TECHNICAL SPECIFICATIONS FOR MOTORIZATION OF BOREHOLE

1.0 GENERAL INTRODUCTION

1.1 Definitions

The Client is GOAL Relief and Development Organisation P.O. Box 33140 Kampala

The Engineer here refers to a representative of GOAL who will oversee the works on behalf of GOAL

GOAL, the client and the Engineer should be read to mean the same entity representing the interests of GOAL

1.2 This document is the technical specifications for materials and workmanship for the construction of a Solar-PV Powered motorized wells in Butaleja District (Eastern Uganda), and Kaabong (Northeastern Uganda). In total, GOAL shall construct 2 motorised Boreholes (Community Tap Stands [CTS] in the two districts of Butaleja and Kaabong.

1.3 Scope of Works

1.3.1 Scope of this Specifications

This specification covers the overall works to be done. The works consist of civil works, reservoir RC - stand Construction, Solar Power & Pump Installation, electrical installations and wiring, water tightness testing and any landscaping where necessary. These works are recorded in the Contract Drawings, the detailed Bill of Quantities, and this specification and in documents which wholly form the terms and conditions of the Contract.

A Community Tap stand (CTS), [Borehole Motorization] is a GOAL Terminology for micro-piped water scheme that is normally constructed in communities where a handpump (borehole) cannot serve them well. So, a handpump is fitted with a Solar Powered Pump and three draw-off points at strategic locations within the community are provided through distribution pipe networks.

The main parts of the work consist of Construction of Reservoir tower, Tank supply and Installation, Pump Supply and Installation, PV Supply and Installation and Lastly Civil works for the Transmission and Distribution Networks. These have been broken down as noted below:

1. Civil Works Construction of the reservoir to a height of 5 - 6meters - high **reinforced** concrete for support of the reservoir. Please see drawings and Bill of Quantities

2. Tank Supply and Installation. The Tank is Plastic and 8000litres- Gentex Brand and all its plumbing accessories.
3. PV Pump Supply and Installation plus its accessories and fittings. Please see details in the drawings and Bill of Quantities
4. Installation of the transmission line of 50mm GMS. Please see drawings and Bill of Quantities for Details
5. Trenching and burying of transmission and distribution pipe networks of total length to 900meters with Pipe sizes of 40mm and 32mm PN6 and its fittings/accessories. Please check details in the Bill of Quantities

Note: Transmission line will apply to only the site in Kaabong District.

1.1.2 Location of the works

The works are in communities located in Butaleja and Kaabong districts.

1.3.2 Site Access

Prior to the commencement of construction, the Client or his authorized representative shall supply to the Contractor, the names and addresses of contact persons. The Contractor shall notify the Client or Engineer five days in advance of his intention to start work at the site.

The Contractor shall keep records of the dates of his entry onto and departure from site, together with the date of removal of all the enclosures and shall furnish copies of these records when required by the Resident Engineer or his authorised representative.

1.3.3 Survey of Property and Land

The route where the pipeline is going to pass has already been surveyed by GOAL together with the community leaders and members. This was to ensure minimum damage to crops and property during trenching by the contractor during construction. Still GOAL together with the contractor and community leaders shall work together during trenching to ensure that the proposed and approved pipe routes are both economical and do not result into considerable damage to crops and other sources of livelihoods for the communities.

1.3.4 Site Fencing

Where temporary fencing is described in the contract, the Contractor shall erect such fencing upon possession of the site. The Contractor shall regularly inspect and maintain all fencing and any defects made good without any delay.

Access shall be provided in temporary fencing as necessary for the occupiers of the adjacent lands. Temporary fencing shall remain in place until either permanent fencing or the works are sufficiently completed to enable that portion of the site to be brought into use.

1.3.5 Interferences with land Interests

The Contractor shall confine his constructional operations within the site, or such other areas of land as may be negotiated and shall instruct his employees not to trespass.

Subject to any unavoidable disturbance that may be necessitated by the execution of contract, the Contractor may not interfere with any other activities within the communities.

Before exercising any right negotiated in connection with way leaves or accommodation outside the site, the Contractor shall notify the Client or his authorized representative in writing of such arrangements.

1.3.6 Interferences with access to properties

Before interfering with access to any property, the Contractor shall provide alternative arrangements. The Contractor shall notify the Client or his authorized representative and the relevant occupiers in writing 14 days in advance of any such interference and shall confirm to the Engineer those alternative arrangements have been made.

1.3.7 Terms and Conditions

Procedure for Complaints and Claims for Damage.

Details of all claims or warnings of intended claims that the Contractor may receive in respect of matters against which s/he is required by the contract to indemnify the employer shall be notified without delay to the Engineer, who shall likewise pass to the Contractor any such claims or warnings which may be submitted directly to the Client.

A similar exchange of information shall also be made in relation to all complaints that may be received. The Contractor shall notify the Client or his authorized representative in writing immediately following any damage or injury arising out of execution of works.

Protection against Damage

The Contractor shall take all necessary precautions to avoid causing any unwarranted damage to roads, private and public property, trees, and features of cultural and traditional value. The contractor should deal promptly with any complaints by owners, occupiers or representatives to such property.

1.3.8 Tidiness of Site

The Contractor shall be responsible for the proper upkeep and maintenance of the site and the works and shall remove from the site rubbish and other waste as it accumulates. Materials and equipment shall be positioned, stored, and stacked in an orderly manner.

1.3.9 Explosives and Dangerous Substances

No explosive or other dangerous substance shall be brought onto the site or used for any purpose unless the Contractor has previously obtained the written approval of the Client or his authorized representative. Where the client is not in position to authorise such

equipment, the contractor will be required to obtain authorisation from the responsible local or national authority.

The location of each explosive's magazine and store of any other dangerous substances on site shall be approved in writing by the Client or the responsible local or national authority.

The storage of blasting explosives shall be in accordance with the conditions of the statutory license obtained by the Contractor and the relevant provisions of BS 5607

1.3.10 Contractor's Campsite

The Contractor 's camp, shop, office, and yard area shall be located and arranged in a manner to preserve trees and vegetation to the maximum possible extent. On abandonment, all camp, storage, and construction buildings, including concrete footings and slabs, and all construction materials and debris shall be removed from the site. The camp area shall be left in a neat and natural condition.

1.3.11 Prevention of Water Pollution

The Contractor's construction activities shall be performed by methods that will prevent entrance, or accidental spillage of solid matter, contaminants, debris, objectionable pollutants and wastes into streams, surface and underground watercourses, and the reservoir or tank areas. Such pollutants include but are not restricted to, refuse, garbage, cement, concrete, oil and other petroleum products, aggregate processing tailings and thermal pollution.

De-watering works for earthwork operations adjacent to, or encroaching on, streams or water courses shall be conducted in a manner that will prevent muddy water and eroded materials from entering water courses by construction of intercepting ditches, bypass channels, barriers, settling ponds or by other approved means.

Wastewaters from construction operations shall not enter streams, watercourses, or other surface water without the use of such turbidity control measures such as settling ponds. Any such wastewaters discharged into surface waters shall be essentially free of settleable material. For the purpose of these specifications, settleable material is defined as that material which will settle from the water by gravity during 1-hour quiescent detention period.

1.3.12 Site Drainage

All drains shall be constructed at the locations shown on the drawings or as directed. Care shall be exercised to avoid clogging of the drains during the progress of the work, and should any drain become clogged or obstructed from any cause before final acceptance of the work, it shall be cleaned in a manner approved by the Client or replaced by at the expense of the Contractor.

The Contractor shall not allow water to lie in any parts of the works unless required to do so under the contract; water arising from or draining into the works shall be drained or pumped to an approved disposal point.

The Contractor shall take all necessary precautions to prevent any adjacent ground from being adversely affected by loss of fines through any de-watering process.

Where temporary drains are required, they shall be laid in a narrow trench formed below the bottom of the excavation in an approved position. The pipes shall be open-jointed and shall be surrounded with free draining granular materials.

Records shall be kept of all drainage system reinstatement work carried out, and a copy shall be given to the Client or his authorized representative.

1.4 Demolition and Site Clearance

1.4.1 General

This shall include the demolition and removal of natural and artificial objects and obstructions to construction, which are above the original surface. It shall cover landscape preservation, clearing of site works and all other areas related to the works of trees and all other unwanted vegetation as determined by the Client or his authorized representative.

1.4.2 Landscape Preservation

The Contractor shall exercise care to preserve the natural landscape and shall conduct his construction operations to prevent any unnecessary destruction or defacing of the natural surroundings in the vicinity of the work.

Except where clearance is required for permanent works, for approved construction of roads and for excavation operations, all trees, native and vegetation shall be preserved and shall be protected from damage which may be caused by the contractor 's operations and equipment.

Movement of crews and equipment within the right of way and over routes provided for access to the work shall be performed in a manner that prevents damage to crops or property.

No special replanting will be required under these specifications; however, on completion of works and in' addition to all other requirements of these specifications, all work areas should be smoothed and graded in a manner to conform to the natural appearance of the landscape.

Where unnecessary destruction damage or defacing may occur because of the Contractors operations the same shall be repaired or corrected at the Contractor's expense.

1.4.3 Disposal of Materials

Materials from clearing operations shall become the property of the Contractor and shall be at the Contractors option, buried or burned, removed from the site of work before the completion date or otherwise disposed of as approved.

Materials disposed of by burying shall be buried at locations approved by the Client or his authorized representative and shall be covered with not less than 600mm of earth material. Approved locations will be natural or excavated depressions in the reservoir area which are not subject to erosion from stream flow or wave action.

Burning will be permitted only at times when conditions are considered favourable for burning and at locations approved by the Client or his representative. Materials to be burned shall be neatly piled and when in a suitable condition shall be burned completely. Piling should be in a position as to prevent the least fire risk. The Contractor shall always take special precautions to prevent the fire from spreading to limits beyond the cleared areas and shall always have available suitable equipment and supplies for use in preventing and suppressing fires.

Cut timber, dead timber and other floatable or combustible material over 100 mm in diameter, to be disposed of by cutting to lengths, shall be trimmed, and cut into approximate 2.0 m lengths. Such cut material may be sold off by the Contractor or hauled to stockpiles at locations as approved by the Client or his authorized representative. Cut material shall be neatly stacked into piles. All other similar material less than 100mm shall be chopped up and used in making barricades along the fence line.

2.0. EARTHWORK

Earthworks shall include excavation of suitable materials, filling, disposal of waste material and landscaping. It shall also include transportation of materials and backfill for pipe trenches. Except as otherwise provided in these specifications, materials excavated will be measured and classified in excavation, to the lines shown on the drawings or as provided in these specifications and will be classified for payment as follows.

2.1.0 Common Excavation

Common excavation includes all material other than rock excavation. All boulders or detached pieces of rock less than 0.70 m^3 in volume will be classified as common excavation.

No additional allowance above the unit rate bid in the schedule for excavation will be made on account of the material being wet.

The Client or his authorized representative and the Contractor shall be present during the classification of the excavated material. On written request of the contractor made within 10 days after the receipt of the monthly estimate, a statement of the quantities and

classifications of excavations between successive stations or in otherwise approved locations included in the said estimate will be furnished to the Contractor within 10 days of receipt of such a request. This statement will be considered as satisfactory.

2.2.1 Open Cut Excavation

Excavation shall be made to the lines, grades, and dimensions shown on the drawings or established by the Client or his authorized representative.

2.2.2 Excavated Materials

So far as practicable, as determined by the Client or his authorized representative, all suitable materials from excavations for specified permanent construction shall be used in the permanent construction required under these specifications.

The Contractor's blasting and other operations in excavations shall be such that the excavations will yield as much suitable material as practicable and shall be subject to the approval of the Client or his authorized representative.

Where practicable as determined by the Client or his authorized representative, suitable materials shall be excavated separately from the materials to be wasted, and loads shall separate suitable materials during the excavation operations.

2.2.3 Roads, Buildings and Utility Lines in Borrow Areas

Prior to the relocation of a road, the Contractor shall not excavate within 16 m of the centreline of the road. The Contractor shall conduct his operations in such a manner as to permit continued use of the road and to provide safety to the public until such a time that the road has been relocated. The Contractor shall permit access as necessary to others for the purpose of relocation of this road and should seek written permission from the relevant authorities prior to excavations across community roads.

Prior to the disposal of buildings, they shall be protected from damage from the contractor's operations. The Contractor shall permit access as necessary to others for the purpose of disposal of these buildings.

2.3 Disposal of Excavated Materials

Excavated materials that are unsuitable for or are in excess of permanent construction requirements shall be wasted.

The disposal of all excavated materials that are to be wasted shall be subject to the approval of the Client or his authorized representative, but the Contractor shall not be required to haul material to be wasted not more than 250m along the most practicable routes to the approved disposal areas.

2.4 Damp Proof Membrane

Damp proof membrane underlay to floors and ground slabs shall be 1000-gauge polyethylene sheet laid with minimum 150 mm laps and dressed over the horizontal wall damp proof course for the full width of the course

3.0 Pipe Laying

The pipes, valves and fittings required for this Contract are all to be supplied by the Contractor and for this purpose drawings and schedules have been included.

The Contractor's rates are to cover supplying, taking delivery, transporting, loading, inspecting, stacking, stringing, laying, jointing, and testing all the material listed.

In executing all such work, the Contractor shall take every precaution to ensure the safe and efficient handling of material in such a manner that it shall in no way be damaged while under his care.

3.1 Site Inspection and Testing

All items delivered to site are to be carefully inspected by the Contractor 's Site Agent immediately they reach site and carefully checked against their detailed specification both for manufacturing defects and for damage since manufacture. Any defect or damage shall be reported at once to the Engineer and the damaged or defective valve, pipe or fitting laid aside for his inspection, when he shall decide whether to permit repair of the item or to reject it.

3.2 Levels for Pipe layer

Immediately before pipe laying begins, the Contractor's agent shall check the level of the pegs to which the pipe layer is to work, using an Engineer's level.

3.2.1 Laying Pressure Pipes

The Contractor will be responsible for the correct distribution of the various classes of pipes, valves, and fittings along the trench so that they are convenient for laying.

After enough length of trench has been prepared for laying, the pipes are to be carefully lifted and not skidded or rolled but lowered into place on the trench bottom.

Where pipes are to be laid to an appreciable gradient laying is to be commenced at the bottom of the incline and is to proceed uphill.

To prevent the entry of stones or loose material into the pipeline, plugs or caps are always to be provided to cover the mouth of any open pipe while pipe laying is not actually proceeding.

3.2.2 Completion of the Pipe Surround

After completion of the relevant operations above, fill material shall where require, be placed, and compacted over the full width of the trench in layers not exceeding 150mm before compaction, to a finished thickness of 250mm above the crown of the pipes.

3.3 Jointing of Pipes and Fittings

Before being butted together, the ends of valves, pipes, fittings, couplings, and all flanges are to be inspected and cleaned to ensure that all parts forming the joints are undamaged and clean. Buried flanges, and the ends of bitumen-lined steel pipes shall be painted with two coats of approved bituminous paint.

In all cases care must be taken that the pipes are kept to line and grade during jointing, and any jointing material that has found its way into the barrel of the pipe shall be immediately removed with a badger or other approved tool, where after the interior of the pipe is to be wiped clean and the joint on the inside of the pipe trued up and cleared of any protuberances so as to offer no obstruction to the passage of liquids. Except as authorised by the Engineer for pipelines with full-strength welded joints (steel, PVC and HDPE), pipes are not to be moved or disturbed after jointing and any pipes so moved or disturbed shall have their joints cut out and be rejointed.

Where pipes with rigid joints connect into manholes, valve-chambers and /or other concrete structures subject to settlement, the pipes entering and leaving the structures shall be laid in position but shall not be jointed until the completion of a reasonable amount of concrete work in the structure. This is to avoid breaking of built-in pipes.

When pipes with flexible joints connect into structures, a flexible joint shall be provided within 1 metre of the manhole wall, and a second 1 metre from the first.

3.3.1 Steel Pipes with Flexible Joints

These pipes, together with plain ended fittings, will be joined/jointed by means of approved detachable couplings, each consisting of one centre collar, two special flanges, two rubber rings and mild steel bolts.

The flanges are first put on, one over the end of each pipe, and the rubber rings fixed by stretching them over the pipes. Any twists in the rubber rings must be eliminated, and the rings put into position so that

the distance from the end of the pipe to the ring is equal to half the length of the collar. The collar shall then be placed over the end of one of the pipes and the two pipe ends brought to within 20 mm of each other, whereupon the collar shall be set concentrically over the pipe joint. The bolts shall now be inserted into the flanges and carefully tightened up evenly across diameters to ensure a watertight joint. Bolts on flexible couplings for steel pipes are

to be tightened to the torque specified by the coupling manufacturer and a torque wrench must be used for this purpose.

On completion of the joint, the metal work of the joint shall be protected with an approved polythene tape wrap, or as directed by the Engineer on site.

The jointing of plain-ended valves and specials to the pipes shall be executed in the same way.

3.3.2 Flanged Joints

Flanged faces shall be cleaned thoroughly and the jointing material, cut properly to size and holed for bolts, inserted immediately before bringing the two flanges together. Before closing the joints, the flanges must be parallel to each other, with at least two-thirds of all bolts inserted in the bolt holes and evenly distributed over the circumference of the flange. After the flanges have thus been aligned and well supported, the joint shall be closed by bolting up all bolts to uniform tightness. All bolting up must be done using torque wrenches.

3.3.3 Screwed and Socketed Pipes

Prior to joining, the threads shall be thoroughly wiped clean and then treated with a thin layer of an approved pipe jointing compound to be supplied by the Contractor. The pipes and fittings shall be brought into correct alignment and the joints screwed up tightly. Tightness of the joints must be obtained by means of screwing only. Threads may not be caulked except where specially permitted by the Engineer. Care shall be taken to avoid damage to the surface due to improper use of tools or other causes.

3.3.4 Welded Joints in Steel Pipes

The process of welding steel pipes shall be in accordance with BS 4515.

The ends of the pipes shall be cut and prepared, and be free from fins, planar defects, tears and other surface defects, prior to welding. Cleaning to base metal shall extend for at least 25 mm from the end of the pipe on both the external and internal surfaces.

The alignment of abutting pipe ends shall be such as to minimize the internal offset between surfaces. The Contractor shall submit details of the proposed welding and welding repair procedures before production welding starts. The Contractor under simulated site conditions shall make test welding using these procedures.

Welders shall only make welds for which they are approved.

Joints shall be tested using non-destructive techniques unless it is required to use destructive testing to achieve adequate interpretation.

3.3.5 Ogee Joints

Ogee joints shall be so made that the required jointing material fills the cavity. Any surplus jointing material extruded inside the barrel shall be trimmed off and, where practicable, pointed on completion.

3.3.1 Brick and In-situ Concrete Manholes and Chambers

Manholes and chambers constructed in brickwork or in in-situ concrete shall comply with the provisions for concrete works.

3.3.2 Small Slab Covers

Small reinforced concrete slabs of an area less than 100cm2 shall be made for covers of valve boxes and access ways for manholes. The slab thickness shall not be less than 50mm and not greater than necessary to cover a bar with 25mm of concrete on both sides.

The concrete mix shall be 1:2:4 with aggregate, which is small enough to fit through the wire mesh used. These slabs shall be cured for 3 days in accordance with procedures for concrete works. The slabs shall be plastered with a 1:3 mortar to give smooth and clean surface.

3.3.3 Water Tightness for Manholes and Chambers

Manholes and chambers shall be substantially watertight, with no identifiable flow of water penetrating the permanent works.

3.3.4 Manhole Covers and Frames

Manhole covers and frames shall comply with the relevant provisions of BS 497 Part 1 and have a minimum clear opening of 600mm.Covers and frames with minimum clear openings outside the ranges in BS 497 shall comply with the provisions of that standard where applicable.

3.3.5 Setting Manhole Covers and Frames

Manhole frames shall be set to the required level on well-burnt clay engineering brickwork, or on a precast concrete cover frame seating rings as described in the contract. The frames shall be set to level, bedded, and hunched over the base and sides of the frame in mortar mix of 1:3.

3.3.6 Valves

Valves for pipeline installation shall comply with the relevant provisions of the appropriate British Standard, as set out below:

Type	BS
Check and Gate Valves	5154

Valve parts to be in contact with water shall meet the relevant provisions as set out below

Type	BS
Metallic	6920
Non-Metallic	6920

Valve Boxes

The sole purpose of a valve box shall be to protect the control valve from undesirable tampering which could upset the hydraulic balance of the system and hence disrupt flows.

A strong and secure cover, which is not readily opened, shall protect the valve from damage by the users. The cover shall be bolted down, nailed down, buried, or welded. The method used shall be at the discretion of the Client or his authorized representative.

The valve box shall be free draining. No valve box shall have a solid floor so that any leakage or ground seepage can drain away quickly. A bed of gravel shall be used for the flooring.

The valve box shall be adequately large enough. This will enable the valves to be removed and replaced without tearing down the valve box during maintenance.

3.4 Pipes for Land Drainage and Temporary Drains

Pipes, joints and fittings for land drainage and temporary drains shall comply with the relevant provisions of the appropriate British Standard, as set out below:

Type	BS
Plastic pipes for use as light duty sub-soil drains	4962
Perforated or Surface water vitrified clay pipes and fitting	65

3.4.1 Storage of Pipes

PVC pipes crack when subjected to high temperatures. They shall hence be stacked over supports and stored in a shed, which shall be erected by the Contractor.

Galvanized iron pipes are susceptible to rusting and hence ought not to be stored in the open. They should similarly be stored in a shade, which shall be erected by the Contractor

HDPE Pipes

Laying of HDPE pipes shall be in accordance with the appropriate British Standards or ISO norm. Pipe lengths are to be butt welded. All fitting and specials shall be of HDPE to match the rating of the piping on which they are being installed.

All HDPE pipework installed above ground level shall be supported continuously on pipe supports provided by the Civil Contractor.

Branches are to be socket or butt welded. Reducers shall have weld ends to suit the manufacturer's range.

Flanges are to be used at flanged valves, equipment items, at intervals of 30m for straight pipe lengths or as directed by the Engineer.

The Contractor is required to make appropriate arrangements to deal with thermal expansion of the pipework. These arrangements shall require written approval of their suitability by the Engineer before installation.

3.5 Tolerances in Pipe laying

3.5.1 Water Mains

For sections permanently exposed above ground the deviation from the specified line and level shall not exceed 5 mm if the section is no longer than 30 metres and 1O mm for longer sections. For buried pipelines the deviation shall not exceed 15 mm.

The deflection at any joint shall never exceed the maximum recommended by the manufacturer and should in general be less than three-quarters of that deflection except with the permission of the Engineer.

3.5.2 Cutting of Pipes

Cut pipes shall be used only where permitted by the Engineer and the ends which have been cut shall be dressed square and to a smooth even finish, which shall not be inferior to that of the uncut pipe. The finished dimensions of the ends cut at Site must be within the tolerances applicable to the joint.

Unless billed separately, the cost of all cutting and trimming, and where necessary screwing, shall be included in the rates for laying and jointing of the pipes.

3.5.3 Concrete Protection to Pipelines and Existing Services

Where the Engineer directs, pipes will be laid on a concrete mat, or haunched, encased or surrounded with Grade C10/20 concrete. The Contractor shall receive payment based on the quantity of concrete required, calculated from the exact specified geometric sectional area of the concrete and the exact length haunched or surrounded, and this shall apply also to concrete in drops or ramps. Where haunch or surround is discontinued at flexible joints, no payment will be made for forming the discontinuity, but no deduction will be made from the volume of concrete.

Where any new pipe passes under an existing service, the Contractor shall consult the Engineer who will determine whether a reinforced concrete supporting beam shall be provided under the service prior to backfilling. Any work of this kind will be paid for at agreed rates unless separately billed.

The rates quoted for concrete protection shall allow for all the associated excavation and shuttering.

3.5.4 Setting Valves and Pipe Fittings in Position

All valves and fittings are to be set correctly into positions indicated and supported on concrete supporting stools as shown on the Drawings. Valve spindle guide brackets and stays shall be secured to concrete work and shall be set and carefully adjusted to give true vertical alignment of the spindle wherever possible.

3.5.5 Inspection of Pressure Pipelines

Before being filled with water, pipelines shall be inspected externally and, where large enough to permit it (normally 600 mm nominal internal diameter and above), internally by the Engineer or his designated Representative/Inspector, and the Contractor shall provide all necessary attendance including lighting and other facilities for this purpose except transport and inspecting trolleys.

3.6 Filling and Testing Pressure Pipelines

3.6.1 Filling

In rainy weather or where the ground is wet, suitable arrangements shall be made to prevent pipes from floating before they are filled and each portion of the pipeline shall be filled with water as soon as possible after it has been laid, the water being obtained solely from the well, unless otherwise agreed by the Engineer.

Before filling any section of the pipeline with water, the Contractor shall ensure that all pipes and valves are properly anchored to prevent movement. The main shall then be cleaned and flushed with water so that it is completely clear of all foreign material, silt, dirt, rags, or other objects. Filling shall be carried out carefully to avoid shock and prevent the entrapment of air anywhere in the main, and for this purpose suitable arrangements shall be made for the escape of air and for introducing water into the pipeline at a rate of flow approved by the Engineer. All filling shall be carried out strictly in accordance with the instructions of the Engineer who shall be warned well before filling takes place.

Suitable blank flanges capable of withstanding the test pressure and provided with 40 mm diameter nipples at crown and invert of the pipe are to be supplied and installed at the ends of each section under test. In the event of air and scour valves not being available by the time testing is due to commence the Contractor will be required to provide suitable blank flanges for all scour and air valve branches within the section under test. Blank flanges for air valve branches shall be provided with a 19 mm diameter nipple and stop cock for the release of air during filling. Items are provided in the Bill of Quantities for the supply of all necessary blank flanges.

Testing of pipelines shall be included in the rates for laying pipelines unless separate items are provided in the Bill for this. The Contractor must make his own arrangements for obtaining water for flushing and filling of each pipeline for test purposes, and for refilling the main for retesting as necessary

3.7 Testing

3.7.1 Pre-testing

After filling, but before the application of the specified field test pressure, the test section shall be allowed to stand for a minimum of 24 hours. In the case of asbestos-cement and concrete pipes the objective is to ensure saturation of the pipe and coupling surfaces. In addition, and irrespective of the type of pipe and coupling, the entire test section shall be inspected to check for: -

(a) Visual leaks or sweating at couplings, flanges or through pipe walls

(b) Signs of pipe, fitting or anchor block movement

(c) Air discharge

(d) Leakage of any kind

Any faults thus found shall be made good prior to the application of the specified/detailed Field Test Pressure.

3.7.2 Failure to Pass Test

If the specified pressure is not attained or maintained, or if the rate of pumping or leakage is excessive, or in the event of any weakness, defect, leakage, or fracture occurring in the pipes under test, the Engineer may order the test to be discontinued or repeated, and the Contractor shall thereupon search for and rectify any weakness or defect in the pipes under test.

The work of rectification is to consist of repair or replacement or both to the order and satisfaction of the Engineer; the pipework shall thereafter be refilled with water and retested in the manner specified. This process shall be repeated until a satisfactory test is obtained, and no section of a pipeline will be accepted unless it has withstood the hydraulic test under the specified conditions. Where the work fails test due to the act or omission of the Contractor, all the work of rectification shall be done entirely at his expense.

4.0 CONCRETE WORKS

Concrete shall be used for troughs and trough hardstands, bases of reservoirs, tap stands and for foundations of pump houses.

4.1 Materials

Concrete shall be composed of cement, sand and coarse aggregate, water as required and well mixed and brought to the proper consistency. In general, cement will be accepted on manufacturer's certification of compliance with specification requirements. Concrete shall except where otherwise described in the contract, be produced transported and assessed for compliance with the specification in compliance with the relevant provisions of BS 5328 Parts 3 and 4.

4.2 Cement

Unless otherwise specified the cement used in the Works shall be ordinary Portland cement (OPC) complying with BS 12 at the time of use.

The Contractor shall supply samples of cement, when requested by the Engineer, both from the Contractor 's store on Site and from the place of manufacture.

For the purpose of BS 12, the Site shall be deemed to have a tropical climate.

Where specified or ordered, sulphate resisting cement (SRC) shall comply with BS 4027, and the provisions for samples, tests and test certificates specified above for Portland cement shall apply for sulphate resisting cement.

4.3 Storage of Cement

Cement easily absorbs moisture from the air and as a result loses strength during long periods of storage. Typical loses are given in the table below.

Period of Storage Loss of Strength

3 Months 20%

6 Months 30%

12 Months 40%

Cement on a project site shall be stacked in a closely packed pile, not greater than 10 bags high (to prevent bottom bags from bursting). Close packing reduces air circulation between the bags. The cement pile shall be raised on a platform above the floor. Aged cement forms lumps. All lumps should be screened out of the cement before use; lumps, which cannot crumple by fingers, should not be used.

4.4 Water

Water in the concrete mix serves two purposes. First to take part in the hydration reaction of the cement and secondly to make the mix fluid and plastic enough so that it can easily be worked and placed. Water shall be free from objectionable quantities of silt, organic matter, salts, and other impurities.

4.5 Sand and Coarse Aggregate

Sand and coarse aggregate shall be furnished by the contractor from any approved source. The sand particles shall be clean, hard, dense, durable, uncoated rock fragments that will pass a screen having 4 - 6.50 mm openings. The sand shall be well graded from fine to coarse and shall be free from injurious amounts of dirt, organic matter, and other deleterious substances.

The coarse aggregate shall consist of natural gravel or crushed rock and shall be clean, hard, dense,

durable, uncoated rock fragments, free from injurious amounts of thin pieces, organic matter, or other deleterious substances. The coarse aggregate shall be reasonably well graded from 5 - 37.5 mm and shall be separated into two sizes by an intermediate screen having 20 mm square openings. Screens having openings of other sizes and shapes may be used if equivalent results are obtained.

The Client or his authorized representative reserves the right to test the sand and coarse aggregate and, if required, the Contractor shall submit, for preliminary tests and approval, representative samples of the sand and coarse aggregate proposed for use in the concrete works.

4.6 Composition

Sand and coarse aggregate shall be mixed in proportions as directed by the Client or his authorized representative.

The slump of concrete shall not exceed 50 mm for slabs, and 75 mm for all other concrete.

4.7 Batching and Mixing

The sand and coarse aggregate shall be weighed and proportioned based on integral bags of cement unless the cement is weighed. Weighing equipment of the beam type shall be used. The Contractor shall provide equipment and shall maintain and operate the equipment as required to accurately determine and control the amount of each ingredient entering the concrete.

All concrete shall be thoroughly mixed in **mechanical batch mixers** of approved type, size, and design to ensure positively that the mixing operation gives a uniform distribution of all the ingredients throughout the mass. Each mixer and its operation shall be approved by the Engineer, and, if in his opinion any mixer is producing unsatisfactory results, the Contractor shall discontinue its use until such time as it is repaired or replaced temporarily or permanently with an approved mixer, as required by the Engineer. The total capacity of the mixing plant on the job must be enough to permit any reasonable pour that may be ordered to be satisfactorily completed in one operation in daylight.

Batching shall be such that the combined inaccuracies in feeding and measurement of materials will not exceed 1.5% for water and weighed cement and 2% for sand and each size of coarse aggregate.

The concrete shall be uniform in composition and consistency throughout the mixed batch, and from batch to batch, except where changes in composition or consistency are directed. The mixing time shall be at least 1.5 minutes.

Excessive over-mixing requiring the addition of water to preserve the consistency will not be permitted. The mixers will and their operation are such that the concrete throughout the mixed batch and from batch to batch is uniform with respect to both consistency and grading. Any concrete retained in truck mixers so long as to require additional water to permit satisfactory placing shall be wasted.

Where a mixing pad is used it shall be as close to the final placing point as possible to prevent segregation (heavier aggregate sinking to the bottom and water rising to the surface). Concrete shall be re-mixed with a steel trowel prior to placing.

4.8 Additives

Concrete shall be made from cement, aggregates and water as specified. No additives shall be mixed with the concrete without the Engineer's approval.

4.9 Concrete Blinding

Where specified, a concrete screed or blinding layer in Grade 10 concrete is to be laid on the trimmed foundation to give an even working surface. The screed must be laid immediately following the completion of trimming and cleaning the foundation and is to be level or graded to a fall as shown on the drawings.

Unless otherwise specified, blinding shall be 50 mm thick.

4.10 Forms, Preparations for Placing, and Placing

Forms shall be used to shape the concrete to the required lines the surfaces of construction joints shall be clean, rough, and surface dry when covered with fresh concrete or mortar. Cleaning shall consist of the removal of all laitance, defective concrete, coatings, sand, sealing compound if used, and other foreign material.

The methods and equipment used for transporting the concrete, and the time that elapses during transportation, shall be such as will not cause appreciable segregation or slump loss more than 25mm in the concrete as it is delivered to work. Re-tempering of concrete will not be permitted. Any concrete, which has become so stiff that proper placing cannot be assured, shall be wasted. Formed concrete shall be placed in continuous approximate horizontal layers, the depth of which shall not exceed 500mm.

Concrete shall be vibrated until it has been consolidated to the maximum practicable density, is free from rock pockets of coarse aggregate, and closes snugly against all surfaces of forms and embedded materials.

All porous and fractured concrete shall be removed by chipping openings into the concrete shall be filled with dry pack, mortar or concrete as directed.

Exposed unformed surfaces of concrete shall be brought to uniform surfaces and worked with suitable tools to a reasonably smooth wood float or steel trowel finish as directed.

4.11 Reinforcement and Binding Wire

Steel reinforcement bars shall be placed in the concrete as shown on the drawings. Before reinforcement is placed, the surfaces shall be cleaned of heavy flaky crust, dirt, grease, or other foreign substances. Reinforcement shall be accurately placed and secured in position so that it will not be displaced during the placing of concrete.

Reinforcement will be inspected for compliance with requirements as to size, shape, length, splicing, position, and amount after it has been placed.

Binding wire for the steel reinforcement shall be 1.6mm diameter finally annealed mild steel wire complying with BS 105.

Steel reinforcement shall comply with the relevant provisions of the appropriate British Standard, as set

out below:

Type	**BS**
Carbon steel bars	4449
Cold reduced steel wire	4482

Spacing of the Reinforcement

Spacing of the steel in the concrete should distribute the cross-sectional area of the steel uniformlyy for a floor slab the bar area should not exceed 0.23% of the total cross-sectional area. Reinforcement should be free from oil, grease, dirt, or rust and properly fixed to the approval of the Engineer.

4.12 Mortar

Mortar for masonry and plaster shall be mixed only and when as required in the relevant proportions indicated in the Bill of Quantities for various masonry and plaster works. The mixing of the different ingredients (Cement, Sand and Water) shall be done until its colour and consistency are uniform. The constituent materials shall be accurately gauged allowing for the bulking of sand.

4.13 Concrete/Mortar Placing

To be placed as soon as mixing of constituents with water is complete, and to be carefully placed to avoid segregation.

Where reinforced concrete is used, the reinforcements are supposed to have a minimum cover as specified in the table below or as indicated on drawings. Spacer blocks shall be applied to achieve the nominal concrete cover.

The concrete will be compacted using a concrete vibrator.

4.14 Concrete Cover

Table 1: Concrete cover recommendations

Member	**Cover (mm)**	
	Below water or in corrosive exposure	**Above water table or non-corrosive exposure**
Bases and footings	50	40
Columns	40	32
Beams	32	25
Slabs	20	15

4.15 Concrete Mixes Table 2: Concrete mixes

Mix by Volume Cement: Sand: Aggregate	**Use in**
1:1.5:3	Concrete column footings, stud column for water reservoir (Tank) stand
1:2:4	Column Stud, Stub bases for solar mounting structures
1:3:6	Ground floor slabs, wall strip footings
1:4:8	Blinding Concrete

NOTE: Contractors must use batching boxes in mixing mortar and concrete. The recommended size of batching boxes shall be **300mm x 300mm x 400mm,** internally.

4.16 Form work/shuttering

The formwork shall be constructed to prevent deflection and leakage. Formwork should be struck after written consent of the Engineer. If Pozzolanic cement is used, the formwork should be removed after 28 days, however, for ordinary Portland cement the formwork can be removed after 14days.

4.17 Reinforced Concrete stands for the Tank (Reservoir).

Erected on a 1000X1000mm pad foundation, the RCC tank stand shall be well constructed to carry plastic reservoir (tank) elevated to 5000 - 6000mm as per the attached technical drawings. Where applicable as detailed in the drawings, the columns shall be well braced by an intermediate and ground beam (230x300mm), and 175mm thick RCC slab at intermediate and top levels (floors) of the RCC stand. The pad footing should be constructed on structurally stable strata at a depth not exceeding 1500mm from ground level**.**

A 230mm thick wall plinth wall spanning the columns shall be constructed with excellent quality burnt clay bricks, plastered, and rendered with 1:4 sand mortar mix to a wooden float finish.

350mm access steel ladder (man way) anchored to the steel post should be provided to facilitate access to the reservoir and the solar panels elevated on the steel frame fastened on the RC columns by means of bolts. **Ref drawing no. 1 for structural and construction details of all the elements of the RCC tank stands.**

4.18 Surface Finishes Produced without Formwork

1. Screed Finish

   The concrete shall be levelled and screeded to produce a uniform plain or ridged surface as required. No further work shall be applied to the surface unless it is a first stage for a wood float or steel trowel finish.

2. Wood Float Finish

   The screeded finish shall be wood floated under light pressure to eliminate surface irregularities.

3. Steel Trowel Finish

   When the moisture film has disappeared, and the concrete has hardened sufficiently to prevent laitance from being worked to the surface. The surface to the wood float finish shall be steel trowelled under firm pressure to produce a dense, smooth, uniform surface free from trowel marks.

   Where the type of finish is not given, it shall be wood float finish.

4.19 Surface Finishes Produced with Formwork

1. Rough Finish

This finish shall be obtained using moulds or properly designed forms of closely jointed sawn boards. The surface shall be free from substantial voids, honeycombing or other large blemishes.

2. Fair Finish

This finish shall be obtained from forms designed to produce a hard-smooth surface with true clean arises. Only very minor blemishes shall be permitted and there shall be no staining.

3. Fair Worked Finish

This finish shall be obtained by first producing a fair finish and then filing all the surface blemishes with fresh, specially prepared cement and fine aggregate paste while the concrete is still green where possible. After the concrete has been properly cured the faces shall be rubbed down, if required to produce a smooth and even surface. If the surface is to be exposed during the final work, every effort shall be made to match the colour of the concrete.

4.20 Curing of Concrete Work

The Contractor must allow in his rates for adequate curing, of all concrete work. After concrete has been placed it is to be prevented, in a manner approved by the Engineer, from drying out too rapidly. The contractor should also allow for flooding, spraying with water or covering with sacks, sheeting or sand and keeping the work damp for a period of six, eight or ten days after placing, when ambient temperatures are over 18°C.

All vertical surfaces are to be thoroughly rubbed down immediately after stripping to remove all fins and marks from formwork. Small vertical members such as columns may be wrapped in plastic sheeting into which water shall be regularly introduced at the upper end of the member to make good the loss of water from the member to the inner surface of the sheeting and to supply the additional water required for curing. Larger members may be covered with hessian which shall be frequently watered.

Floors and roofs are to be cured by flooding with water to a minimum depth of 15mm and for this purpose a nib of mortar shall be constructed around each panel or section of the work and all drains or openings sealed.

None of this work is billed and the rates for concrete must allow for curing.

4.21 Hardcore Material Below Building Floors/Tank Platform

Where hardcore material is specified below building floors, the material shall consist of durable gravel, broken stone or crushed concrete with a particle size not exceeding 100 mm. The grading of the material shall be such that there is no migration of fines into the fill and not more than 10% of material shall pass a BS sieve with 5 mm apertures.

The method of placing shall be to the approval of the Engineer and shall ensure that fines separating out during transportation are discarded or selectively placed.

The material shall be compacted in an approved manner to give a stable fill and shall then be blended with sand to the level.

Sand used as blending above fill shall be clean and free from all impurities. The material shall pass a BS sieve with 5 mm apertures and shall be compacted in an approved manner to the final level of the underside of the slab.

4.22 Weather

All the concrete/mortar is to be protected from the inclement weather by the contractor.

5.0 Painting

The internal paint in the rooms shall be off white or any equivalent colour while the external wall shall not be painted by the brickwork pointed. Below are details for the workmanship for internal wall painting clean surfaces to be painted before applying paint. Remove oil and grease prior to mechanical cleaning. Programme cleaning and painting so that contaminates from cleaning process will not fall onto wet, newly painted surfaces.

Sandpaper smooth finished surfaces to view and dust off. Scrap and clean small, dry, seasoned knot sealer before application of priming coat.

After priming fill holes and imperfections in finish surface with putty or plastic wood-filler. Sandpaper smooth when dried.

5.1 Preparation of Materials

Mix and prepare painting materials in accordance with manufacture's direction of use

Stir materials before application to a mixture of uniform density and stir as required during application. Do not stir surface film into material. Remove film and, if necessary, strain material before using.

Apply paint in accordance with manufacturer's directions. Do not apply the final coat of paint, until film is of uniform finish, colour, and appearance.

Apply first-coat material to surfaces that have been cleaned pre-treated or otherwise prepared for painting as soon as practical after preparation and before subsequent surface deterioration. Allow enough time between successive coatings to permit proper drying. Do

not recoat until paint has dried to where it feels firm, and application of another coat of paint does not cause lifting or lose of adhesion of the undercoat.

6.0 Plumbing

6.1 Materials and Workmanship

All materials and workmanship shall be of best quality and comply with the relevant British Standards and Code of Practice 305 - Sanitary Appliances and 310 Water Supply where applicable.

6.1.1 Coupling Unions

Coupling unions shall be installed at reasonable intervals on vertical and horizontal pipe runs to facilitate erection and dismantling of the pipework without interference to the structure. Similar union connect ions shall be provided for connecting the pipework to all valves, cisterns, electric heaters, etc.

6.1.2 Brackets

Pipework shall be fixed to walls using an approved pattern plastic brackets for screwing into walls or concrete. The brackets shall be such that the pipe is held 25 mm clear of the finished wall surface. Brackets shall be fixed at regular intervals appropriate to the pipe diameter to ensure that the pipe is securely fixed to the wall.

6.1.3 Pipe Sleeves

In all cases where pipes pass through floors or walls, rigid PVC sleeves shall be provided, extending the full thickness of the floor or wall and of bore just sufficiently large for the pipe to pass through.

6.1.4 Valves

Stop valves to BS 1010 shall be used on rising mains; gate valves full way pattern to BS 1952, Type "a", shall be used on pipework to be supplied from water storage tanks. All valves shall be gunmetal.

6.1.5 Manhole Cover and Frames

Cast concrete covers and frames shall be manufactured in accordance with the requirements of BS 49 and shall generally fall into the following categories.

6.1.6 Draw-off Taps

Draw-off tap shall be chromium plated or natural finished gunmetal high-pressure screw down easy clean pattern, threaded for union with crutch handles as BS 1010, fitted with hose union.

6.1.7 Overflow Pipes

Overflows to water storage tank shall be in PVC tubing as specified for service pipes.

Overflow pipes shall be visible externally and shall incorporate a vertical drop of 300 mm as a barrier. They shall project 60 mm beyond, and discharge clear of the wall face. All external overflow pipes shall be painted and fitted with a mosquito proof filter.

6.1.8 Ball Float Valves

Ball float valves shall be suitable for use with the tank specified and the pressure of the mains served and shall he unplasticized PVC pipes in accordance with BS 4576.

6.2 Pipework and Fittings

Pipework and fittings of nominal bore 50 mm and less shall be galvanised steel (GS) to BS 1387 medium weight. Fittings shall be galvanised malleable cast iron to BS 143. Screwed threads shall be clear taper threaded to BS 21.

Pipework and fittings of nominal bore greater than 50 mm diameter shall be UPVC to BS 4514 and of the spigot and socket push fit type, with suitable connections to GS pipework.

Bends shall be used where practicable in preference to elbows. Square elbows will not be accepted. Pipelines shall be straight except at changes of direction, which shall be made using standard fittings. Eccentric reducing sockets shall be used (to facilitate air venting and draining) where changes of diameter are made in runs of normally horizontal pipework.

Pipes passing through walls, partitions and ceilings shall be provided with pipe sleeves. Sleeve sizes shall allow for the free movement of the pipes. Sleeves passing through finished surfaces or exposed to view shall be flush with the surface of the partition through which they pass, and they shall be provided with suitable end covers of approved pattern and finish.

7.0 STEEL WORKS

7.1 Materials and Workmanship

Unless otherwise approved, steel and other metal work shall comply with the following British Standard Specifications:

(a) BS 4, Structural Steel Sections, Part 1, Hot-rolled sections.

(b) BS 639, Covered Electrodes for the Manual Metal-Arc Welding of Mild Steel.

(c) BS 916, Black Bolts, Screws and Nuts.

(d) BS 1083, Precis ion Hexagonal Bolts, Screws and Nuts.

(e) BS 1775, Steel Tubes for Structures.

(f) BS 1856, Metal-Arc Welding of Mild Steels.

(g) BS 2642, Arc Welding of Carbon Manganese Steels.

(h) BS 4395, High Strength Friction Grip Bolts.

(i) BS 4604, High Strength Friction Grip Bolts; and

(j) BS 4360, Weldable Structural Steels.

Working Drawings

The Contractor shall be responsible for the correctness of his shop details and for shop fittings and site connections.

Welding

Welding shall be metal-arc welding complying with the requirements of BS 1856 or BS 2642, as appropriate. All welds shall be continuous. Electrodes shall comply with BS 639.

Welding shall be carried out only under the direction of an experienced and competent supervisor and only certified welders qualified in this class of work shall be employed.

Nuts and Bolts

External bolts and filing rag bolts, nuts and washers shall be sherardized steel. Assembly nuts, bolts and washers on galvanised fittings or equipment shall be galvanised. Sherardizing shall be in accordance with BS 729: Part 2.

Nuts and bolts shall comply with BS 1494 and BS 916 and shall have Whitworth threads to BS 84 unless otherwise approved.

Works Erection

If required by the Engineer, the steel and other metal work shall be temporarily assembled at the place of manufacture for inspect ion by the Engineer and, if considered necessary, for testing before delivery.

Site Erection

The Contractor shall fix the steel and other metal work complete and shall provide and erect all temporary staging and bracing necessary for carrying out the Works.

The Contractor shall be responsible for the accuracy of setting out of all steel and other metal work. He may use shop details and other necessary drawings provided by the supplier. The approval of the Engineer for any such drawings shall not relieve the Contractor of responsibility for the correct fitting of all material.

Before any work on erection is begun on the Site, the Contractor shall submit to the Engineer for his approval the methods he proposes to use for the erection of the steel and other metal work and shall make any arrangements and take any precautions directed by the Engineer.

7.2 Marking of Parts

Steel and other metal work shall be uniquely and indelibly marked to indicate the position and direction in which it is to be fixed.

7.3 Connections

The ends of all columns shall be machined perfectly square and special precautions shall be taken to ensure good bearing at all column splices, etc.

Connections of metal members shall be bolted or welded as shown on the Drawings or approved by the Engineer.

Bolted joints subject to vibration shall be securely locked.

In general, bolted, or welded joints shall not be weaker than the connected members. Members meeting at a point shall, wherever practicable, have their gravity axis meeting at a point to avoid eccentricity.

All steel bases shall be positioned 50 mm above the concrete foundations on steel wedges and after the stanchions have been plumbed and levelled, the intervening space shall be filled with a stiff mixture of cement mortar 2:1.

The contractor shall be responsible for the perfect fitting of all materials supplied and shall replace at his own expense all materials which do not fit.

7.4 General Requirements for Plant and Components

All component parts of the tank/tank platform shall be new, unused, in current production and shall comply with the latest relevant British Standard and other specified standards.

7.4.1 Means of Lifting

All items to be raised shall be provided with adequate means for lifting, and heavy covers and other similar components shall be drilled and tapped for lifting eyes. Parts having spigot joints or otherwise likely to be difficult to separate be drilled and tapped for starting screws unless other easy means of separation are provided.

7.4.2 Design for Low Maintenance

The design of the tank and its accessories shall be governed by the need for long periods of operational service without frequent maintenance and attention being necessary.

7.4.3 Wearing Parts

Components subject to wear shall be indelibly marked with their part number and maker's name and address and be easily accessible. Provision shall be made for taking-up wear in bearings and other wearing parts and for easy replacement if adjustment is not practicable. If during the Defects Liability Period any parts show, in the opinion of the Engineer, signs of

undue wear, corrosion or erosion they shall be replaced at the Contractor's expense notwithstanding that they may be working otherwise in a satisfactory manner.

7.4.4 Suitability for Duty

Except as otherwise specified or app roved, all the tank, stand and accessories shall be rated for continuous service under the most onerous duty conditions that may occur under normal circumstances and shall be effectively protected against damage in the event of overloading arising from the incidence of abnormal working conditions.

Except as otherwise prescribed or approved, all apparatus and components thereof which comprise the Works shall be of tried and proved design and construction which experience has shown to be entirely suitable for service according to the Contract.

7.4.5 Access and Safety Protection

The tank shall include such guards, hand railing, access steel work, walkways, etc., as may be required to meet the current relevant regulations for the safety of personnel and of the tank, and to afford adequate and safe access to all parts of it for maintain ace purposes.

7.4.6 Fixings

The tank and tank stand shall be provided with all the necessary supporting steelwork, holding-down bolts, cleats, fixing. etc., whereby it shall be secured to the structures, the cost of them being included in the prices of the items with which they are associated.

7.4.7 Resistance to Vermin

All supplies under the Contract shall be suitably resistant to or protected against termites and vermin. No organic material shall be used and all seals, grommets, etc., shall be made of neoprene or alternative suitable material.

7.4.8 Identification Labels

Each item the supply (tank, tank stand & accessories) and each sub-assembly for which spare parts may be required, shall have attached to it an un-tarnishable metal or equal approved form of plate clearly showing the manufacture's name, serial number, and basic information as to rating etc, in sufficient detail to allow the component or assembly to be readily identified in correspondence and when ordering spare parts. The foregoing information shall be secured by threaded screws and nuts or equal approved method. Self-tapping screws or soft threaded rivets will not be accepted.

External labels shall be engraved on black plastic with light infill and shall be secured by non-ferrous screws. Internal labels may be like external labels or may be painted and varnished. Adhesive labels shall not be used.

7.4.9 Lubrication

Adequate, and as far as possible means of lubrication shall be provided for all moving parts. Lubricating grease points shall comprise hexagon headed nipples to BS 1486, Part 1.

All lubrication points shall be fitted with engraved plastic labels. Each label shall bear an approved identifying mark showing the frequency of attention required and the lubricant to be employed. Labels shall be so placed as to be clearly visible.

The Contractor shall supply enough quantities of all necessary oils, greases, and electrolytes for the first filling, for use during commissioning and site acceptance trials and for twelve months operation of the plant and shall provide a list of various grades of oil and suppliers for them in Uganda.

7.4.10 Resistance to Corrosion and Abrasion

Where corrosion or abrasion of materials may be expected from contact with water or sediment or from any other cause, the Contractor shall supply suitable resistant materials. Any material showing signs of corrosion or pitting before the expiry of the Defects Notice Period shall be replaced by the Contractor at his own expense with materials to the Engineer's approval.

7.4.11 Noise and Vibration

The Contractor shall make all reasonable provision to reduce noise and vibration to a minimum. All rotating parts of the plant shall be statically and dynamically balanced so that they operate over all specified conditions without undue vibration.

7.4.12 Flanges

All flanges shall comply with BS 4504, unless otherwise stated. The machined faces of flanges shall be coated with a suitable protective composition to prevent their being affected by corrosion.

7.4.13 Protective Coatings

Paint and protective coatings shall be sufficiently durable to withstand normal wear and tear without excessive deterioration or damage and without frequent maintenance painting or other treatment being necessary.

Non-ferrous valves and parts which are to be built into the structure shall not be painted.

Before leaving the Contractor's works the surface condition of all painted items shall be checked and any defect made good.

Bright surfaces shall be covered with a suitable lacquer which shall he removed by the Contractor on site, machine finished surface shall be coated with preservative before shipment or being exposed to the open air.

On completion of erection and test the external surfaces of all items not painted to finish in the works shall be cleaned and finishing coats applied.

Damaged stove (baked) enamelled surfaces shall be made good to the satisfaction of the Engineer and enough "touching in" paint shall be supplied by the manufacturer of the equipment at the time of shipment.

If in the opinion of the Engineer, the painting is unsatisfactory, the paint shall be removed, and the surfaces thoroughly cleaned and repainted at the expense of the Contractor. Only approved non-toxic and odour free paint shall be used for coating of internal surfaces of water pipelines and similar equipment.

7.4.14 Suppliers of Materials

Before ordering an item of any description under this contract, intended for the Permanent Works, the Contractor shall submit for the approval of the Engineer the name of the manufacturer or supplier proposed and the details of the place of origin and specification of the material. If requested by the Engineer, the Contractor shall supply to the Engineer for his retention a copy of each order placed.

The Contractor shall confirm with the Engineer the length of the pipe straight specials before placing order for the items.

7.4.15 Natural Materials

The Contractor shall make all arrangements for locating, selecting, and processing natural materials to comply with the specification and shall submit to the Engineer for approval, full information regarding the proposed location well in advance of commencement of working of the material. Approval of a source does not imply that all material in that source is approved.

7.4.16 Compatibility of Materials

It shall be the Contractor 's responsibility to ensure that all materials supplied under this Contract are compatible with each other unless specific adjacent materials have been specified herein or shown on the drawings. For example, form oil and curing compounds used shall be compatible to the damp proofing materials and paints that are applied shall also be compatible with the original parts that are being painted over.

The Contractor shall be required to correct at his own expense any defective work cause by the non - compatibility of materials.

7.4.17 Sampling and Testing of Construction Materials

The Contractor shall provide for the approval of the Engineer samples of all construction materials and manufactured items required for the Permanent Works, if ordered. All material rejected by the Engineer shall be removed from Site. All approved samples shall be

stored by the Engineer for the duration of the Contract, and any materials or manufactured items subsequently delivered to Site for incorporation in the Permanent Works shall be of a quality at least equal to the approved sample.

7.4.18 Inspection, Rejection and Protection of Materials and Equipment

The Contractor shall submit to the Engineer full information as to materials, fittings and fixtures and arrangements which the Contractor proposes to finish or make. This information shall be submitted in a form approved by the Engineer to determine if the proposed materials, equipment, and arrangements will meet the Contract requirements.

Insofar as practicable, inspection of material, plant and equipment will be conducted jointly by the Contractor and Engineer before delivery to the site. Costs associated with much inspection shall be included in the Contractor's rates.

In addition, the materials supplied by the Contractor for the performance of the work shall be inspected by the Engineer at the time of delivery to the Contractor and at such other times before use, as the Engineer may elect, and materials rejected after delivery to the Contractor shall be returned to the point of delivery by and at the expense of the Contractor. All work done by the Contractor shall also be subject to the inspection of the Engineer and defective work repaired or replaced as directed. Facilities for the handling and inspection of materials and work shall, always, be furnished by and at the expense of the Contractor, who shall provide suitable and adequate storage room for materials during the progress of work and be responsible for any loss of or damage to materials stored therein.

The Contractor shall also be responsible for any loss or damage to materials or equipment until the final acceptance of the completed work.

Any work done by the Contractor prior to a review by the Engineer, or the construction methods, materials, and equipment to be employed by the Contractor, or not in accordance with the Contractor's approved construction schedule, shall be considered to have been done without the consent of the Engineer.

The review of the information covering materials, equipment and arrangements by the Engineer shall in no way release the Contractor from his responsibility for the proper design, installation and performance of any material, equipment, or arrangement or from the liability to replace same should it prove defective or deficient.

7.4.19 Coatings

Cleaning ffollowing fabrication, parts will be thoroughly cleaned by a power wash-rinse process followed immediately by hot air drying.

Surface Preparation

Following the wash-rinse and drying, the parts will be steel grit-blasted to the equivalent of a near-white finish SSPC-SP10-63T.

The surface anchor pattern will not be less than 1.0 mil (25 microns)

Coating

All parts must be coated within 30 minutes after blasting and no shaping, bending, punching, flanging, or grinding may be done on the steel after blasting and before coating. Interior coatings must be certified for potable water usage.

Inspection

All coated parts are to be inspected prior to shipment and marked with a part number which will correspond to the appropriate tank erection drawings to clarify and simplify tank assembly.

All coated sheets and parts are to be inspected for colour uniformity.

A representative sampling of coated sheets is to be inspected in accordance with AWWA D103, Section 10.5.3 to verify minimum coating dry film thickness.

All scratches or defects in the factory applied coating that are noted in the field are to be removed and repaired at the discretion of the engineer.

7.4.20 Steel doors for Pump house.

Pump House.

The door for pump house shall be steel grilled door (2000x2650mm) double leaf with permanent vent over. All these shall be welded with Hollow Section mild steel. With frame of 60x60x3mm and the grills with 30x20mm. The louvres shall be 1.5mm. This will be provided with a locking mechanism that will be such that one can easily bolt from inside and from outside as shown in the ***drawings number 6***.

7.4.21 Elevated Tank

The levels of the finished tanks must be precisely in accordance with the levels shown on the drawings. All support towers shall be set on concrete foundation slabs which also support all fittings and valves at ground level. Support towers shall be of RC Columns and slabs as specified below.

All tanks shall be fitted with pipes as shown on the drawings. The overflow shall be fitted below the level of the supply valve. The tank drain may be connected to the overflow drain via an appropriate gate valve. All tanks shall be fitted with a drain to allow them to be completely emptied.

Flow into the tank shall be controlled by a float-operated valve. Outlet services shall be taken from the bottom of the tank, and the outlet opening(s) shall be situated higher than the drain opening.

All tanks shall be fitted with float level indicators which shall be easily readable from the ground Covers:

All tanks shall be equipped with covers to protect the contents. The covers shall be suitable for all loading types including those imposed by men on maintenance and other duties.

Covers shall be adequately ventilated to prevent the build-up of pressure or vacuum inside the tank. Ventilation shall be mosquito proof. Covers shall be of such dimensions as to allow entry into the tanks for servicing and maintenance.
Ref drawings no. 6 for tank and tank installation details.

Water Tanks (storage reservoir)

High density Polyethylene tanks of 8,000ltrs capacity (132kgs and 2430x2170mm) shall be installed as reservoirs for water storage. The tank shall have an overflow, inlet, and outlet; installed as per the ***drawings in number 6***

Appurtenances

Unless otherwise noted, standard appurtenances will be as follows:

Nozzles

Tank nozzles will be bolt-on for field installation and will include all necessary hardware and gaskets for attachments to tank. Nozzles will have a minimum 150mm projection from tank wall.

Outside Tank Ladder

Outside tank ladders will be vertical and in accordance with applicable safety standards. All required rest platforms and safety cages will be included. Ladder and safety cages will be hot dipped galvanized.

Overflow

Provide a tank overflow to ground level, supported at proper intervals with suitable brackets. The overflow pipe will terminate with an elbow at the bottom.

7.4.22 Permanent Fencing

Fencing for the intake and reservoir/water tank shall be chain-link of gauge 10 and barbed wire G14 as ***per drawing number 7.*** The pole (100x100) shall be made of concrete of mix 1: 1.5: 3/ 15mm aggregates. Effective height (above the ground) of the pole shall be 1800mm with a 45° bent of 300mm for razor wires of gauge 24 blade shall be provided.in three lines as per the drawings. The spacing of the concrete pole shall be 2000mm centre to centre

Gate

The gate for the intake and for reservoir shall be 2000mm in width and height of 2300mm. The Main frame of the gate shall be hollow section 100x100mm of 6mm thick and the secondary members shall be hollow section of 50mm galvanized steel tubing; refer to drawing no. 4 for details of the same. The whole gate shall be hinged on hollow section steel post of 100x100mm and 6mm thick erected vertically in concrete of 1:2:4/20mm aggregate. The steel post shall be embedded in a 420x420mm RCC as per the drawings number 2.

10.0 ENERGY PACKAGE COMPONENTS

10.1 Solar-PV System Specifications

10.1.1 General introduction

This section covers the specification of works for the abstraction of water from the source using solar energy related equipment here collectively referred to as Solar Photovoltaic [SPV] water pumping system/plant. The modules, panels and array shall be referred to as Solar-PV modules, -panels and - array respectively.

When designing and installing the system, the following precautions shall be considered.

- The proposed pump site shall be examined to determine its suitability for the installation.
- It should be noted that Uganda lies within the tropics; hence the solar panels require a south/north facing location pointing to the equator.
- Suitable locations shall be found for the water pump (surface), controllers, storage tank and other system components.
- The solar array shall be as close to the pump as much as possible to minimize wire size [voltage drop precautions] and installation cost.

General specifications for SPV plants

Structural Robustness: All components of the Solar-Photovoltaic (SPV) power plant shall be robust, neatly assembled, firmly fixed supports in ground and designed to allow easy access using adequate tools. The SPV power plant shall have a minimum useful life of 20 years, with solar modules warranted for 25 years.

Protection against Corrosion and rusting: All components and accessories shall be made from corrosion resistant material and made good to be rust-free by galvanizing and or painting of all surfaces. that are exposed to the ambient conditions. All materials shall be resistant to effects of excessive moisture, water, and ambient temperature. Resistance to corrosion shall be according to DIN 8985 standards.

Protection against thefts: All equipment, parts and accessories shall be well designed and fastened against theft, with considerable difficulty to un-screw the solar modules or metal parts from the entire assembly.

Abbreviations

For the purposes of these Technical Specifications, the following abbreviations shall apply:

A.C: Alternating Current **D.C:** Direct Current **DOD:** Depth of discharge

e.m.i.: Electromagnetic interference

kWp: Kilo Watt-Peak

MCB: Miniature circuit-breaker

NOCT: Normal Operating Cell Temperature *(irradiance level: B00W/m2, Ambient temperature:* 200C,

AM1 .5 spectrum, wind velocity: 1m/s)

PV: Photovoltaic

SOC: State of charge

STC: Standard Test conditions *(irradiance level: 1000Wl m2, Ambient temperature:* 25°C, *AM1.5 spectrum)*

SPV: Solar Photovoltaic

SPVP: Solar Photovoltaic Power

Wp: Watt-Peak

10.2 Specifications of Solar-PV Modules, Panels and Array

10.2.1 General Electrical and Mechanical Performance

The following forms a guide on the equipment specifications required for this project. The bidder MUST provide on supply, the equipment datasheets detailing equipment characteristics and features.

Only certified Polycrystalline and Mono-crystalline silicon modules are generally acceptable. The modules should be certified for compliance with the following specifications:

- International Electro-technical Commission (IEC) 61215/61646 - 1993, Crystalline silicon terrestrial photovoltaic (PV) modules - Design qualification and type approval (or most recent edition)

1 Number of tthunderstorm days per year

- Uganda standard US-469: Crystalline silicon terrestrial photovoltaic (PV) module - Design qualification and type approval (US-469:2005, 1st edition)

- Uganda standard US-564: Crystalline silicon terrestrial photovoltaic (PV) module - Design qualification and type approval (US-564:2005, 1st edition)

10.2.2 Solar-PV Modules

These shall be constructed from high efficiency mono or multi-crystalline silicon with minimum cell efficiency of 16%. Crystalline silicon cells and modules to be supplied shall be approved to IEC 61215 standards with an EN-ISO certificate, JCRC-ISPRA 503, PV-GAP, UL

listing 1703, NEC 2008 compliant or similar quality type approval. The pertinent conditions are solar irradiance of 1000W/m2, Normal Testing Conditions (STC), Normal Operating Cell Temperature (NOCT) of 25°C.

The PV modules shall have a minimum warranty of Twenty (20) years on performance and materials, with 10% degradation after 10-years (90% nameplate rated power capacity available after 10-years) and 20% degradation after 25 years (80% nameplate rated power capacity available after 25-years).

The entire laminate of the module shall be installed in an anodised aluminium frame for structural strength and ease of installation.

The PV Modules shall be clearly labelled and permanently marked with a data plate containing the following information: manufacturer's name and physical address, type/model number, the watt-peak power rating at STC, open circuit voltage and short circuit current, voltage and current _at maximum power point, tolerance and temperature coefficient, country of manufacture, certification, e.g: UL listing, IEC 61215, ISO certification, with fool-proof +ve/-ve connectors.

NOTE:

I) The Engineer reserves the right to test the modules for qualification and performance characteristics with respect to these specifications. Performance characteristics established by the methods set out in the above specifications shall be used to verify the output of the modules to meet the system performance requirements.

11) Each module shall have a unique serial number inside the module encapsulation (i.e. stickers with serial number are not acceptable). Also, to be included within the encapsulation is the name of the project, name of client and date of manufacture of the solar module.

The acceptable tolerance shall be +5%-3% respectively for all modules supplied under this contract. The modules to be supplied shall comply with or even perform better to the following temperature coefficients:

- aPmpp: - 0.6%/°C
- aVmpp: - 100mV/°C
- al sc: *+2mN °C*
- aV oc: -1 00mV/°C SPV cells in each module

Each module shall be assumed to deliver nominally 1000VDC with the maximum power DC voltage of minimum 37.6VDC.

Modules shall be suitable for operation in high temperature environment. The minimum number of series-connected cells in each mono- or poly-crystalline module shall be 72 cells for 1000VDC modules and 60/72 cells for 24V modules.

10.3 PV Module Installation and Accessories

10.3.1 PV module interconnection

Wiring shall be permanently shaded from UV radiation. Wiring shall be 'Flexible multi-strand copper conductor cables in flexible UV resistant (e.g., Neoprene) sheath compatible with gland seals', with array junction boxes as may be required.

The arrangement of modules on the structure and their interconnection shall be designed to enhance servicing and inspection:

10.3.2 Module or Array Mounting

10.3.3 Structure Assembly

The solar Modules shall be supported on a welded structure erected above the tank and shall slope at 15°C facing the equator. Lock shall be provided to check on theft. *Please refer to drawings Number 6*

10.4 Installation of Array Structure

10.4.1 Orientation and tilt of the PV array

The structure shall be orientated to the south, although this might not be critical. The installer shall note the deviation of magnetic north from true north. The array shall tilt at least 10-15 degrees and not more than 15 degrees from horizontal, to allow water and dust to freely wash off the array.

The figure 2 below shows the tilt and orientation of ground-mounted solar arrays.

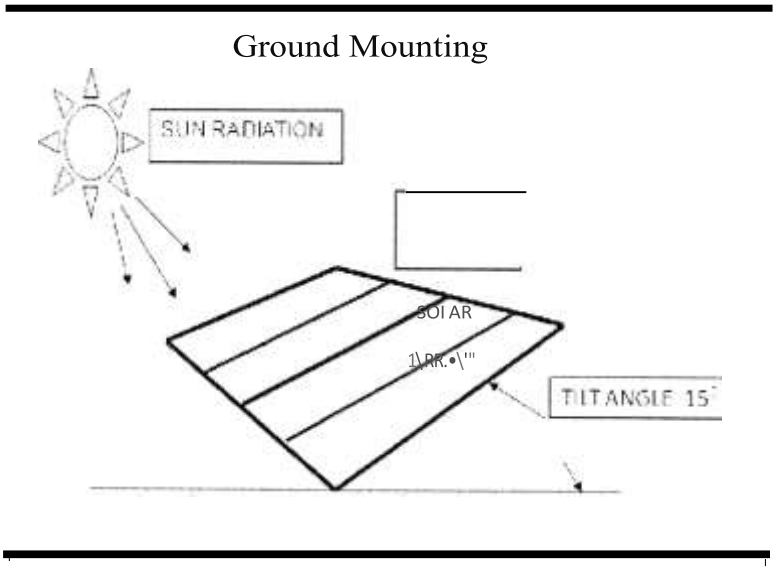

Figure 2: Tilt and orientation of solar arrays

10.4.2 Quality of installation

Ground Mounting structure: Ground mount structures shall be reinforced concrete as specified in sections 2.20 and as shown in the append ices

Roof mount structures: Roof mount structures shall be attached to purlins using through-roof J-bolts. J-bolts to penetrate roof only on high point of corrugations, and to use sealed compression glands on both inside and outside to prevent leakage.

Alternatively, anchored threaded studs to be drilled to maximum 10mm (do not understand 10mm) so as not to pierce roof shield, and cause leakage.

Repairing damage made: Any surface damage to galvanising shall be treated with either Galvadip™, Adensotape ™ or Petrotape ™ systems, or other approved cold-galvanising treatments.

Any holes made in the roof material shall be sealed and made waterproof with approved UV resistant material.

Array junction box and wiring: The array junction box must be mounted squarely and accessibly on the array mounting structure.

Wiring shall be UV resistant and should be shaded where possible, or protected with UV-resistant or

painted conduit.

Array structure earthing: PV module frames and array structures shall be properly earthed in accordance with specifications of Section 2.2.8

10.4.3 Solar array (PV) disconnect switch

For PV-direct systems, a two-pole disconnect switch must be installed between the solar array and the controller. The loading of the switch shall not exceed 70% of the nominal capacity-this will allow for system expansion. The switch shall comply with relevant clauses of the IEEC/IEC and UNBS (Uganda National Bureau of Standards) standards for DC electrical systems.

10.5 Electrical wiring

All electrical wiring shall be in accordance with the IEC/IEE and UNBS (Uganda National Bureau of Standards) standards for Photovoltaic systems. Specific clauses of US152: 2000 sections 4.0 and 5.0, shall respectively apply to all DC-wiring requirements, including all cabling, terminations and voltage drops. A voltage drops exceeding 3% of nominal supply voltage across each input/output system component shall not be permissible.

10.5.1 Cables and Interconnections

[a] Cables

All cables shall be UL type TC, 600V, 90°C with PVC sunlight resistant jacket and include corrosion resistant, non-metallic, liquid-tight cable strain relief connectors or approved UNBS/IEC equal, with overall lengths pre-sized for best appearance.

Two-wire cable assemblies are red and black conductors used for 12V system parallel connections on 24V or 48V systems. Three-wire assemblies red/black/blue conductors used for 24/48V series/parallel connection of the last module in a 4-panel assembly. Four-wire assemblies red/yellow/blue/black used for 415VAC 3-phase system.

[b] Submersible cable

Use of a good grade of 4-conductor submersible pump cable is recommended. Each wire must be sealed 100% watertight. A high quality, waterproof connection between the pump wires and supply cable is especially important. Electrical cable tables can be used to select the appropriate cable size for use with respect to the distance, voltage and current values involved.

[c] Interconnections

An important part of the system wiring is proper module connection that exhibits the highest degree of reliability and performance in severe climates and environmental conditions.

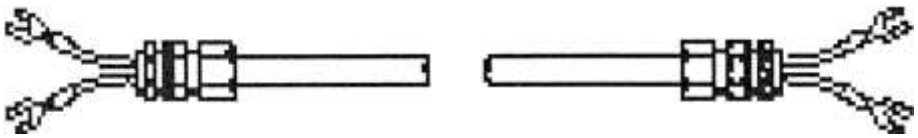

FIG.3: Cable Interconnects - illustrates a standard module interconnection accessory.

Figure 3: Cable Interconnects

All such interconnections shall be pre-assembled, featuring tin-plated copper folk terminals for stud, crimped, and soldered to AWG stranded copper wire with adhesive "melt-wall" shrink tubing heat sealed

over the crimp connection or an equally approved interconnection.

10.5.2 **Guarantee and Warranty requirements**

The contractor shall issue the water pumping system guarantee certificate for a period of two (2) years, under which defects liability conditions shall be applied as required by the General Conditions of Contract.

Further still, as a contract requirement, the contractor shall as well furnish warranty certificates for each major component (solar-PV modules, Inverter, Water Pump) obtained from the equipment manufacturers. The warranty certificates for solar-PV modules, inverters and pumps shall be Twenty-Five (25) years, five (5) years and Two (2) years respectively

It should be noted that solar-PV modules shall have guaranteed capacity for minimum 25-years, such that, 10% degradation is expected after 10-years (available power output is 90% of rated capacity after 10years) and 20% degradation is expected after 25 years (available power output is 80% of rated capacity after 25 years).

10.6 Specifications of Pumps for water abstraction

10.6.1 Ground Water Pumps

The borehole pump shall be of solar submersible-multistage-centrifugal type, made up of an AC motor constructed from high grade Marine Bronze and 304 Stainless steel or approved equivalent metal material. All metal material used for pump construction shall be corrosion resistant, permanently lubricated and maintenance free. *Please see details in the PV & Pump Sizing Report*

For solar systems, a water pump equipped with a variable frequency/speed induction motor is highly recommended.

10.6.2 Motor end

The motor end of the water pump shall be constructed with the following features:

- corrosion-resistant, all stainless-steel exterior construction
- stainless steel splined shaft
- NEMA mounting dimensions
- hermetically sealed windings
- water lubrication
- pressure equalizing diaphragm
- ***Refer to the PV and Pump sizing reports (together with the Design Drawings), attached for the respective locations, for details of the submersible pump.***

10.6.3 Pump end

The Pump end of the water pump shall be constructed with the following features

- centrifugal multistage direct-coupled pump end
- non-return valve
- material: stainless steel (AISI 304), rubber
- dry running protection (a must)

- Able to withstand maximum sand content: 50 g/m3, a higher content will wear the pump and reduce its life span considerably
- **Refer to the PV and Pump simulation report for details of the submersible pump.**
- high life expectancy and very low maintenance requirements

10.7 Grounding and lightning surge protection

10.7.1 Grounding and bonding

All the structural components and electrical enclosures shall be bonded together to a common earth connection. When connecting dissimilar metals, connectors that are approved for the materials involved should be used. (Example: at the aluminium framework of the solar array, connectors labelled "AL/CU" are used).

10.7.2 Earth connection

An effective discharge path for the surge should be created. One or more 8-foot (2.5m) copper-plated ground rods, preferably in moist earth, should be installed. Where the ground gets very dry (poorly conductive, #6 (16 sq. mm) or double #8 (10 sq. mm) or larger bare copper wire shall be buried in a trench at least 100 feet (30m) long. Connection to one end to the array structure and controller should be done or, the ground wire should be cut in half and spread in two directions. The figure 3.4 below shows how grounding and lightning protection can be implemented on a solar-PV site.

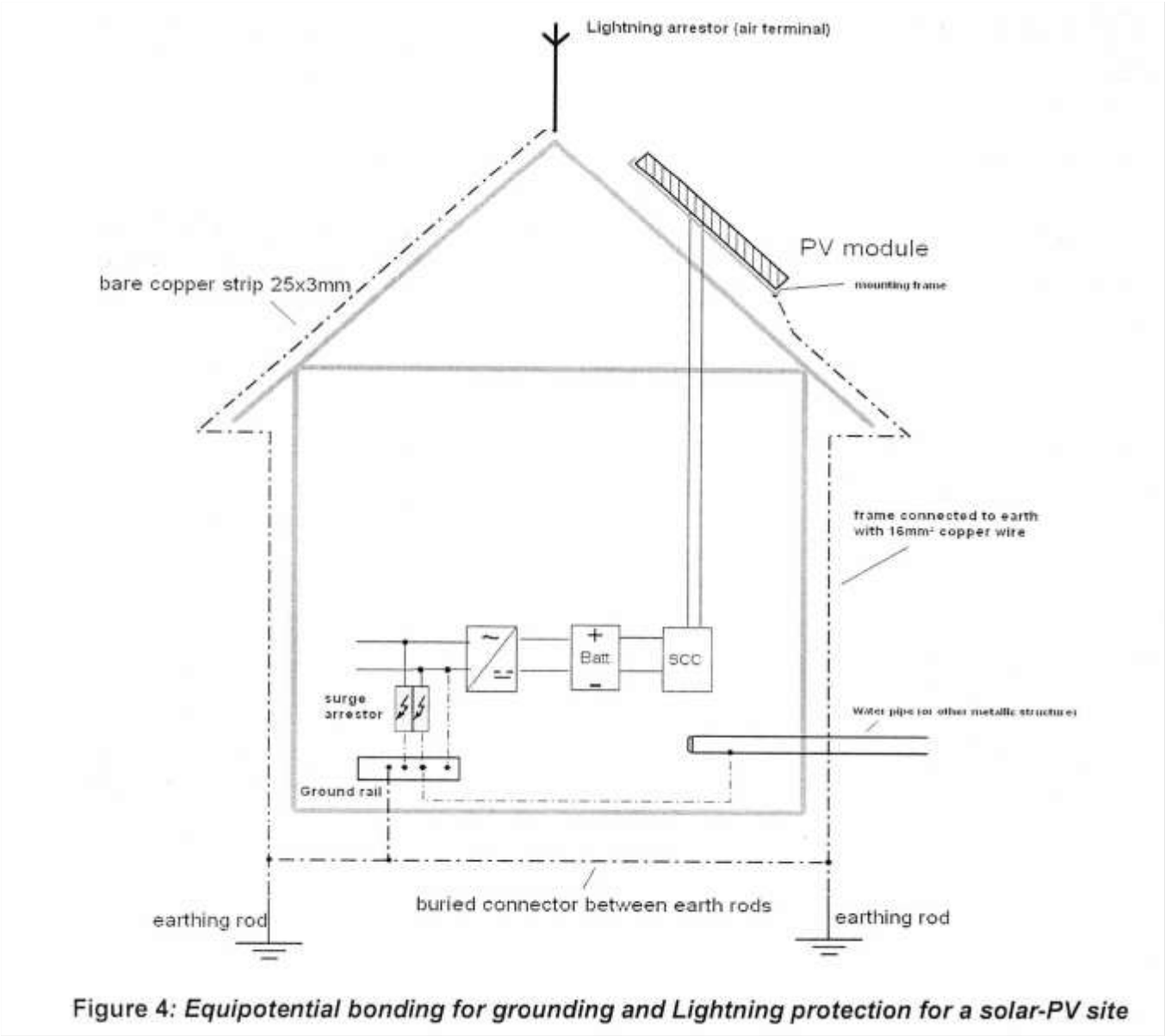

Figure 4: *Equipotential bonding for grounding and Lightning protection for a solar-PV site*

10.8.1 Grounding the pump

The ground wire shall be connected to one of the ground connections in the controller, or to the controller enclosure. Grounding helps to prevent shock hazard if there is a fault in the motor.

Additional grounding measures or surge protection devices are recommended under any of the following conditions:

- Isolated location on high ground in a severe lightning area
- Dry, rocky, or otherwise poorly conductive soil
- Long wire run (more than 100 feet/ 30m) from the controller to the pump, or from the controller to the float switch.

10.8.4 Lightning Protection

The lightening arrestor and associated equipment supplied for this purpose shall be in accordance with the IEC/IEE regulations. The external and the internal protection require a good earthing system to evacuate the lightning currents, and equal potentiality within the earthing system, both protection system and of the electrical circuits to be protected.

Lightning arrestors of type Fast response Silicon Oxide Varistor in potted PVC case may as appropriate be used or copper arrestor with the copper tape and ground rod are recommended for use.

10.8.5 Surge protection

For the electrical system has to be implemented by using a single-pole surge arrestor with rated line- neutral operating voltage of 275Vac, voltage protection level at 5kA is 1kV, with 25ns response time; certified to IEC 61643-1 standard. The surge arrestor system is implemented as shown in the diagram in figure 3.5 below in accordance with EDIN VOE 0675-6:1989 -11, -6/A1:1996-03, and -6/A2 :1996-10 standards.

10.9 Other Balance of System equipment

10.9.1 Wellhead assembly for borehole wells

The well seal is a plate that fits on top of the well casing. It shall be used to provide a seal against contamination of the well, and it supports the weight of the in-well assembly.

Use of metal pipe components above ground, for strength is recommended. A tee and a plug shall be used instead of an elbow because the plug allows direct observation of water level and flow. It also provides a place to attach a lifting device.

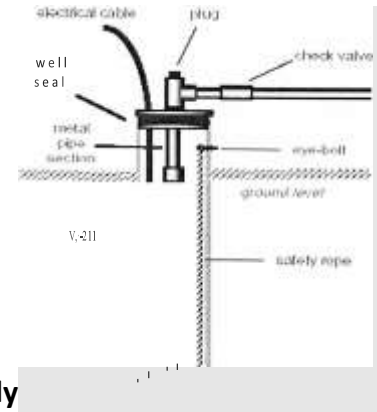

Figure 5: Well head assembly

10.9.2 Well Probe for dry run protection

The purpose of the well probe is to sense the loss of water just above the pump, so that the pump will shut off and not run dry. Runn ing dry damages the pump. The submersible pump

supplied shall be installed with this accessory included. It shall be made from corrosion free and algae resistant material.

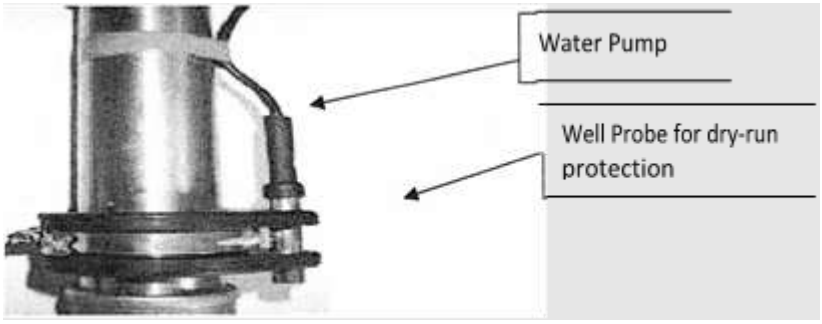

Figure 6: Well Probe for dry run protection

Dry-run protection monitor (optional): Electronic device that provides for monitoring of current, voltage and motor temperature using three integrated current transformers. A digital display provides current and voltage readings for all three legs and allows the user to set up the monitor quickly and easily. Data can be downloaded to a PC.

The monitor can protect the pump against adverse conditions such as low-yielding wells, pump damage, clogging, bound pumps, and power mishaps. It is designed to protect three-phase motor and pump systems with ratings between 3 and 200 hp with 3 seconds response time. An example of such a monitor is the Franklin Electric "SubMonitor ".

10.9.3 Draw Pipe

Larger pipe sizes shall be used to reduce friction loss on long horizontal runs. Larger sizes shall be avoided in vertical runs because sand in the water may settle and cause blockage. Smaller sizes should not be used because of high friction losses. Plastic pipe is preferred for all pumps because the smooth surface of the pipe reduces friction losses and provides a cushioning effect.

10.9.4 Sand Shroud

This device is used when dirty water conditions are experienced. The sand shroud eliminates destructive sand intrusion and is constructed of rugged PVC and Polyethylene for long life.

10.9.5 Photovoltaic Modules

The solar modules to be supplied and the overall solar-array installation shall be in accordance with the relevant clauses of section 3.1 and 3.2 above.

10.9.6 Solar (PV) array disconnect switch

The PV disconnect switch supplied for use with PV systems shall bear manufacturer's PV quality mark, PV GAP, UL, or any other accredited testing laboratory PV Quality mark. The fuses shall be appropriately sized (defined as 1.25 x IMAX@ STC] for fault protection, arising from the array.

10.10.3 Power Controller/Regulators

The power controller or regulator refers to the complete charge/discharge regulator system unless specific reference is made to the separate parts. It shall be used for purposes of controlling charging arid discharging of Battery.

Compatibility: The regulator shall be compatible with the batteries offered for optimal battery cycling life. The regulator function shall protect the battery from over-charging and over-discharging.

Charge control: The regulator to be supplied shall have the multi-stage (boost/float) method of charge control as required for flooded batteries.

The load-shed settings shall be dependent on the battery type specified, load and system design. The Engineer prior to approval shall confirm set points.

Voltage set-points: The voltage set-points shall be adjustable in the factory before dispatch. The voltage set-point adjustment applies particularly to load-shed disconnect, and load-shed reconnect set- points. This is critical to ensure that the 'dual-priority load-shedding and subsequent reconnection occurs in the intended manner. Load shedding shall be set at maximum battery DOD of 60%.

Protection: The regulator shall be protected against the following electrical occurrences:

- Over-voltage conditions if the battery is disconnected,
- Lightning induced surges, with protection either internal or external.
- Regulators shall be mechanically robust and corrosion proof.
- Reverse polarity protection is desirable

Efficiency and energy consumption: The charge regulator energy efficiency shall be high under all operating conditions. The energy loss through the charge regulator from the array input to the battery terminals of the regulator rated current shall not exceed 3% of the nominal input value during system operation and load shading.

10.10 Quality Assurance

A. The CONTRACTOR shall provide a vertical, high density cross-linked polyethylene tank with full drain capability and ability to attach pipe fittings and connections. The flat bottom, upright, cylindrical tanks molded in one-piece seamless construction by rotational molding furnished under this Section shall be supplied by Poly Processing Company or approved equivalent, who has been regularly engage in the design and manufacture of storage tanks for over 10 years.

B. Tanks shall be manufactured from virgin materials.

C. Tanks shall be manufactured from materials certified BS/European standards for chemical /water storage.