline in case problems or faults are detected within the system during operation.
- Relevant schematics and connectivity topologies that would come in handy during regular system operation.

#### **800.4.2 MONITORING AND CONTROL**


The solution implemented shall include a complete control and monitoring system. The control system shall be acquired from the same supplier as system main controller and inverter so that to ensure optimal compatibility and quick fault resolution.

The control and monitoring system should allow the following features:

- Local monitoring: The solution should allow complete monitoring for all main system components including the inverter, variable drive, PV system, etc. Local monitoring should be provided via an easy access' software application.
- Remote monitoring: The solution should allow remote monitoring for the entire system over the internet backbone. User access should be allowed from any remote location via a safe topology and over a reliable server. Remote monitoring platform shall provide easy user login with dedicated credentials.
- The control and monitoring software shall provide complete system diagnostics via log files with errors, warning and alarms.

- The control and monitoring software shall provide history log files to allow tracking system events needed for system maintenance and servicing.
- The monitoring software shall allow the visualization of system performance parameters via informative graphs and charts. Graphed values to include solar production values and flow outputs over periods of days and months.
- Monitoring software should be future resistant meaning that updates made on applications or software by developer in future should not render adaptability of previously installed application versions. The platform should leave capacity for the inclusion of future possible services and features.

## **ANNEX 1**

<div style="display: flex; align-items: center;"> <div style="width: 100%; border-left: 1px solid black; height: 100%;"></div> <div style="writing-mode: vertical-rl; transform: rotate(180deg);">50% of Width</div> </div>	<div style="display: flex; align-items: center; justify-content: space-between;"> <span>←</span> <span>Width (2 meters min)</span> <span>→</span> </div>	
	<b>REPUBLIC OF LEBANON</b> <b>MINISTRY OF ENERGY AND WATER</b>	 <div style="display: flex; justify-content: space-between; padding: 0 10px;"> <div> <b>الجمهورية اللبنانية</b>  <b>وزارة الطاقة والمياه</b> </div> </div>
	<div style="display: flex; justify-content: space-between;"> <span><u>PROJECT NAME:</u></span> <span><u>اسم المشروع:</u></span> </div>	
	<div style="display: flex; justify-content: space-between;"> <span><u>FINANCEMENT:</u></span> <span><u>التمويل:</u></span> </div>	
	<div style="display: flex; justify-content: space-between;"> <span><u>CONSULTANT:</u></span> <span><u>الاستشاري:</u></span> </div>	
	<div style="display: flex; justify-content: space-between;"> <span><u>CONTRACTOR:</u></span> <span><u>المتعهد:</u></span> </div>	
<div style="display: flex; align-items: center;"> <div style="width: 100%; border-left: 1px solid black; height: 100%;"></div> <div style="writing-mode: vertical-rl; transform: rotate(180deg);">Variable</div> </div>	<div style="display: flex; justify-content: space-between;"> <div> <u>COMMENCEMENT OF WORKS:</u>  <u>TIME FOR COMPLETION:</u> </div> <div> <u>تاريخ المباشرة بالعمل:</u>  <u>مدة التنفيذ:</u> </div> </div>	

Font: Helvetica, capitalized lower case, uniform size (3% of width)

Text layout: upper half in bold

Colors: background light yellow; CDR text in dark blue; all other text in black

Logos multicolor: maximum size: 10% of width

L.L = Max 40%  
P.T = Max 10%

على ألا تحتوي على حجارة أو مواد صلبة يزيد حجمها عن 5 سم.

– تردم هذه المواد على طبقات بسماكة 20 سم وحتى عمق 60 سم ابتداء من طبقة الاساس وحتى الوصول الى كثافة 95% بروكتور معدل.

– من 60 سم وما دون ذلك تردم المواد الصالحة بسماكة 30 سم وحتى الوصول الى كثافة 90% بروكتور معدل.

#### ثالثا: فرش الطبقة الاسفلتية:

تفرش الطبقة الاسفلتية فوق طبقة الاساس على الشكل التالي:

نفس سماكة الزفت الموجود على الطرق على الا يقل عن سماكة 9 سم للطرق (الدولية والرئيسية والثانوية) وعلى ألا يقل عن سماكة 4.5 سم للطرق المحلية والداخلية.

رابعا: في حال عدم توفر الردميات المنصوص عنها في البند ثانيا يتم الردم بواسطة ردميات (sraoc esab buS) على ان يتضمن المواصفات التالية:

- معادل رملي لا يقل عن 40%
- التآكل (A.L) لا يقل عن 40%
- حد اللدونة (P.I) % 6 P.I xaM
- لا يزيد حجم الحجارة أو المواد الصلبة عن 5 سم.

– يتم الردم بسماكة 20 سم حتى عمق 60 سم ابتداء من طبقة الاساس حتى الوصول الى كثافة 95% بروكتور معدل.

– من مق 60 سم وما دون ذلك يتم الردم بسماكة 30 سم وحتى الوصول الى كثافة 30% بروكتور معدل.

– تدرج ضمن حدود المواصفات المطلوبة في دفتر الشروط.

## مرسوم رقم 13495

تحديد دقائق تطبيق وتنفيذ المرسوم الاشتراعي رقم 68 تاريخ 83/9/9 (تنظيم أشغال الحفر لمد خطوط الخدمات العامة في الطرق وبراحتها)

ان رئيس الجمهورية،  
بناء على الدستور،  
بناء على أحكام المادة الثامنة من المرسوم الاشتراعي رقم 68 تاريخ 83/9/9 (تنظيم أشغال الحفر لمد خطوط الخدمات العامة في الطرق وبراحتها)،  
بناء على اقتراح وزير الاشغال العامة ووزير الشؤون البلدية والقروية،  
وبعد استشارة مجلس شورى الدولة (الرأي رقم 98/24-99 تاريخ 1998/10/22)،  
وبعد موافقة مجلس الوزراء بتاريخ 1998/10/1،

يرسم ما يأتي:

المادة الأولى – مع مراعاة أحكام المادتين الرابعة والخامسة من المرسوم الاشتراعي رقم 68 تاريخ 83/9/9 (تنظيم أشغال الحفر لمد خط الخدمات العامة في الطرق وبراحتها) تطبق عند ردم اشغال الحفر المواصفات والشروط التالية:

#### أولا: في طبقة الاساس

- granular base coarse (T.V) :
- تردم بسماكة 30 سم على طبقتين تحت طبقة الاسفلت على أن تتكون كل طبقة من مواد صلبة مكسرة خالية من المواد الدلغانية (clay) وتتضمن المواصفات التالية:
- معادل رملي لا يقل عن 50%
- التآكل (A.L) لا يقل عن 40%
- تدرج ضمن حدود المواصفات المطلوبة في دفتر الشروط.

#### ثانيا: المواد الصالحة للردم:

تعتبر مواد صالحة للردم Suitable material المواد ذات المواصفات التالية:

المادة 2 - يبلغ هذا المرسوم من يلزم ويعمل به فور نشره في الجريدة الرسمية.

بعيدا في 5 تشرين الثاني 1998

الامضاء: الياس الهراوي

صدر عن رئيس الجمهورية

رئيس مجلس الوزراء

الامضاء: رفيق الحريري

وزير الاشغال العامة

الامضاء: علي حراجلي

وزير الشؤون البلدية والقروية بالوكالة

الامضاء: باسم السبع

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