Government of Nepal

Ministry of Irrigation

**Department of Irrigation**

**Irrigation and Water Resources Management Project (IWRMP)**

**Irrigation Infrastructures Development & Improvement (AF), Component-A**

**(Word Bank Project ID: P144474)**

# DTW Electro-mechnical Design, Installation and Operation

**CMS Engineering Consult Pvt. Ltd.**

**Full Bright Consultancy Pvt. Ltd. JV**

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## Contents



## List of Figures

## List of Annexes

## Abbreviations

| | |
|---|---|
| AMIS | Agency- Managed Irrigation System |
| AO | Association Organizer (Social Worker) |
| CBO | Community Based Organization |
| DADO | District Agriculture Development Office |
| DDC | District Development Committee |
| DDG | Deputy Director General |
| DG | Director General |
| DHM | Department of Hydrology and Meteorology |
| DIO | District Irrigation Office |
| DoA | Department of Agriculture |
| DoI | Department of Irrigation |
| DTL | Deputy Team Leader |
| DTT | District Technical Team |
| DTW | Deep Tube Well |
| DWRC | District Water Resources Committee |
| EIA | Environmental Impact Assessment |
| FMIS | Farmers Managed Irrigation System |
| FY | Fiscal Year |
| GIS | Geographical Information System |
| GMIS | Geographical Management Information System |
| GoN | Government of Nepal |
| GW | Groundwater |
| GWID | Groundwater Irrigation Directorate |
| GWIDD | Groundwater Irrigation Development Division |
| ha | hectare |
| ICWMP | Integrated Crop and Water Management Program |
| IDA | International Development Association |
| IDD | Irrigation Development Division |
| IDSD | Irrigation Development Sub Division |
| IEE | Initial Environmental Examination |
| ISE | Initial Social Examination |
| ISEA | Integrated Social and Environment Assessment |
| ISF | Irrigation Service Fee |
| IWRMP | Irrigation and Water Resources Management Project |
| M&E | Monitoring and Evaluation |
| MIS | Management Information System |
| MoA | Ministry of Agriculture |
| MoF | Ministry of Finance |
| MoI | Ministry of Irrigation |
| MTR | Mid Term Review |
| MWDR | Mid Western Development Region |
| NGO | Nongovernmental Organization |
| NISP | Nepal Irrigation Sector Project |
| NPC | National Planning Commission |
| O&M | Operation and Maintenance |

| | |
|---|---|
| OPD | Office of the Project Director |
| PAD | Project Appraisal Document |
| PBME | Project Beneficiary Monitoring & Evaluation |
| PC | Project Coordinator |
| PD | Project Director |
| PICC | Project Implementation and Coordination Committee |
| PIM | Project Implementation Manual |
| PIU | Project Implementation Unit |
| PMU | Project Management Unit |
| PSC | Project Steering Committee |
| RAC | Regional Appraisal Committee |
| RAD | Regional Agriculture Directorate |
| RD | Regional Director |
| RfP | Request for Proposal |
| RID | Regional Irrigation Directorate |
| RPSU | Regional Project Support Unit |
| SAC | Sub-project Appraisal Committee |
| SBD | Standard Bidding Document |
| SDE | Senior Divisional Engineer |
| SEA | Social and Environment Assessment |
| SEMP | Social and Environmental Management Plan |
| SMU | Sub-project Management Unit |
| TA | Technical Assistance |
| ToR | Terms of Reference |
| WB | World Bank |
| WUA | Water Users Association |
| WUG | Water Users Group |

# 1 DESIGN AND SELECTION OF SUBMERSIBLE MOTOR PUMPSET (WORKED EXAMPLE)

## 1.1 Calculation for Capacity (Power) of Submersible Motor Pump Set

(Discharge = 40 lps and Dynamic water level = 4.50 m)

### *1.1.1 Calculation of Total Head (H)*

a) Static Head ($H_s$) m:

| | | |
|---|---|---|
| Dynamic water level (below ground level) (m) | = | 4.5 |
| OHT height from G.L. (m) | = | 7 |
| Total (m) | = | 11.5 |

b) Friction Loss (Head Loss) ($H_f$) (m):

i Loss of head due to friction in pipe ($H_p$)

Formula: Darcy Weishbach's

$H_p = (4flv^2)/(2gd)$

where,

f = coefficient of friction for the pipe [ f= 0.0005 X ( 1 + 1/(40 X d)) ]
l = total length of pipe (m)
v = velocity of water (m/sec)
g = acceleration due to gravity = 9.81 m/sec$^2$
d = inner diameter of the pipe (m)

and given,

d = 0.15 m Q = 40 lps = 0.04 m$^3$/sec
g = 9.81 m/sec$^2$ l = 40m
f = 0.005(1 + 1/(4 x 0.15)) = 0.0134

Water velocity (v) = Q/A = Q/($\pi d^2$/4) where A = cross-sectional area of the pipe
v = 0.04/(3.14 x 0.15$^2$ / 4) = 2.26 m/sec

$H_p$ = 4 x 0.0113 x 40 x 2.262 / (2 x 9.81 x 0.15) = 3.14 m

ii Loss of head due to friction in sluice (gale) valve ($H_s$), (m):

$H_s = Kv^2/(2g)$ = 1.50 x 2.262/(2x9.81) = 0.39m

where,

K = coefficient depends on the type of pipe fittings and their inner roughness of the surface

iii Loss of head due to friction in non-return valve ($H_n$), (m):

$H_n = Kv^2/(2g)$ = 2.5 x 2.26$^2$/(2x9.81) = 0.65m

iv Loss of head due to friction in Tee ($H_T$), (m):

$H_T = K\ v^2/(2g)$ = 2.0 x 2.26$^2$/(2x9.81) = 0.52m

v Loss of head due to friction in 90° Bend ($H_b$), (m):

$H_b = K\ v^2/(2g) = 1.5 \times 2.26^2/(2 \times 9.81) = 0.39$m

Say, number of bends = 3 nos, then

$H_b = 3 \times 0.39 = 1.17$ m

vi Therefore, Total Friction Loss ($H_f$), (m)

$= H_p + H_s + H_n + H_T + H_b$
$= 3.14 + 0.39 + 0.65 + 0.52 + 1.17$
$= 5.87$ m

c) Velocity head ($H_v$), (m) = $v^2/2g = 2.26^2 / (2 \times 9.81) = 0.26$ m

d) Annual fluctuation ($H_{fl}$), (m), say = 5 m

e) Residual Head ($H_r$), (m), say = 2 m

f) Total Head (H)

for Discharge = 40 lps and Dynamic water level = 4.50 m

| **Head Component** | **Qty (m)** |
|---|---|
| Static Head | 11.5 |
| Total Friction Loss | 5.87 |
| Velocity Head | 0.26 |
| Annual Fluctuation, say | 5 |
| Residual Head, say | 2 |
| **Total** | **24.63** |
| Safety Margin, say, 30% | 7.389 |
| H | 32.019 |

**say, H = 32 m**

*1.1.2 Calculation for Capacity (Power) of Submersible Motor Pump Set*

| | | **Description of Capacity (Power)** | | |
|---|---|---|---|---|
| | | **Water Power ($P_w$)** | **Pump Power ($P_p$)** | **Motor Power ($P_m$)** |
| Specfic Weight of Water | ($kg/m^{3)}$ | 1000 | | |
| Acceleration due to gravity | ($m/sec^2$) | 9.81 | | |
| Design Discharge | ($m^3/sec$) | 0.04 | | |
| Total Head | (m) | 32 | | |
| Efficiency of Pump | $\eta_p$ (%) | 75% | | |
| Efficiency of Motor | $\eta_m$(%) | 84% | | |
| Formula for calculation of power | | $P_w = \rho*g*Q*H$<br>= 1000x9.81x0.04x32<br>= 12.56 kW | $P_p = P_w/\eta_p$<br>= 12.56/0.75<br>= 16.75 kW | $P_m = P_p/\eta_m$<br>= 16.75/0.84<br>= 19.94 kW |
| **Capacity (Power) of (kW)** | | | | |
| Water ($P_w$) | | 12.56 | | |
| Pump ($P_p$) | | | 16.75 | |
| Motor ($P_M$) | | | | 19.94 |

### *1.1.3 Calculation of 11/0.4 kV Distribution Transformer*

| | |
|---|---|
| Motor Power ($P_w$) | 22 kW |
| Lights and Heater ($P_l$) | say, 2 kW |
| Total Demand ($P_d = P_w + P_l$) | 24 kW |
| Power Factor (cos ψ) | 80% |
| Number of Transformers | 1 |
| Distribution Transformer ($P_T$) | = $P_d$.n/cosψ<br>= 24 x 1 / 0.8<br>= 30 kVA |
| Since the efficiency of transformer is more than 95%, therefore, we have taken safety margin of 5% | 1.5 kVA |
| Total | 31.5 kVA |
| Selection of Standard Transformer | 50 kVA |

# 2 TECHNICAL SPECIFICATION

## 2.1 General Specifications for Submersible Motor Pump Set

### *2.1.1 Workmanship*

All goods furnished under the contract shall be new and guaranteed free from defects in materials, design and workmanship. If inadequate information is provided in the specifications, it shall be the contractor's responsibility ascertain the conditions and service under which the equipment is required to operate and to acquire and to warrant that operations under such conditions shall be adequately proportioned to safely withstand all stress that may occur or be induced in them during manufacture, erection and intermittent or continuous operation.

All goods shall be designed manufactures and assembled in accordance with the best current engineering and workshop practice. Individual parts shall be manufactured to standard sizes and gauges so that spare furnished at any time can be installed in the field. Corresponding parts of duplicate units shall be fully interchangeable. Equipment shall not have been at service at any time prior to delivery, except as required for test. All materials used shall be appropriate for the service conditions. Casting shall be tough close-grained free from blow-holes. Flaws or excessive shrinkage and shall comply with the requirements of relevant standards.

### *2.1.2 Pump Bowls*

Pump bowls shall be constructed from a material having a suitable tensile strength and shall be of sufficient thickness and so constructed to withstand twice the internal pressure developed by the pump at closed valve operation and so as the withstand all loads imposed during into installation and operation. Pump bowls and impellers within one pump set shall be equal to one another. Bowls and impellers shall be constructed with open and smooth water passages constructed so as to present cavitations under minimum conditions of immersion of the pump set. Bowls and impellers shall be fitted with removable wear rings. Each bowl shall be provided with bearing housing and bearing for the shaft carrying the impellers) constructed so as properly to support the shaft and prevent vibration, so that the cool water pumped continuously lubricates the bearing wear surfaces and so that maximum protection is provided and there is minimum injurious affection of the pump set from the effects of the contaminants in the cool water. Bearings shall have aB-10 life of 5 years as per NEMA test procedures. Bearings bushes shall be readily removable during pump maintenance. The pump shaft shall be continuous between the top bearings to the coupling with the motor shaft through all the bowls and shall be adequately sized to withstand the torque developed by the motor under any operating condition. Each impeller shall be secured to a shaft with a key. The rotating element of each pump set shall be dynamically balanced.

### *2.1.3 Top Bearing*

The discharge assembly or top bowl of the pump set shall include the top bearing of the pump shaft and shall in addition provide restraint against any upward movement: of the pump shaft occurring during transient conditions where, by virtue of the construction of the pump set, the top bearing is exposed to sand entrained in the cool water pumped by the unit, the design of the top bearing shall include special provision to isolate the top bearing from the passage of the pumped cool water.

### *2.1.4 Suction Assembly*

The suction assembly shall be constructed to provide a secure fixing between the bottom pump bowl and the motor and shall contain open water ways properly arranged to guide the water into the bottom impeller of the pump set without undue changes of direction or loss of pressure. The assembly shall contain a strainer across the waterways conveying the water from the well or pump set so as to prevent rubbish or stones from entering the pump. The suction assembly shall be so constructed to accommodate the coupling between the pump shaft and the motor shaft and all arrangements on the top of the motor for sealing the motor bearing from damage by sand. The coupling between the pump shaft and the motor shaft shall be constructed to transmit the full torque developed by the motor under any operation conditions to the shaft of the pump. The discharge assembly shall be constructed to allow the submersible cable

providing electrical power to the motor to pass through the top flange and of the motor at a suitable seal. Suction portion of the pump shall be covered with a stainless strainer (screen).

*2.1.5 Alternative Arrangements of Suction Assembly and Pump Bowls*

Alternative arrangements of suction assembly and pump bowls so as to provide a balanced hydraulic trust will also be permitted.

*2.1.6 Submersible Pump Sets (General)*

Submersible pump sets shall consists of a close coupled assembly consisting of the following main components or assemblies close coupled together by means of s crewed connections straps, or bolts or screws:

- discharge assembly
- required numbers of pump bowls with impellers
- suction assembly
- submersible motor with total length of submersible cable

The complete assembly shall be one piece and shall be suited for suspension at least the top of the discharge assembly form column pipe carrying the output flow from the pump, in a well with casing and screen under deferring depth of immersion in the cool water to be pumped. Pumped components and the assembly as a whole shall conform to industry standards for strength and durability in the anticipated conditions and shall he valid for continuous duty (24 hours in a day) over the entire operating range between closed valve and minimum head conditions. Service factors where applicable, shall be assumed to be 1.0

Vibration of the units when running shall not exceed the limits set forth in the current edition of the Hydraulic Institute Standards of the United States or as per ISO Standard, DIN, JIS, BS or equivalent.

*2.1.7 Discharge Assembly of Pump*

The discharge assembly shall be fitted with threaded or flanged connections and shall be constructed with open and smooth water passages from a material having a minimum ultimate tensile strength of 2100 kg/sq.cm. The discharge head shall be of sufficient thickness and so constructed to withstand twice the internal pressure developed at closed valve operation of the pump and so as to withstand all loads imposed during installation and operation.

The discharge assembly shall incorporate a no-return valve sufficiently robust in construction to withstand repeated shock loadings arise.

*2.1.8 Technical Specification of the Submersible Pump*

The submersible pump set shall meet the following specifications (but may consist of other too):

| S.N. | Description | Remarks |
|---|---|---|
| 1 | Total Dynamic Head at best efficiency: mentioned in BoQ | |
| 2 | Discharge at best efficiency: mentioned in BoQ | |
| 3 | Efficiency of Pump ≥ 75% | |
| 4 | Efficiency of motor ≥ 84% | |
| 5 | Operation Duty: continuous (24 Hrs) | |
| 6 | Speed: 2900 (approx.) | |
| 7 | All rotating parts: Dynamically balanced | |

| S.N. | Description | Remarks |
|---|---|---|
| 8 | Pump Impeller: Mixed Flow Type | |
| 9 | The pump shall be suitable for water having solid particle approx. 30gm/$m^3$ water | |
| 10 | Manufacturing Standard: DIN, JIS, BS, ISO or equivalent | |
| 11 | ISO 9001 Certification: The manufacturing Company must have ISO 9001 Certification | |
| 12 | Manufacturer's name plate with technical data: as per manufacturer's standard | |

### *2.1.9 Material Specification of the Submersible Pump Parts*

The submersible pump sets shall meet the following materials specifications (but may consist of other required materials too):

| S.N. | Description of Parts | Materials | Remarks |
|---|---|---|---|
| 1 | Vertical Check Valve (non-return valve) | As per manufacturer's recommendation | |
| 2 | Valve Seat | As per manufacturer's recommendation | |
| 3 | Wear ring | Stainless Steel/As per manufacturer's recommendation | |
| 4 | Coupling (For pump and motor shaft connection) | Stainless Steel | |
| 5 | Pump Shaft | Stainless Steel | |
| 6 | Impeller (mixed Flow Type) | Stainless Steel/Zinc Free Bronze | |
| 7 | Spring for valve cup | Stainless Steel | |
| 8 | Intermediate Chamber (Bowl) | Stainless Steel/Close grain cast iron | |
| 9 | Intermediate bearing | Zinc Free Bronze/ As per manufacturer's recommendation | |
| 10 | Lower bearing | Stainless Steel/Zinc Free Bronze/As per manufacturer's recommendation | |
| 11 | Intermediate sleeves | Stainless Steel | |
| 12 | Cable guard | Stainless Steel | |
| 13 | Nuts, Bolts, Washers, Screws, Keys | Stainless Steel | |
| 14 | Inlet strainer | Stainless Steel | |
| 15 | Name plate | Stainless Steel or Bronze | |
| 16 | Painting | As per manufacturer's standard | |
| 17 | Other essential parts to complete the pump: as required | | |

### *2.1.10 Technical Specification of Submersible Motor*

The submersible motor set shall meet the following specifications (but may consist of other too):

| S.N. | Description | Remarks |
|---|---|---|
| 1 | Motor; 3-Phase, 400V, Rewindable type, Vertical Installation, Continuous Duty (24 hours operation) squirrel cage inductor motor | |
| 2 | Starting method: Auto Transformer Starter or Star-Delta starter | |
| 3 | Frequency = 50 Hz | |
| 4 | Enclosure Class: IP20 | |
| 5 | Ambient temperature: -1°C to +4°C | |
| 6 | Relative Humidity: 99% | |
| 7 | Voltage Variation: +15%; -20% of normal voltage | |

| S.N. | Description | Remarks |
|---|---|---|
| 8 | Motor Efficiency (Π) ≥ 84% | |
| 9 | Submersible cable shieling into motor: well water should not enter into the motor during operation and stop | |
| 10 | Speed: 2900 (approx.) | |
| 11 | All rotating parts: Dynamically balanced | |
| 12 | The motor shall be protected by the means of cable glands, grommets, rubber seals etc. From ingress of bore well water, sand, silt, etc. | |
| 13 | Insulation of the water filled motor ≥ 500 mega ohm or infinitive | |
| 14 | Manufacturing Standard: DIN, JIS, BS, ISO or equivalent | |
| 15 | ISO 9001 Certification: The manufacturing Company must have ISO 9001 Certification | |
| 16 | Manufacturer's name plate with technical dates: as per manufacturer's standard | |
| 17 | The motors shall have high corrosion resistance stainless steel body. | |
| 18 | Shaft seal: high wearing resistant | |
| 19 | Rotor and its shaft: corrosion resistant | |

### *2.1.11 Material Specification of Submersible Motor Parts*

The submersible motors sets shall meet the following materials specifications (but may consist of other required materials too):

| S.N. | Description of Parts | Materials | Remarks |
|---|---|---|---|
| 1 | Shaft | Stainless Steel | |
| 2 | Shaft Seal | High wear resistance material | |
| 3 | Bush Bearing upper, lower | High wear resistance material | |
| 4 | Radial Bearing | tungsten carbide/ As per manufacturer's recommendation | |
| 5 | Thrust Bearing | carbon/ceramic/ As per manufacturer's recommendation | |
| 6 | Rubber Parts | As per manufacturer's recommendation | |
| 7 | All bolts, nuts, washers, screws, studs, etc. | Stainless Steel (non-corrosive) | |
| 8 | Winding cable | Special PVC insulated pure copper 99.9% | |
| 9 | Motor shall be made as rewindable, easy for dismantling, assembling and repairing | As per manufacturer's standard | |
| 10 | Name plate | Stainless Steel or Bronze | |
| 11 | Painting | As per manufacturer's standard | |
| 12 | Priming of clear water into the motor should be done by using funnel with pipe | As per manufacturer's standard | |
| 13 | Bolt with washer for water priming holes | Stainless Steel | |
| 14 | Earthing Screw with washer | Stainless Steel | |
| 15 | Other essential parts as required to complete the motor for ready to operate | As per manufacturer's standard | |

### *2.1.12 Specification for Submersible Cable*

The Submersible Cable shall meet the following specifications:

a) Submersible cable for connection within the motor:

- Type: Twisted Copper Conductors and jacketed type flat cable 4-Core (3-core Red, Yellow, Blue plus one core Green for earthing standard copper conductor) shall be

furnished in more than 5m lengths with water tight viton plug on one end for direct connection to motor.

- for construction of the cable (electrical and physical test parameters): UL Standard 83
- The individual insulated primary conductors: shall have a 0.020 to 0.030 inch insulation wall of (FEP Floropolymer) or as per manufacturer's recommendation.
- The insulated jacketed cables should be able to pass the large scale IEEE-383 flammability test.
- The cable shall have abrasion resistance, chemical resistance and continuous service temperatures of 200°C.
- Flexibility: High (Bending radius ≤ 40 mm)
- Wall thickness of insulation jacket: as per manufacturer's standard
- Termination Assembly shall consist of jam nut, outer sleeve, flat cable (3-core for power supply and one core for earthing purpose)
- External color of the submersible cable jacket: as per manufacturer's standard

b) Submersible cable for connection with the above cable:

- Type Twisted Copper Conductors and jacketed type flat submersible cable
- Core: 4-Core (3-core Red, Yellow, Blue for power supply 400V and one core Green for earthing purpose)
- The individual insulated primary conductors shall have a 0.020 to 0.030 inch insulation wall thickness of FEP Floropolymer.
- Another layer insulated jacketed cable: Abrasion resistance, chemical resistance, continuous service temperatures of more than 100°C.
- Wall thickness of insulation jacket: 0.035 inches or as per manufacturer's recommendation
- Bending radius of submersible cable ≤ 40 mm
- Flexibility: High
- Maximum Supply Voltage: 550V
- Norman Supply Voltage: 400±20%
- External color of the submersible cable jacket: Black

*2.1.13 Installation of Submersible Motor Pump, Electro-Mechanical Equipments and Accessories*

The submersible motor pump sets and accessories shall be installed for the operation Ground Water Tube Wells.

During the transportation and installation of submersible motor pump, the following technical steps should be followed:

a) The cable must be handled carefully to avoid abrasion. It should be checked that no cuts are present in the place where it goes out from motor pump, cable guard, screws fixing the cable guard to pump should be well fastened. Check the bolts, nuts, screws in order to ensure that the bowls, discharge and suction casing are well fixed. Once the pump set has been placed over the well opening and has been lifted hitched to the crane hoist hook, the motor must be filled with very clear water for lubrication. Very clean water means there must not be any solid particles, otherwise motor shaft bearings will be damaged. All safety rules mentioned in the electro-mechanical equipment's catalogues of manufacturer must be followed strictly. All electro-mechanical equipment shall be installed, commissioned and tested as per the latest engineering rules and versions as mentioned in the catalogs and instruction.

   The following required works, equipment and materials shall be managed and provided by the contractor for complete installation:

   - Experienced and skilled man power
   - Vehicle, crane with accessories, welding machine, gas welding machine, torque wrench, tools etc.
   - Safety equipment and devices
   - Testing equipment
   - Stainless steel welding rod and steel welding rod: as required
   - Excavation and backfilling works
   - Making of gasket in proper size by Gasket Sheet
   - Other required works and equipment: as required.

b) Submersible Motor Pump Set Test at Tube Well Site (Only as an example)

   Additional testing of submersible motor pump set at manufacturer's factory and client's site:

   - The submersible motor pump sets supplied shall also be tested at the Tube well site in the presence of an engineer and the contractor's representative. In case of failure, the manufactured goods shall not be accepted. During the test, the submersible motor pump sets should not exceed the manufacturers recommended rated current at any operating condition.
   - The example (practically tested) of the submersible motor pump having the following configuration should have the capability as given in the following table:

     Configuration of the motor pump (for an example only) for a pump of:

     41 HP motor/rated current = 58.5 Amp/ voltage = 400 V +10% - 15%
     Pump discharge = 40 - 100 $m^3$/hr
     Pumping head = 116 to 68 m

| Amp | | | 3 Phase Voltage | Head (m) | Discharge (liter/min) |
|---|---|---|---|---|---|
| R | Y | B | | | |
| 51 | 51 | 49 | 400 | 0 | 2000 |
| 51 | 51 | 50 | 400 | 10 | 2000 |
| 52 | 52 | 49 | 400 | 20 | 2000 |
| 52 | 52 | 49 | 400 | 30 | 1900 |
| 52 | 51 | 50 | 400 | 40 | 1800 |

| Amp | | | 3 Phase Voltage | Head (m) | Discharge (liter/min) |
|---|---|---|---|---|---|
| R | Y | B | | | |
| 52 | 51 | 50 | 400 | 50 | 1700 |
| 53 | 52 | 50 | 400 | 60 | 1600 |
| 52 | 51 | 49 | 400 | 70 | 1400 |
| 51 | 50 | 49 | 400 | 80 | 1300 |
| 50 | 49 | 48 | 400 | 90 | 1150 |
| 47 | 48 | 46 | 400 | 100 | 950 |
| 40 | 39 | 38 | 400 | 110 | 550 |
| 38 | 37 | 36 | 400 | 120 | 400 |

Notes: i. The current first rises from 1 to 7 and decreases from 8 to 13. Similarly, in the manufactured submersible motor pump set, as there is rise in the pressure, the current must decrease likewise, else the submersible motor pump set shall not be accepted.

ii. The manufacturer's tested data of each submersible motor pump set along with the goods should be provided.

### *2.1.14 Auto Transformer Starter Panel Board to Operate Submersible Motor Pump Set*

The auto transformer starter panel board shall be suitable to start submersible motor pump set, 3-phase, 400 V, AC, 50 Hz and shall be ready for operation without any difficulty.

Major items of starter shall consist of (including but not limited to):

| SN | Description of items and specification | Quantity | Unit | Remarks |
|---|---|---|---|---|
| 1. | Voltmeter 0-500 V, 3-phase with accessories | 3 | Sets | |
| 2. | Ammeter with selector switch and accessories of required Ampere range (current measurement of 3-phase and single phase) | 1 | Set | |
| 3. | Air Brake contractor with necessary accessories (current capacity should not be less than 1.40 times the full load current of submersible motor) | 3 | Sets | |
| 4. | Auto transformer, 400 V, 50 Hz with necessary accessories. It should be insulated and assembled as one piece. Capacity (Power) ≥ Power of motor | 1 | Set | For star-delta starter, it is not needed |
| 5. | Minimum/Maximum voltage relay, 400 V, with selector switch and accessories | 1 | Set | |
| 6. | Phase Failure Relay, 400 V with accessories | 1 | Set | |
| 7. | Minimum water level cut relay (plus one spare), 230 V, 50 Hz | As required | Set | |
| 8. | Current Transformers with accessories of required capacity | As required | | |
| 9. | Timer with suitable seconds, selector and accessories | 1 | Set | |
| 10. | Moulded Case Circuit Breaker (MCCB) of suitable capacity and high quality with accessories, 3-phase, 50 Hz. Rated ultimate Breaking Capacity (kA), should be chosen in high range (Low range will not be accepted)<br>• Insulation Voltage up to 690 V AC<br>• Rated operation voltage = 500 V<br>• Handle (switch) indication (3 positions): ON, OFF and Tripped<br>• Push button to trip<br>• Other accessories as required | 1 | Set | |
| 11. | Overload relay with selector of suitable current (A) range for the motor capacity | 1 | Set | |
| 12. | Power factor meter, 400 V with necessary accessories | 1 | Set | |

| SN | Description of items and specification | Quantity | Unit | Remarks |
|---|---|---|---|---|
| 13. | Capacitor with accessories as follows:<br>1) Up to 15.0 kW motor: 2.5 kVAR<br>2) Above 15.0 kW to 30 kW: 5.0 kVAR<br>3) Above 30.0 kW to 50 kW: 10.0 kVAR<br>4) Above 50.0 kW to 63 kW: 15.0 kVAR<br>5) Above 63.0 kW to 80 kW: 20.0 kVAR<br>6) Above 80 to 110 kw: 25.0 kVAR | Complete | Set | |
| 14. | Differential relay with necessary accessories | 1 | Set | |
| 15. | Power factor meter 400 V, 5 A with necessary accessories | 1 | Set | |
| 16. | Heater with temperature regulator (auto ON – OFF), with necessary accessories | 1 | Set | |
| 17. | Auxiliary Relay with switches and accessories | As required | | |
| 18. | Miniature Circuit Breaker (MCB) of different required capacities with accessories. MCB should be used instead of HRC fuses | As required | | |
| 19. | Terminal Blocks or connectors of different required capacities for the connection of power cables and other cables with necessary accessories | As required | | |
| 20. | Copper Bus Bars with accessories (if necessary) | As required | | |
| 21. | Starter box:<br>• Indoor type<br>• Front side covered with transparent plastic sheet of thickness 2.5 to 5 mm<br>• Front door with gaskets, 2 locks with handles and keys<br>• Holes with cable glands for cables<br>• Air cooled with ventilation holes<br>• Mild steel sheet at least 1.40 mm thick<br>• Painted with one coat of primer and two coats of anti-corrosive electric resistance paint<br>• SS bolts, nuts, washers for earthing wall mounted: up to 22 kW, with four no. of bolting above 22 kW<br>• Floor mounted with C-channel stand, foundation bolts, nuts, washers<br>• Complete parts as required | | | |
| 22. | Copper cable shoes or silver coated cable shoes of different sizes for the connection of cables | As required | | |
| 23. | Copper bus bar with SS bolts, nuts, washers for earthing cable connection and accessories | As required | | |
| 24. | Indicating lamps with accessories:<br>• White – For electrical power supply<br>• Green – For motor pump “ON”<br>• Red – For motor pump “OFF”<br>• Orange – For low water level and reset | | | |
| 25. | Push button with accessories:<br>• Start : Green<br>• Reset: Orange<br>• Stop: Red<br>• Others: if required | <br>1<br>1<br>1 | <br>Set<br>Set<br>Set | |
| 26. | Single pole switch | As required | | |
| 27. | Hours run meter 230 V with necessary accessories | 1 | Set | |
| 28. | Alarm with alarm switch and accessories. Alarm should be automatically “ON” when motor pump trips automatically due to low water | | | |

| SN | Description of items and specification | Quantity | Unit | Remarks |
|---|---|---|---|---|
| 29. | Copper PVC insulated complete wiring as per circuit diagram of the starter. Laying of cables should be made into PVC cable trays. All cables ends should be indicated by using PVC numbers. | As required | | |
| 30. | Other parts, accessories and work which are necessary to complete starter | As required | | |
| 31. | Standard for all electrical, electronic etc. parts: ISI, DIN, JS, IEC or equivalent | | | |

### 2.2 Specification of Double Flanged Sluice Valves (Gate Valves)

Sluice Valves (Gate Valves) should conform to the following specifications for trouble free operation:

| | | |
|---|---|---|
| Nominal Diameter (mm) | : | As mentioned in the BoQ |
| Stem | : | Stainless steel non rising, clockwise closing |
| Flow | : | Both directions |
| Stem Nut | : | Zinc Free Bronze/ Stainless Steel |
| Rated Value Pressure | : | 16 bar |
| Body and bonnet | : | Ductile iron |
| Hand wheel | : | Manual operation |
| Stem sealing | : | O-rings or as per manufacturer's standard |
| Bonnet bolts | : | Stainless steel |
| Hydraulic Test | : | 24 bar |
| Nominal Pressure | : | 16 bar |
| Water Temperature | : | Max 70°C |
| Painting | : | As per manufacturer's standard |
| Other necessary Parts | : | As per manufacturer's standard |
| Standard | : | BS/DIN/JIS/ISO or equivalent |

### 2.3 Specification of Water Meter

The water meter shall meet the following specifications:

| | | |
|---|---|---|
| Type | : | Woltmann |
| Nominal diameter | : | As mentioned in BOQ |
| Maximum working pressure (approx.) | : | 16 bars |
| Installation position | : | Horizontal |
| Maximum flow rate | : | As per manufacturer's standard |
| Nominal flow rate | : | As per manufacturer's standard |
| Accuracy | : | ± |
| Starting flow | : | As per manufacturer's standard |
| Smallest graduation | : | As per manufacturer's standard |
| Smallest reading | : | 10 liters |
| Maximum reading | : | $10^6$ $m^3$ or higher |
| All internal parts | : | Non corrosive as per manufacturer's standard |
| Body ends | : | Flanged |
| Body materials | : | As per manufacturer's standard |
| All bolts, nuts, washers and screws | : | Stainless steel |
| Painting | : | As per manufacturer's standard |
| Standard | : | BS/DIN/JIS/ISO or equivalent |

### 2.4 Specification of Double Flanged Non-return Valve

The valve shall be designed to prevent the water from flowing backward. The non-return valve shall meet the requirements as follows:

| | | |
|---|---|---|
| Nominal diameter (mm) | : | Mentioned in BoQ |
| Valve Body | : | Ductile iron/Cast iron |
| Bonnet | : | Ductile iron/Cast iron |
| Rod Pin, Axle Pin | : | Stainless Steel |
| Disc | : | Ductile Iron/Cast Iron/Stainless Steel |
| Disc Seal Ring | : | Zinc free bronze/ Stainless Steel/ as per manufacturer's standard |
| Bolt, Nuts, Washers | : | Stainless steel |
| Pressure Ratings | : | PN16 |
| Painting | : | As per manufacturer's standard |
| Other essential parts | : | As per manufacturer's standard |
| Standard | : | BS/DIN/JIS/ISO or equivalent |

# 3 SUBMERSIBLE MOTOR PUMP INSTALLATION AND OPERATION

## 3.1 Submersible Motor Pump Set Installation

i The submersible cable and water level control cables must be handled carefully to avoid abrasion. Check that there is no cut starting from the pump cable guard and that the screws fixing the cable guard to the pump are well fastened. Check the screws, studs, nuts in order to be sure that the bowl, discharge, suction casing and check valve (non-return valve) are well fixed.

ii The submersible motor should be filled with clean water alongside special nonfreezing solution allowing the lubrication of bearings. Clean water means that there must not be any solid particles, otherwise motor shaft and bearing will be damaged.

iii Before installing the submersible motor pump set, it is necessary to check its water filling level as follows:

a) Place the motor vertically

b) Unscrew the water filling plugs (upper vent valve and lower vent valve), screw the nipple with pipe and funnel in lower vent holding the funnel higher than the upper vent valve ; pour clean water until the clean water solution inside the motor begins to flow out of the vent valve (allow the air inside the motor to escape).

c) At this point stop pouring water and screw the lower vent plug and then the upper vent plug.

iv The submersible motor pump set must not run without water. To prevent serious damages, motor should not be run for even a short period of time without water.

v Before lowering the submersible motor pump set into the deep tube well, the submersible cable and other related cables must be fastened to prevent them from falling into the well. While lowering the pump set, two supporting clamps are required (to be used alternatively). Ensure that the insulating resistance of the motor is correct.

a) Measure the static water level of the deep tube well

b) Connect the outlet of pump with pump pipe (adaptor), ensuring that water does not leak, by means of Teflon tape. Fix the water level control cables with electrodes at operating depth.

c) Lift the whole motor pump set with pipe by means of crane (or hoist) and lower it into the well till the clamp rests against the well flange.

d) Connect the second pipe section and fit it with a supporting clamp at its upper end.

e) Suspend the second pipe to the hoist, remove the first supporting clamp and lower the pump set as mentioned in point b.

f) Repeat the operation till the desired depth is reached, keeping in mind that the pump set must always have a submergence of at least 1 to 2 meters below pumping level (dynamic water level).

g) In case of threaded column pipe with socket, they must be properly tightened and two pipe ends should be supported by welding of 3 nos. of flat iron.

vi During the mounting of column (riser) pipe, a suspension collar or device must always be fixed to it because a failure of the pulley block or, of the chain or of the hanger/hook may cause the pump set to fall in the well.

vii During the installation of pump set, we should prevent the cables from damage by rubbing against the well casing. While lowering the pump set, the electrical cable must be fastened to the column (riser) pipe by means of cable belt (clips).

viii The motor pump set must not be installed on the bottom of the well. In this case, it would burn motor winding due to insufficient cooling and pumping of sand.

ix Motor Insulation Test: An insulation test should be performed before coupling the motor shaft with pump shaft. Measure the insulation of the motor coil the reading should not be less than 30 mega ohm (for a new motor).

### 3.2 Checks to be Performed Before Operating Submersible Motor Pump Set

i Check that the parts of the starter are in good condition. If any part is broken and loose, then fix them

ii Adjust the overload relay according to the rated current value of the motor.

iii Make sure that the MCB or fuses are of suitable rating for the motor.

iv Check that the calibration of the indicating instruments such as ammeters, voltmeters etc. are correct at “zero” value and at required voltage.

### 3.3 Operational and Shut Down Procedure of Submersible Motor Pump Set, Deep Tube Well, Starter and Others

#### *3.3.1 Daily Check (Operational)*

The correct operation f tube well system can be checked as follows:

a) Check the pressure with pressure gauge. The value should correspond to the total required head of the pump (not less than 70% efficiency of the pump).

b) Check the water discharge on the flow meter or in tank. Water discharge should be according to the performance curve of the pump at greater than 70% efficiency of the pump.

c) Check the voltmeter. Voltage should not be more or less than 5% of the nameplate value.

d) Check the power factor meter. The value should be between 0.85 and 0.90.

e) Check the signal lamps of the starter:

- White lamp “Supply available” must be lighted
- Green lamp “Pump running” must be lighted
- Orange lamp “Power on fault” must be switched off
- Orange lamp “Low water level” must be switched off
- Red lamp “Pump off” must be switched off

f) Signs indicating that the submersible motor pump set is working properly:

- Continuous normal noise
- Low continuous vibrations on the delivery pipe

- Ammeter shows normal current (Ampere)

g) Check the static water level (before operation)

*3.3.2 Shutdown Procedure*

a) Check the dynamic water level of the well before shut down (OFF) of the pump set.

b) Stop the pump set by pushing the stop (Red) button (switch). Switch off the main switch of the tube well, for a long resting period (more than 2 days).

c) Do not change the position of the gate valve and do not close the valve

d) Do not close the valve (connected to air and vacuum valve) unless plant is supposed to be stopped for a long period or for maintenance.

*3.3.3 Causes Behind the Starter Trips or the Fuses Blowing While the Pump Is Operating*

| S.N. | Causes | Remedies |
|---|---|---|
| a. | Low voltage | Check voltage value and if necessary, check the transformer or inform the power company (NEA) to repair it |
| b. | Overload due to clogging of sand | If the ammeter shows a current (Amps) value of 15 to 20% higher than the maximum motor pump set current (Amps), it is necessary to pull out motor pump set and repair it after checking |
| c. | Single phasing | A current 1.5 to 2 time higher than the normal flows, therefore the phase failure relay trips and stomps the motor pump set. Check the value of incoming voltage with voltmeter on the 3-phases. Check the condition of the fuses/MCB, replace the damaged or blown fuses/MCB. Check the condition of the contactors of the starter. |
| d. | Ambient temperature where the starter is installed is too high | Due to high ambient temperature, the overload relay of the starter trips easily. Adjust the relay to da higher value. In any case, the ammeter must show a normal current (Amps) value. |
| e. | Wrong relay | If the ammeter shows normal current and the starter trips even after repeated adjustments of the relays, at least one of them must be replaced |
| f. | Pump set is blocked inside a crooked well | If the pump is lowered into a crooked well (with reduced diameter), motor shaft and thrust bearing may be subjected to rubbing. In this case, the rotor is locked and absorbed current has high value. This causes the fuses to blow or the overload relays to trip the starter. Pull out the pump set, check, repair and re-install (ensuring it is straight). Ensure that the franges of column pipes are straight. |
| g. | Conductors interrupted in the starters | Check the circuit diagram and correct as necessary |
| h. | Short circuit in the submersible cable joints | Pull out the pump and correct the short circuit |

## 3.4 Troubleshooting

*3.4.1 Low Discharge and Head (despite pump running properly)*

| **Possible Causes** | **Remedies** |
|---|---|
| The motor is running in incorrect direction | Reverse the connections of the two phase electrical cables |
| Leakage in discharge pipe. (Loose flanges or sockets or damaged gasket) | Pull out the pump set, check and repair |

| Possible Causes | Remedies |
|---|---|
| Voltage lower than normal (absorbed current (amps) higher than normal) | Check voltage value. Increase the voltage of the incoming supply line. |
| Suction strainer obstructed by rags, paper or other material fallen into well | Remove the pump and clean it |
| Impellers and diffusors worn due to sand | Check and replace the worn parts |

*3.4.2 Water Does Not Flow Even Though Pump is Operational*

| Possble Causes | Remedies |
|---|---|
| Water level inside the well lower than the pump section inlet. In this case, current will be lower than normal. | Check the water level and lower the pump deeper if necessary. |
| Discharge pipe leaking at the joint of the flanges or sockets | Check the discharge pipe and tighten them properly with gaskets or Teflon tape |
| Voltage is lower than normal | Increase the voltage from the power company (say NEA) |
| The pump is air clogged. In this case, the current (Amps) absorbed is lower than normal. | Start and stop the motor pump set at tintervals of about 2 to 3 minute for releasing the air. |
| The pump strainer may be obstructed by rags, paper or other material which fell into the well. | Pull out the pump and clean it |
| Friction losses (head loss) incorrectly calculated | Recheck the calculation. Replace with proper pump with required total head and if possible replace the pipe with larger diameter. |

*3.4.3 The Pump Set Does Not Start, Yet the Fuses Do Not Blow and the Starter Relays Do Not Trip*

| Possible Causes | Remedies |
|---|---|
| No voltage | Check the voltage at the supply line terminal with multimeter. This problem might have been caused by MCB or burnt fuses. |
| Interrupted circuit in the cable or in the motor winding. | Open the MCB or fuse switch in the starter. Connect one of the ohmmeter conductors to the discharge pipes or to any other grounding. Connect the other ohmmeter to the terminals of each motor cable leading (one at a time). For each terminal, the instrument should show a value of at least 3 MegaOhms. |
| Open circuit in the starter | Check continuity of the circuits referring to electric diagram. |

# 4 PROPER EARTHING SYSTEM

Why should earthing resistance (R) be low (say, less than 1 ohm)?

Using Ohm's Law,

E = IR

where, E = Voltage in Volt (V)

I = Current in Ampere (A)

R = Resistance in Ohm (E = Voltage in Volt (V)

I = Current in Ampere (A)

R = Resistance in Ohm (Ω)

Assume that we have a supply voltage ($E_1$) (to the transformer) of 11000 V and leakage voltage ($E_2$) to ground of 6000 V with an earthing resistance ($R_1$) of 20 Ohms. Again, assume that an exposed wire in this system touches a motor frame that is connected to a grounding system which has a 10 Ohm resistance ($R_2$) to earth (earthing resistance).

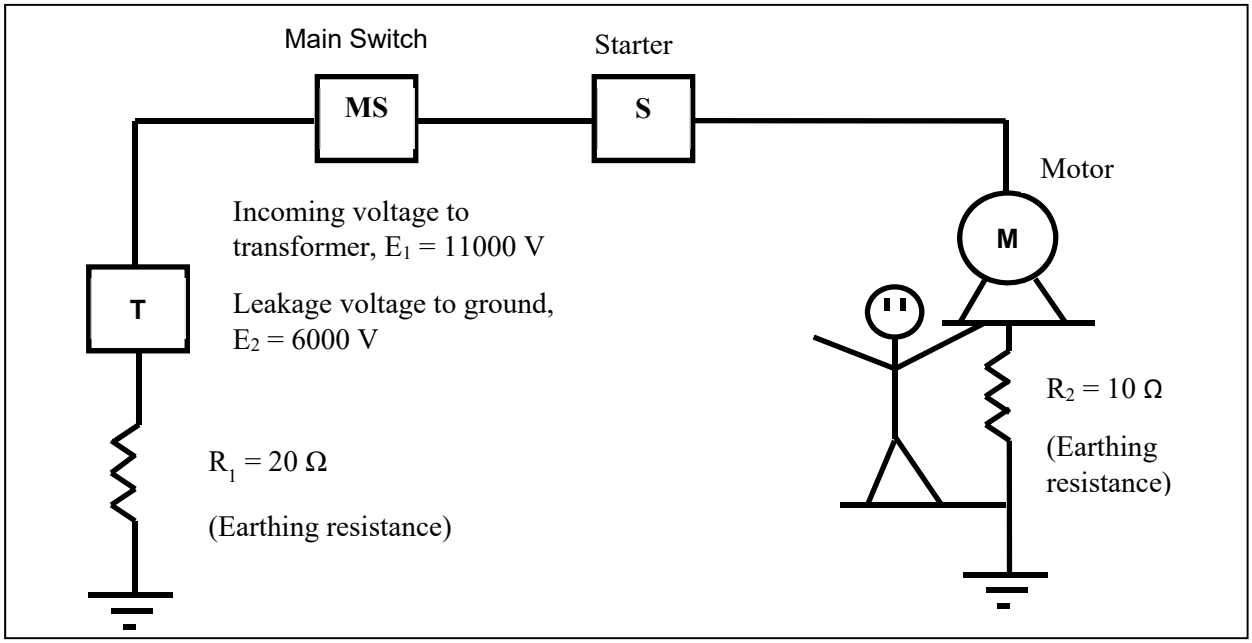


**Figure 1 Example of an Electrical Circuit with Very High Earthing Resistance**

Case I Calculate the leakage current ($I_1$) through the fault (from the motor frame to the earth):

Leakage Current ($I_1$) = $E_2/(R_1+R_2)$ = 6000/(10+20) = 6000/30 = 200 Ampere

Case II Calculate the leakage voltage ($E_3$), if we happen to touch the motor frame and are grounded solidly to earth (where, resistance ($R_2$) to earth = 10Ω and leakage current ($I_1$) = 200 Amps)

then,

Leakage Voltage ($E_3$) = Leakage Current ($I_1$) x Resistance ($R_2$)

$E_3 = I_1 R_2$ = 200 x 10 = 2000 V

Then, we could be subjected to electric shock of 2000 V. This could kill the person instantly.

Similarly, as per cases I and II, equipment and relays can also be damaged by over voltage and over current caused by high resistance grounding systems.

Case III Calculate the leakage voltage ($E_4$), if we happen to touch the motor frame and are grounded solidly to earth (where, Resistance to earth or earthing resistance ($R_3$) = 1 Ω and leakage current ($I_1$) = 200 Amps)

then

Leakage Voltage ($E_4$) = Leakage current ($I_1$) x Resistance to earth ($R_3$) = 200 Amp x 1 Ohm = 200 V

Here, the shock we get is 200 V and this would not kill the person. In this case, equipment and relays can also be protected by low voltage and low current caused by low resistance (<1 Ω) grounding systems.

**ANNEXES**

**Annex A Monitoring Sheet of Electromechanical Equipment of Deep Tube Well (DTW)**

**1 Name of sub-project :**

**2 District :**

**3 VDC/ Municipality :**

**4 Ward No :**

**5 Tole :**

**6 Tube well :**

a) Name :

b) Deep Tube well (DTW) Number :

c) Date of Construction :

d) Name of the Contractor :

e) Name of the Drilling Company :

f) Tube well Data :

- Ground level above sea mean level (asml), (m) :
- Total height of overhead tank above Ground level (G.l.) ……m
- Housing pipe : i) diameter…….. (inch) ii) length…….. (m) :…….
- Housing pipe material : SS/MS
- Casing pipe : i) diameter(inch) ……. ii) length (m)……
- Casing pipe material : SS/MS
- Screen pipe diameter (inch) :
- Screen pipe length (m) :
- Screen pipe material : SS/MS
- Total length of DTW (m) :
- Static water level (SWL) :
  i. During Construction (date :…….. ) :……..m
  ii. Present (date :……) :……m
- Dynamic water level (DWL) :
  i. During Construction (date :……..) :……m
  ii. Present (date :……..) :……m
- Discharge :
  i. During Construction (date :……..) :……lps
  ii. Present (date :……) :……litres/minutes
  iii. Recommended :……litres/minutes
- Specific capacity of DTW ($M^3$ /Day/M : During Construction (date :……) :……..
- Sand/silt contained at present gm/$m^3h_2o$ :……
- Separate pipe for Artesian water flow on the well : Yes/No
- Drawing of DTW assembly :

i. Available :
ii. Not available :
iii. Remarks :

**7 Submersible motor pump set :**

**a) Manufacture's Name :**

**b) Made in :**

**c) Condition of motor pump set :**

i. Inoperation :
ii. Not inoperation :
iii. Needs repair :
- Motor
- pump

iv. In store :
v. Others :

**d) Motor Data :**

- Date of purchase :
- Serial no. :
- Type :
- External diameter (size) mm :
- Power (Kw/Hp) :
- Phase : 3
- Voltage (V) :
- Voltage variation of normal voltage : ±……%
- Rated current (Full load current ) (Amp) :
- Frequency (Hz) : 50
- Max Efficiency (η) :
- Max. Power Factor (Cosφ) :
- Speed (rpm) :
- Dimension : Length (mm) : weight (kg) :
- Submersible cable size ($mm^2$) :
- Submersible cable :
  i. 3-corex1 no. :
  ii. 3-corex2 nos :
- Starting method
  i. Direct on line :
  ii. Start-Delta :
  iii. Auto Transformer :
- Copper winding type of motor
  i. Rewindable :
  ii. Unrewindable :
- Lubricant :

i. Water :
ii. Oil :

- Date of installation :

**e) Submersible pump Data :**

- Date of Purchase :
- Serial No :
- Type :
- External diameter including cable guard and flange (mm) :
- Rated power (Kw/Hp) :
- Speed (rpm) :
- Max efficiency (η)
- Dimension :
  i. Length (m) :
  ii. Weight (kg) :
- Number of stage (nos) :
- Impeller type :
  i. Axial Flow :
  ii. Radial flow :
  iii. Mixed Flow :
- Impeller material :
  i. Bronze :
  ii. Stainless steel (ss) :
  iii. Others :
- Shaft material :
  i. Carbon steel :
  ii. Stainless steel :
  iii. Others :
- Outlet diameter for column pipe connection (mm) :
- Rated Discharge (liters/minute) :
- Recommended operating discharge (liters/minute):From……: to……
- Rated Head (m) :
- Recommended operating head (m): From…… : to……
- Maximum efficiency (η) :
- Direction of rotation when viewed from top : i) clock wise ii) anti clock wise
- Date of installation :

**8 Submersible cable :**

- Conductor material : Copper
- Cross- section area ($MM^2$) :
- Core :
  i. 1x3 core :

ii. 2x3 core :
iii. 1x3 1/2 core :
iv. 2x3 1/2 core :

- Manufacture's name :
- Made in :
- Total single length of submersible cable (m) :
  i. 1x……..
  ii. 2x……..
- Entrance of Submersible cable at Tube well :
  i. From discharge head flange
  ii. From top of tube well pipe

**9 Turbine motor pump set :**

**a. Manufacture's Name :**

**b. Made in :**

**c. Condition of motor pump set :**

i. Inoperation :
ii. Not inoperation :
iii. Needs repair :
- Motor
- pump

iv. In store :
v. Others :

**d. Motor Data :**

- Date of purchase :
- Serial no. :
- Type :
- Power (Kw/Hp) :
- Phase : 3
- Voltage (V) :
- Voltage variation of normal voltage : ±……%
- Rated current (Full load current ) (Amp) :
- Frequency (Hz) : 50
- Max Efficiency (η) :
- Max. Power Factor (Cosφ) :
- Speed (rpm) :
- Starting method
  i. Direct on line :
  ii. Start-Delta :
  iii. Auto Transformer :
- Date of installation :

**e. Turbine pump Data :**

- Date of Purchase :
- Serial No :
- Type :
- External diameter including flange (mm) :
- Rated power (Kw/Hp) :
- Speed (rpm) :
- Max efficiency (η)
- Number of stage (nos) :
- Impeller type :
    i. Axial Flow :
    ii. Radial flow :
    iii. Mixed Flow :
- Impeller material :
    i. Bronze :
    ii. Stainless steel (ss) :
    iii. Others :
- Shaft material :
    i. Carbon steel :
    ii. Stainless steel :
    iii. Others :
- Diameter of column pipe (mm) :
- Rated Discharge (liters/minute) :
- Recommended operating discharge (liters/minute):From……: to……
- Rated Head (m) :
- Recommended operating head (m): From…… : to……
- Maximum efficiency (η) :
- Direction of rotation when viewed from top : i) clock wise ii) anti clock wise
- Date of installation :

**10 Cable for Low/High water level control :**

- Length (M) :
- Cross-section area ($mm^2$) :
- Number :
- Entrance of cable at the tube well :
    i. From discharge head flange
    ii. From top of tube well pipe

**11 Column (riser) pipe :**

a) Pump out let pipe

- Diameter (mm) :

- Both ends flanged :
  i. Standard Flange OD……mm
  ii. Special Flange OD……..mm
- Both ends threaded :
  i. Standard pipe thread
  ii. Special thread
- One end threaded and another end flanged :
- Length (m) :

b) Column (riser) pipe :

- Length of single column pipe (m) :
- Diameter (mm) :
- Connection type :
  i. Threaded :
     - Standard pipe thread
     - Special thread
  ii. Flanged :
     - Standard Flange OD……..mm
     - Special flange OD……..mm
- Total installation length/depth (m):

**12 Sluice valve (Gate valve) :**

- Installation : Yes/No
- Manufacture's name/made in……..
- Nominal diameter (mm) : ……
- Pressure rating PN or Kgf/$cm^2$) :……
- Condition : i) good ii) needs repair iii) needs replacement

**13 Pressure gauge/Manometer with gate valve**

- Installation : Yes/No
- Manufacture's name/made in : ……
- Connection diameter (mm) :……..
- Dial diameter (mm) :……
- Pressure rating (Kgf/$cm^2$) : from ……to……..
- Pressure rating (m) : From……to……..
- Condition of pressure gauge or manometer : i) good ii) needs repair iii) needs replacement
- Condition of gate value : i) good ii) needs repair iii) needs replacement

**14 Air Valve :**

- Installation : Yes/No
- Manufacture's name/made in :……..
- Connection diameter (mm) :……
- Pressure rating (PN or Kgf/$cm^2$) :…….
- Type : i) Air release valve ii) Air release and vacuum valve iii) Combination air valve

- Condition : i) good ii) needs repair iii) needs replacement
- Condition of gate valve : i) good ii) needs repair iii) needs replacement

**15 Non return Valve :**

- Installation : Yes/No
- Manufacture's name/made in :……..
- Nominal diameter (mm) :……..
- **Installation : Horizontal/Vertical**
- Pressure rating (PN or Kgf/$cm^2$) :…….
- Condition : i) good ii) needs repair iii) needs replacement

**16 Water meter :**

- Installation : Yes/No
- Manufacture's name/made in :……..
- Nominal diameter (mm) :……..
- Pressure rating (PN or Kgf/$cm^2$) :…….
- Condition : i) good ii) needs repair iii) needs replacement

**17 Water level measuring pipe :**

- Installation : Yes/No
- Nominal diameter (mm) :……..
- Material : i) GI Pipe ii) PPR Pipe iii) Others
- Depth (length),m :……..
- Condition :

**18 Discharge head (well head pipe with 90˚ bend) :**

- Installation : Yes/No
- Nominal diameter of pipe (mm) :
- Gasket between well flange and discharge head flange : Yes/No
- Clamping of discharge head flange with well head flange (by means of bolts, nuts, washers) : Yes/No

**19 Distribution pipe line of the tube well :**

I. Pipe line from value to distribution end point :
   - Material : G.I./ Polyethelyre /PVC
   - Diameter :……..mm/inch
   - Total length : ……m
   - Condition : good(nos……..)/needs repair(nos……)/needs replacement (m) :……

II. Valve
   - Sluice valve (nos……..)/Butterfly valve (nos……..)/Alfa valve (nos……)
   - Diameter : ……..mm/inch
   - Condition :good(nos……..)/needs repair(nos…….)/needs replacement (nos……..)

III. Bend 90˚

- Diameter ……mm/inch
- Quantity (nos) :…….
- Material : GI/MS/Polyethelyre/PVC
- Condition: good(nos……)/needs repair(nos……)/needs replacement (nos……..)

IV. Bend 45°

- Diameter ……mm/inch
- Quantity (nos) :…….
- Material : GI/MS/Polyethelyre/PVC
- Condition: good(nos……)/needs repair(nos……)/needs replacement (nos……..)

V. Tee

- Quantity (nos) :…….
- Material : GI/MS/Polyethelyre/PVC
- Condition: good(nos……)/needs repair(nos……)/needs replacement (nos……..)

**20 Electrification/ House wiring within the tube well/ Premise**

a. Condition of lights within the tube well premise : goods/needs repair/ (nos……..)/needs replacement (nos……..)
b. Condition of distribution board of well house
   - DPMCB : goods(nos……)/needs replacement(nos……)
   - MCB : a) goods (nos) :…….Ampere b) needs replacement (nos) :……Amper

**21 Earthing :**

- Type : i) Copper plate ii) G.I. Pipe iii) S.S. Pipe iv) Copper rod v) Others
- Earthing Resistance : ……Ohm(Ω)
  (Present Date……)
- Number of earthing :……nos.
- Condition : i) good ii) not good iii) needs repair iv) needs replacement
- Earthing connection :
  I. With transformer body : Yes/No
  II. With transformer Neutral (N) : Yes/No
  III. With lighting arrestors : Yes/No
  IV. With motor : Yes/No
  V. With Panel Board (Starter) : Yes/No
  VI. With main switch : Yes/No
  VII. With well : Yes/No
  VIII. With pipes and fittings : Yes/No
  IX. With house wirings/sockets etc : Yes/No
  X. With Distribution board : Yes/No
  XI. With NEA DB : Yes/No
  XII. With NEA Electricity consumption meter Box : Yes/No

XIII. With other equipments :

**22 Chainpulley stand :**

- Installation : Yes/No
- Condition : i) good ii) needs repair iii) needs replacement

**23 Chainpulley :**

- Installation : Yes/No
- Capacity :……..ton
- Condition :i) good ii) needs repair iii) needs replacement

**24 Tools Set :**

- Name and size of the tools :

i.
ii.
iii.
iv.
v.
vi.
vii.
viii.
ix.

**25 Pipe clamps for pump installation**

- Size: i) Diameter (mm)…… ii) QTY (nos)……..
- Condition : i) good……ii) needs replacement ……..

**26 Electrical measuring tools :**

- MultiMeter : Yes/No/needs repair/needs replacement
- Megar : Yes/No/needs repair/needs replacement
- Tester : Yes/No
- Others

**Annex B Monitoring Sheet of 11 kV Electrical Transmission Line**

District : Monitoring Date :

VDC/Municipality : Tole : Ward no :

DTW No :

- H.T. pole for 11 KV electrical line : GI/Mild steel/R.C.C/PSC
- Total quantity of poles :……..nos.
- Pole length (height) :……..m
- Total length of acsr/PVC insulated acsr conductor (m) : 3X…….
- Condition of poles : Painted/unpainted/corrosive/ not required painting tilted/straight
- Condition of cross-arm channel : Galvanized/painted /unpainted/corrosive/tilted
- Condition of Bolts/Nuts/Washers/Clamps : Galvanized/painted /corrosive/needs replacement
- Condition of Disc insulators with tension set : good/crack/broken/needs replacement nos :
- Pin insulators : good/crack/broken/needs replacement (nos) :
- Sickle insulators : good/crack/broken/needs replacement (nos) :
- Condition of ACSR conductor : good/loose/needs tighten/needs replacement

P.C.C. around

**Annex C Log Book Sheet of Deep Tube Well (DTW) Operation**

**Date :…….**

- District :
- Location : VDC/Municipality ……..Ward No……Tole/Street……
- DTW No : ……..Safe discharge of DTW……lps
- DTW Size :
  - i. Housing dia :……mm length :……m
  - ii. Casing/screen dia : ……mm Length……..m
- Manufacturer's name of the Submersible motor pump set :…… Made in……
- Power of submersible motor pump set (Kw/Hp) : ……
- Manufacturer's name of motor panel board (Starter) / made in……power (Kw/Hp)……
- Manufacturer's name of the Turbine motor pump set/ made in ……Power(Kw/Hp)……
- Type of motor panel board (starter) : DOL/SD/ATS
- Installation of motor pump set

i. Date ……. ii. Installation depth……m .iii. Column pipe (riser pipe) : diameter :……..mm length per piece : ……..m Type : Flange/ Thread

- 11kv/400v Transformer (KVA) :…….. Manufacturer's name/made in……
- Main switch (Amp)…… Manufacturer's name/made in ……..
- Operation Record

Table :

| S.N | Motor Pump Set ON | | Motor Pump Set OFF | | Total operation Hr/day | Flow meter discharge lpm | Flow meter total discharge $m^3$per total pumping hrs. | Pressure kgf/cm$^2$ | Voltage (V) | | | Current (A) | | | SWL m | DWL m | NEA meter readingUnit KWH | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Time | | | | | | | | | | | | | | | | | |
| | AM | PM | AM | PM | | | | | Ry | YB | BR | R | Y | B | | | Before Pump Start | Before Pump Stop |
| 1 | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | | | |

Note: SWL- Static Water Level, DWL- Dynamic Water Level, R- Red Phase, B- Blue Phase, Y- Yellow Phase

Operated by

Name :…….. Signature:…….. Position : ……..

Checked by

Name:…….. Signature:…….. Position:……

**Annex D** **Monitoring Sheet of Panel Board Starter**

**Panel Board Starter Rating (kW…… ..HP……..)**

**Starter : DOL/SD/ATS/Soft**

**District :** **Monitoring date :**

**Location :** **Manufacturer's name/made in :**

**DTW No. :** **Condition : i) inoperation ii) not inoperation iii) instore**

**Installation Date :**

| Description of Parts | Technical data | Quantity set/No. | Manufacturer | Made in | Condition | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Good | Damaged | Needs Repair | Needs Replacing | |
| Volt meter 0-500v | | | | | | | | | |
| Ammeter……A | | | | | | | | | |
| Volt meter change (selector) switch | | | | | | | | | |
| Ammeter change (selector) switch | | | | | | | | | |
| a) Contactor……A<br>b)Contactor……A | | | | | | | | | |
| Phase Failure Relay 400v | | | | | | | | | |
| Water level relay | | | | | | | | | |
| Overhead relay from…..A to……A | | | | | | | | | |
| Auxiliary relay | | | | | | | | | |
| Timer (Time relay) | | | | | | | | | |
| Min.max. Voltage relay 400v | | | | | | | | | |
| Power factor meter, 400v | | | | | | | | | |

| Description of Parts | Technical data | Quantity set/No. | Manufacturer | Made in | Condition | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Good | Damaged | Needs Repair | Needs Replacing | |
| HRC Fuses……Amp | | | | | | | | | |
| a)……A | | | | | | | | | |
| b)……A | | | | | | | | | |
| c)……A | | | | | | | | | |
| d)……A | | | | | | | | | |
| Hours Run meter, 230v | | | | | | | | | |
| Differential relay, 230v, 0.03÷3A | | | | | | | | | |
| Moulded case circuit breaker (main switch) (MCCB); V=400 / Amps:…… | | | | | | | | | |
| Indicating lamp: | | | | | | | | | |
| White | | | | | | | | | |
| Green | | | | | | | | | |
| Red | | | | | | | | | |
| Orange | | | | | | | | | |
| Others a)……b)……c)……. | | | | | | | | | |
| Push botton switch | | | | | | | | | |
| Start | | | | | | | | | |
| Reset | | | | | | | | | |
| Stop | | | | | | | | | |
| Others a)……b)……c)……. | | | | | | | | | |
| Auto Transformer (Kw): | | ° | | | | | | | |
| Current transformer (Amps) | | | | | | | | | |

| Description of Parts | Technical data | Quantity set/No. | Manufacturer | Made in | Condition | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Good | Damaged | Needs Repair | Needs Replacing | |
| Heater with thermal relay (thermostat 0÷31˚c | ˚ | | | | | | | | |
| Capacitor ……KVAR a)……..b)…… | | | | | | | | | |
| HRC Fuse link ……A a)……..b)……c)……. | | | | | | | | | |
| Fuse holder with fuse | | | | | | | | | |
| ……A | | | | | | | | | |
| ……A | | | | | | | | | |
| ……A | | | | | | | | | |
| ……A | | | | | | | | | |
| ……A | | | | | | | | | |
| Miniature circuit breaker (MCB) | | | | | | | | | |
| ……A | | | | | | | | | |
| ……A | | | | | | | | | |
| ……A | | | | | | | | | |
| ……A | | | | | | | | | |
| DPMCB | | | | | | | | | |
| ……A | | | | | | | | | |
| ……A | | | | | | | | | |
| ……A | | | | | | | | | |
| ……A | | | | | | | | | |
| Terminal Blocks | | | | | | | | | |
| ……A | | | | | | | | | |
| ……A | | | | | | | | | |
| ……A | | | | | | | | | |

| Description of Parts | Technical data | Quantity set/No. | Manufacturer | Made in | Condition | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Good | Damaged | Needs Repair | Needs Replacing | |
| ……A | | | | | | | | | |
| Single Pole Switch 0-1 | | | | | | | | | |
| Cable Shoes | | | | | | | | | |
| Wiring cables | | | | | | | | | |

**Annex E Monitoring sheet of Distribution Transformer and Tower**

District : Monitoring date :

VDC/Municipality : Tole : Ward No. :

DTW No. :

1. Transformer
    a) Manufacturer's name :
    b) Made in :
    c) Serial no. :
    d) Manufacturing year :
    e) Voltage : 11kv/400v
    f) Power (KVA) :……Current : HV……A LV……A
    g) Core type : i) Amorphous core ii) Silicon core
    h) Winding material : i) copper ii) Aluminium
    i) Phase : 3
    j) Frequency : 50 hz
    k) Date of installation :
    l) Transformer oil capacity (liter) :…….
    Condition : goods/needs filtration/ needs replacement
    m) Condition : In operation/not in operation/in store
        I. Transformer : needs repair/needs replacement
        II. Bus Bar (H.V.) : R : good/needs repair/needs replacement
        (11 KV) Y : good/needs repair/needs replacement
        B : good/needs repair/needs replacement
        III. Bus Bar (L.V.) : R : good/needs repair/needs replacement
        (400 V) Y : good/needs repair/needs replacement
        B : good/needs repair/needs replacement
        N : good/needs repair/needs replacement
        IV. Breather with Silicagel : goods/needs repair/needs replacement
        V. Transformer oil level : Normal/Down
        VI. Radiator tubes for cooling : Leakage : Yes/No
        VII. Explosion vent : Yes/No/Damaged
        VIII. Temperature gauge : Yes/No/Damaged
        IX. Tap changer : a) Good b) Needs repair c) needs replacement
        X. Earthing connection:
            - With transformer's body : Yes/No/insulated conductor/uninsulated conductor
            - With neutral : Yes/No/Insulated conductor/ un-insulated conductor
            - With lighting arrestor : Yes/No/insulated conductor/uninsulated conductor

XI. Earthing conductor (copper wire) : yes/No/insulated/uninsulated
XII. Others :

2. Transformer Tower/Poles :
    - H.T.Pole type : GI/Mild steel/R.C.C/PSC
    - Pole length (height) :……m
    - Condition of poles : Painted/unpainted/corrosive/not required painting/inclined/straight
    - Condition of C-channels (cross arm channel) : Galvanised/Painted/Unpainted/Corrosive
    - Bolts/Nuts/Washers : Galvanised/Painted/Unpainted/Corrosive
    - Condition of Insulators(H.T.side)
        i. Disc insulators with tension set : good/crack/broken/needs replacement nos :
        ii. Pin insulators : good/crack/broken/needs replacement nos :
        iii. Sackle insulator : good/crack/broken/needs replacement nos :
        iv. Others :
    - Condition of ACSR conductor : i) good ii) needs replacement (m) :
    - Condition of Drop out (DO) Fuses : i) good ii) needs replacement nos :
    - Condition of lighting arrestor : i) good ii) needs replacement nos :
    - P.C.C. around the poles (above/below the ground level) : Yes/No
    - Gang operating switch (H.T.) : Yes/No/Operating/unoperating
    - Condition of LT cables : good/needs replacement
    - Condition of H.T. cables : good/needs replacement
    - Condition of clamps, Bolts, Nuts, Washers:
3. Armoured cable : (LV 400V)
    - Size : i) area……Sq.mm ii) core : $3/3^{1/2}$ iii) core : 4
    - Condition : i) good ii) damaged
        I. Cable shoes : Yes/No/Needs replacement nos :
    - Cable shoes material : Cu/Al
    - Others :
4. Main Switch/ Distribution Board within the well house
    - Power Kw/hp :……
    - Voltage :…….....V /3-phase+neutral
    - Condition : good/needs repair/needs replacement
    - Others :
5. Nepal Electricity Authority (NEA) Electrical Power consumption meter
    - Existing Demand meter capacity (Kw) :…….Current (A)……..
    - Actual needs demand meter capacity (Kw)……current (A)……
    - Consumer's name :…….

- Date of installation/operation :…….

6. Low Voltage (400v) distribution board for NEA power connection
    - Power Kw/Hp :
    - MCCB (Amp) :
    - Voltage 400V/3 phase +nermal
    - Condition : good/needs repair/needs replacement
7. Stay Set
    - Installed Quantity :……..sets
    - Condition :
        I. Stay plate : Ok/Not Ok/Can’t identify
        II. Stay rod : Ok/Not Ok/Can’t identify
        III. Turn buckle : Ok/Not Ok/Can’t identify
        IV. Stay wire : Ok/Not Ok/Can’t identify
        V. Stay insulator : Ok/Not Ok/Can’t identify
8. Others :