Energy Audit of Water and Wastewater Utilities
in 6 towns of Moldova

Supply and Installation
of Plant and Equipment

TECHNICAL SPECIFICATIONS

for
Mechanical and Electrical Equipment for
Boreholes in Causeni and Floresti

TECHNICAL SPECIFICATIONS
for
Mechanical and Electrical Equipment for
Booster Pumping Station

Contents:

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1 General Information

1.1 Description of the Site and Equipment

1.1.1 Site “A”. Causeni

Water intake consists of one wellfield located in the western part of the City center, along the right bank of the Botna River. The wellfield area is located at ground elevation of some 9-11 m a.s.l. and includes ten (10) deep wells, out of which only two (Wells No1 and 2) are in regular use and one (Well No3) is decommissioned in 2010 due to the water debit reduction. All operated deep wells have submersible pumps, type ЭЦВ, manufactured in Moldova.
According to existing well passports, all wells are fed from the same aquifer. All submersible pumps in use lift water at a constant pressure head directly into two (2) existing water tanks from the Main PS, at elevation of 11 m a.s.l.
General data on installed pumping equipment are presented in the following Table:

Design parameters of the existing pumping equipment at the Causeni water intake

Well No	Model	Qty	Design Flow rate	Design Head	Design Motor Data					Operating	Depth of installation
					P	Voltage	Speed	cosφ	In		
			m^3/h	m	kW	V	rpm		A	hrs /day	m
1	**ЭЦВ 8**-25-100	1	25	100	11.0	3x400	3000	0.83	24.2	24	63
2	**ЭЦВ 10**-63-110	1	63	110	32.0	3x400	3000	0.84	67.4	18	63

As can be seen from the Table above, design heads of the pumps in use are oversized (100-150 m), having to pump water from geodetic height of -30 m to 11 m a.s.l. (Main PS water tanks elevation). Furthermore, pump motors are oversized as compared to the modern pump equipment.
All submersible pumps are operated manually. Both wells are not equipped with water meters and pressure gauges.

1.1.2 Site “B”. Floresti

Main Water intake consists of one wellfield located some 8 km West of Floresti center, along the left bank of the Cainari River, a tributary to the Raut River. The wellfield area is located at ground elevation of some 80-85 m a.s.l. and includes eight (8) deep wells, out of which only four (Wells No.1461, 4181, 4277 and 1560) are in regular use and the other wells are used as reserve. Deep well No.4182 is taken out of operation due to inadequate operating conditions (low groundwater level). All operated deep wells have submersible pumps, type ЭЦВ (ECV), manufactured in Moldova.

According to existing well passports, all wells from Cainari wellfield are fed from the same aquifer at depth of some 20 m (hydrostatic water level). All submersible pumps in use lift water at a constant pressure head directly into two (2) existing water tanks from the Main PS, at elevation of 94 m a.s.l.

General data on installed pumping equipment are presented in the following Table:

Design parameters of the existing pumping equipment at the Floresti main water intake

Well No	Model	Design Flow rate	Design Head	Design Motor Data					Opera-ting	Depth of instal-lation
				P	Voltage	Speed	cosϕ	In		
		m^3/h	m	kW	V	rpm		A	hrs /day	m
1461/5	ЭЦВ10-63-110	63	110	22	380	3000	0.8	48	7	48
1462/6	-	-	-	-	-	-	-	-	reserve	-
4181/7	ЭЦВ10-63-80	63	80	22	380	3000	0.8	47.4	7	48
4182/8	-	-	-	-	-	-	-	-	closed	-
4183/9	-	-	-	-	-	-	-	-	reserve	-
4277/10	ЭЦВ10-63-110	63	110	22	380	3000	0.8	48.3	7	48
4278/11	-	-	-	-	-	-	-	-	reserve	-
1560/12	ЭЦВ10-63-110	63	110	22	380	3000	0.8	48	7	40

1.2 Scope of Works

1.2.1 Introduction

The Contractor shall design, supply and install all necessary mechanical and electrical equipment for two (2) borehole pumping stations in Causeni and four (4) borehole pumping stations in Floresti.

All electrical and mechanical equipment, valves and pipes inside the pumping stations are to be replaced.

Each item of the requested mechanical, electrical material and equipment is described and specified in detail below.

Borehole Pumping Stations

Each well is equipped with a submersible pump, a flow meter and pressure manometer for the outlet pressure of the pump.

Operation of the submersible pumps shall be controlled manually. In addition future possibilities for distance control according to the level in the potable water reservoirs shall be anticipated.

Parameters of the boreholes to be supplied with new pumps are provided in the Table below.

Delivery of complete equipment, management of mounting, testing and commissioning of boreholes and borehole head structures will be performed. The equipment shall be installed in the borehole, borehole head structure. Piping shall be connected to raw water pipes in the ground, also as a part of this contract. All electrical equipment, including electrical switches, pump protection devices will be installed inside the separately located concrete Switchboard buildings. Electrical cables shall be supplied and laid between all borehole head structures and between each Switchboard building.

1.2.2 Detailed design, manufacturing, delivery, dismantling, construction, installation, testing, pre-commissioning and commissioning

The Scope of Works for the Contractor includes the following main tasks:

- Detailed design of mechanical equipment installations,
- Detailed design of electrical installations,
- Detailed design of pump control unit,
- Manufacture of materials, equipment,
- Delivery of all materials and equipment to the site,
- Supervision during the dismantling of the existing constructions, pumps and valves,
- Installation, testing, pre-commissioning and commissioning of all new materials and equipment for complete borehole pumping station installations

- Training of Water Utility staff in the operation and maintenance of equipment supplied under this contract

The Contractor shall perform all tasks in accordance with the instructions and specifications described in this document.

1.2.3 Mechanical supply

Borehole pumping stations

- Six (6) borehole pumps for pumping water from wells, including motors and submerged cables
- All necessary pipes, flow meters, gate valves, check valves and fittings for connecting the pumps to the existing pipe system.

1.2.4 Electrical supply

Borehole pumping stations

- Cables to be laid for the connection of the transformer sub-station with the borehole Switchboard buildings
- Cables to be laid between well head buildings and Switchboard buildings
- Six (6) low voltage Pump Control Unit
- Electrical installation materials (incl. cables for pumps)
- All other electrical supplies necessary for the completion of the electrical system

1.2.5 Drawings and technical description

The Mechanical/Electrical installations shall be designed in all respects to confirm with the latest current Project Management practice. The philosophy of preparing designs shall be simplicity and reliability, so that the equipment will provide long and trouble-free service with low maintenance costs and low energy consumption.

Particular attention should be paid to easy access to installations for the purposes of inspection, cleaning, maintenance and repair.

The main components incorporated in items of plant shall correspond to the below technical specifications. Any deviation from technical requirements for a pumping station item shall be subject to the minimum requirement that the required features are covered and that the Contractor present full documentation in the form of detailed specifications and literature from the manufacturer.

All supplied equipment shall be designed to meet the requirements of satisfactory operation under all variations of operating loads, pressures and temperatures, including variations in ambient temperature.

All materials shall be new and of the best quality and shall be selected to withstand the stresses imposed by the working and the ambient conditions without distortion or deterioration and not affecting the efficiency and reliability of the plant.

It shall be the responsibility of the Contractor to ensure that the electrical equipment (also cables) is completely satisfactory for use with the offered mechanical equipment.

Each component or assembly shall have been tested in service in a similar application and under conditions no less arduous than those specified herein. The Engineer shall have the right to request the Contractor to justify his selection of equipment. In case it is shown that the material or plant is of a standard lower than the one necessary for complying with the Specification, the Contractor shall modify or replace the equipment concerned at no extra cost.

The choice of materials and finishes shall take into account the atmospheric conditions outside the pumping stations and on the well field. Equipment shall be protected against the penetration of dust, vermin, insects or small animals.

Outdoor equipment shall be weatherproof and designed to prevent the collection of water at any point. Metal-to-metal joints will not be permitted and all external bolts or screws shall be provided with blind tapped holes where a through hole would permit the ingress of moisture.

Mechanisms shall be built from materials that will not jam due to rust, corrosion, brine or dust. Bearings of exposed operating shafts shall be designed to prevent moisture seeping along the shaft into the interior of the equipment.

Equipment and instruments shall not be located in positions where they are vulnerable to falling objects or water drips. Weather shields shall be provided wherever necessary to protect the equipment, instruments and cabling against weather conditions and direct sunlight.

A complete set of drawings and technical description of the installation shall be submitted to the Engineer.

The Contractor shall submit drawings and other details for the approval of the Engineer as detailed below. All drawings must be prepared using CAD systems. The software listed below must to be used for:

- the drawings – AutoCad
- the tables – MS Excel
- the text materials – MS Word

The drawings must be prepared according to all valid rules of the Republic of Moldova and standards for design documentation.

In cases where the Contractor's proposals do not obtain the approval of the Engineer, the Contractor shall amend copies of the drawings in the shortest possible time. In all cases the amendments shall be done within **1 week** of the Contractor being notified of the Engineer's observations.

It shall be clearly understood that any given approval shall not be taken as constituting any expression on the part of the equipment, or in any way relieving the Contractor of his responsibilities or obligations under the Contract.

Technical documentation

The Contractor is requested to document the efficiency of his proposed pumps at the time of tendering by submitting references, including test certificates from similar supplies.

To be submitted with tender

General arrangement drawings, clearly showing all the necessary equipment and materials proposed to be supplied by the Contractor. These drawings shall state all main dimensions and the positions of the equipment.

The Contractor shall submit with his tender all documents (brochures, certificates, etc) showing that all valves, fittings, equipment and materials comply with the specifications presented under this Chapter.

The Contractor shall include with his tender a reference list stating supplies made during the last two years of pumps of similar type and size, including relevant test certificates for the pumps in question.

The Contractor shall submit with his tender individual and full performance curves for the pumps marked with any restrictions in the working range, with regard to power consumption, etc.

Description and Drawing/Diagram of the test facilities with official calibration certificates of flow pressure and power meter systems used for the testing of the pumps. The necessary frequency of calibration of the meters shall be stated. The curves are regarded as guarantee curves of an eventual contract and the accuracy of the curves must be indicated.

Furthermore, the Contractor shall submit with his tender the following material:

- Drawings giving information of the pump construction and main measurements.
- Details of construction materials for housing impeller, shaft etc.
- Description of bearing construction and lifetime.
- Description of coupling and lifetime.
- Specifications on all equipment supplied, including reference to standards according to which it is manufactured.
- Detailed description of the training programme for operation and maintenance

The following are to be submitted within 4 weeks of the acceptance of the tender:

- Detailed mechanical drawings.
- Schematic wiring diagrams for control panels, and all other electrical-automatic equipment. The drawings shall indicate cable sizes and provide complete information on type and production of the equipment.
- The drawings shall provide the Engineer with complete information regarding the design of the equipment, materials proposed and approval of the drawings shall be obtained before commencement of any supply or construction work

As-built drawings

The Contractor shall make as-built drawings based on the contract drawings that show clearly the assembly of the plant's items as installed, including in particular control panels.

At the Commencement of the Commissioning Period, the Contractor shall submit to the Engineer for approval four (4) copies of the following "As Erected" and "As Fitted" drawings:

- Drawings showing the internal construction of the major items, with parts list and reference numbers for ordering spares.
- Complete assembly drawings of machinery and ancillary plant showing all pipework and connections.
- General Arrangement drawings showing all mechanical and electrical equipment including cabling.
- Detailed arrangement of any conduit work buried in floors, walls, and ceilings, in any structure.
- Detailed wiring, cable route and electrical layout schematic diagrams for the main circuits.
- Four (4) copies of detailed revised Specification as actually installed.
- Four (4) copies of the final version of the Operating and maintenance Instructions in English and Romanian/Russian.

When items have been approved by the Engineer, the Contractor shall provide two black and white prints of each item on thick paper for the use of the Engineer together with a copy on electronic media.

All dimensions marked on drawings shall be considered correct although measurements by scaling may differ.

The Contractor shall be responsible for any discrepancies, errors or omissions in the mechanical and electrical drawings and information supplied by him whether they have been approved or not, provided that such discrepancies, errors or omissions are not due to inaccurate drawings or information furnished to the Contractor by the Beneficiary or the Engineer.

1.2.6 Operation and maintenance manuals

Submission of complete operation and maintenance manuals of the installation to the Engineer upon delivery of plant and equipment.

Four copies of fully detailed manuals in English (vital parts of the manuals shall be translated into Russian/Romanian) for the operation and maintenance of the equipment are to be provided in a durable form for approval by the Engineer or the Engineer's Representative.

The Contractor's attention is drawn to the need to ensure that the following items are included in the Maintenance Manuals:

- Contents
- General description
- Safety instructions
- Design criteria
- Main data
- Functional description
- Special conditions

- Control description
- P+I-diagram. This drawing, together with the arrangement drawing and numbered item list, shall be framed and hung up on the wall in the pumping station
- Operation and maintenance description of the system. Description of preventive maintenance of the system, how to register parameters that in the long run can give the staff indication for the development of condition of the system's components.
- Maintenance instructions
- Installation and start up instructions for all items, such as
  - Safety instructions for all items during operation and maintenance.
  - Schedule for intervals between maintenance of all items
  - Calibration of instruments
  - Oil change
  - etc.
- Schedule of supplied equipment giving the producer's name and appropriate Model No,Type,
- Other necessary information for positive identification of the component
- Schedule of routine maintenance for all supplied equipment.
- Schedule of supplied spares.
- Schedule of supplied tools and lubricants.
- Sectional arrangement drawings of major items of plant, i.e. pumps, valves etc., with dismantling instructions.
- Plant layout drawings showing the "As Erected" installation.
- General arrangement and schematic diagrams of the "As Installed" control panels and switch gears.
- "As Wired" diagrams of all electrical connections, between the control boards, switch gears and installed loads.
- Full and comprehensive instructions for all items of supplied equipment.

- The documentation for each item shall as minimum contain the following:
  - Contents
  - Brochures and /or data sheets stating the address of the manufacturer
  - Performance guaranties and warranties
  - Characteristics (curves, diagrams, test certificates etc.)
  - Description of functions
  - Wiring diagram
  - Arrangement drawing with detailed items list
  - Installation and start up instructions
  - Maintenance instructions
  - Trouble shooting
  - Repair guidelines
  - Complete list of spare parts
  - Summary of supplied spare parts
  - Direction for maintaining stock of spare parts
  - General plan and cross sectional drawing
  - Coating specification
  - Application methods of coating and safety precautions.
  - Guidelines for repairing damage coating
  - Specification of surface treatment. Methods for repair, specifications for contents, application methods and safety precautions.
  - Conservation instructions for storage
  - Trouble shooting instructions
  - Special conditions
  - Safety instructions
  - Test certificates for motors/pumps/pressure vessels/lifting equipment for both works and site tests and for transformers/electrical installation and other items, where appropriate.
  - Pump and blowers performance curves as tested.
  - System Curves.
  - Schedule of recommended lubricants and their equivalents.

Thus, the manuals shall contain all relevant information in order to properly maintain and repair the equipment, and obtain correct spare parts wherever and whenever necessary.
A lubrication schedule shall be provided, containing a recommended lubrication schedule for all equipment and shall indicate comparable qualities of lubricant and grease, if necessary.

Recommendations of special tools and spare parts sufficient for 3 years of operation shall also be elaborated. Prices for tools and spare parts shall be included in the tender.

1.2.7 Delivery of tools and spare parts

The Contractor shall include in his price the set of spare parts each item being separately numbered and priced, a list of such spares that he recommends for 3 years of operation, with due regard to location conditions and the availability of such spares.

The Contractor shall quote and provide a complete set of tools to enable the staff of the plant to maintain and repair every item of the plant. List of tools shall be presented with the Tender.

The Contractor will be responsible for the supply of the recommended lubricants and consumable items such as oil, sufficient for a period of two years operation. The Contractor is responsible for ensuring that all grease lubricators have been filled and the grease applied to all nipples before starting up the plant.

The Contractor shall ensure that the used lubricants or their equivalent are obtainable on the Moldovan market.

1.2.8 Training

The Contractor shall include in his tender, as an option, the training of the Beneficiary's staff to provide service and repair of the pumps, change of wear parts etc. Duration is to be recommended and stated in the Tender by the Contractor.
The Contractor shall provide training for the operation and maintenance staff of the water supply company:

- The staff shall participate in the running of the plant.
- The Contractor shall hold at least 1 theoretical course on operation and maintenance of the pumping installation.
- The Contractor shall give notice of the courses in good time.
- The Contractor shall prepare an agenda for the courses.
- The operation and maintenance manuals shall be translated, finished and delivered to the participants in good time before the courses are held.

1.3 Work Program

The Work Program for the Machinery to be supplied and installed shall be divided into the following parts:

Part I Manufacturing Period: Design and manufacture of all equipment to be supplied under the Contract including Inspection and Testing.

Part II Shipping Period: Delivery of all equipment from factory to Contractor's storage depot including all freight loading, off loading, customs duties and clearance, etc.

Part III Removal of all equipment from off site or on site storage, delivery to erection site.

Part IV Installation works.

Part V Site Testing

The Contractor shall be deemed to have completed installation when the entire plant is ready for the witnessing of Dry Testing by the Engineer and the Contractor has informed the Engineer of this.

Part VI Maintenance manual and training period

The Contractor is therefore requested to elaborate his Work Program for the supply and installation of the mechanical and electrical equipment in conformity with the Contract time limits.

This work program shall form part of the Contractor's tender documents, and shall be updated before start of works.

1.4 Work Requirements

1.4.1 Standard of materials and workmanship

All materials and equipment shall as a general rule meet the appropriate international standards (ISO) or approved similar with regard to material, quality, workmanship and performance and have ISO 9001 certificates. Coating of all mechanical components shall meet the appropriate Swedish standards (SIS) (Environmental Class III) or approved similar. The electrical equipment shall as a general rule meet the IEC or/and DIN Standard or approved similar. Local laws and regulations concerning electrical equipment and installations shall be observed.

1.4.2 Completion, Pre-commissioning, tests, commissioning and guarantees of Facilities

As soon as the Facilities or any part thereof have, in the opinion of the Contractor, been completed mechanically and structurally and put in a tight and clean condition as specified in the Technical Specifications, excluding minor items not materially affecting the operation or safety of the Facilities, the Contractor shall so notify the Beneficiary in writing.

Within seven (7) days since the receipt of the notice, the Beneficiary shall supply the operating and maintenance personnel for pre-commissioning of the Facilities or any part thereof.

As soon as all works in respect of Pre-commissioning are completed and, in the opinion of the Contractor, the Facilities or any part thereof are ready for Commissioning, the Contractor shall so notify the Engineer in writing.

If the Engineer notifies the Contractor of any defects and/or deficiencies, the Contractor shall then correct such defects and/or deficiencies and shall repeat the procedure described above.

If the Engineer is satisfied with the Facilities, or that part thereof has reached Completion, the Engineer shall, within seven (7) days since the receipt of the Contractor's repeated notice, issue a Completion Certificate stating that the Facilities or that part thereof have reached Completion at the date of the Contractor's repeated notice.

If the Engineer is not so satisfied, then he shall notify the Contractor in writing of any defects and/or deficiencies within seven (7) days since the receipt of the Contractor's repeated notice, and the above procedure shall be repeated.

Commissioning of the Facilities or any part thereof shall be commenced by the Contractor immediately after issue of instructions by the Engineer.

Guarantee Test

The Guarantee Test (and repeats thereof) shall be conducted by the Contractor during Commissioning of the Facilities or the relevant part thereof to ascertain whether the Facilities or that part can attain the Functional Guarantees specified in the Technical Specifications. The Contractor's and Engineer's advisory personnel shall attend the Guarantee Test, and advise and assist the Beneficiary.

The performance of each pump unit shall be tested. Test Certificates, in triplicate, shall be supplied not later than 5 days after the date of the tests.

The approval by the Engineer or the Engineer's Representative shall in no way relieve the Contractor of his responsibility for the performance of the plant after erection.

The entire plant shall be tested to demonstrate its ability to perform the specified duties satisfactorily. The testing on site shall be the Contractor's responsibility.

All equipment subject to water pressure vessels, pipes, fittings and valves, shall be hydraulically tested to the pressure where specified or, at least 1.3 times, to the maximum working pressure. Certificates of tests for all items shall be submitted.
Any of the hydraulically tested items shall be subject to the Engineer for random item proof re-test and notice of testing dates shall be submitted to the Engineer.

The Contractor shall submit, for approval, a detailed description of the on site tests and procedures to be carried out. The description shall be submitted to the Engineer in reasonable time prior to the date of carrying out the tests in order to enable the Engineer to consider the proposed tests and procedures.

The Contractor shall be responsible for co-ordinating the programme of site testing of all items and ensuring that all parties concerned are present during any tests to obligate their responsibilities.

After erection is completed and the equipment is running satisfactorily after primarily setting to work, the Contractor shall notify the Engineer that he is ready to demonstrate the performance of the equipment. Such demonstration is referred to herein as Dry Testing, which shall be witnessed by the Engineer. The Contractor shall then fully test all items of equipment and shall include provision and arrangement of:

- All skilled and qualified operating and test staff for the testing of all equipment.
- Provisions and disposal of all services, lubricants, fuels and electricity.
- All measuring and testing instruments to demonstrate that the equipment operates to the work tests.

All tests shall be carried out by the Contractor under the supervision of and to the satisfaction of the Engineer, as follows:

- For electrical plant and power systems The Test of Completion shall comprise pre-commissioning detailed tests as detailed below, prior to energisation from the power supply system, followed by energisation and demonstration of the operation of the plant and associated protection and control systems to the specified performance requirements and maximum operating and load duties.
- Certificates of temporary acceptance will be issued for equipment of lower voltage on satisfactory demonstration of on-load operation.
- For system equipment installations, tests shall be carried out at 400 V using an approved test instrument. These tests shall be carried out with all circuit breakers/contactor panels closed in the circuits position, between phases and phase to earth. All secondary small wiring circuits shall be similarly tested.
- All mechanical tests specified for conducting the manufacturer’s premises are to be re-checked to ensure satisfactory operation of the plant in the final erected state.
- The satisfactory operation of all protection circuits over their whole operating range shall be tested by secondary current injection, where primary injection tests have been previously carried out on manufacturer’s premises.
- Tests shall be carried out to ensure the correct operation of current and voltage operated indication instruments when energised by actual supply system.
- Continuity tests shall be carried out on the earth conductor within the switchboard, such tests being by current injection.
- Before the application of electric power on the machine windings, the insulation resistance shall be tested (with a suitable insulation resistance tester) and shall be greater than the manufacturer’s minimum recommended figure when corrected for site winding temperature. Any necessary drying out of the windings on site shall be in accordance with the manufacturer’s recommendations.
- It is the responsibility of the Contractor that all motors connected by him rotate in the correct direction and that all thermal overload relays are set up correctly.
- Test that the resistance of the earthling networks and electrodes are within the specified limits and in compliance with the Supply Authority’s Regulations.
- The Contractor will in addition be responsible for arranging and carrying out such witnessed or un-witnessed tests and inspections as may be required by the Electrical Supply Authority and obtain and hand over to the Engineer their certificate of approval of the complete electrical installation.
- All Equipment and items, after installation either prior to or after commissioning as

necessary or as may be directed by the Engineer, shall be finally painted to comply strictly to surface protection specification.

- *All functions and possible fault situations of the plant shall be tested at full capacity Functional tests shall be carried out on all alarm systems, overloads and safety equipment*

- *Any other tests necessary to demonstrate the ability of the supplied equipment to perform the specified functions.*

The Contractor shall include all the necessary costs for carrying out these tests on all equipment, plant, and labour.

The Contractor shall guarantee the following:

- All equipment shall be new and of best quality.

- The mechanical and electrical solutions presented in his tender shall be new and of the highest quality standards with respect to material and performance.

- The Contractor is responsible for any defects in manufacture and/or defects in materials for two (2) full years after the commissioning of the plant.

- The Contractor shall guarantee surfaces of non-stainless materials for two (2) full years after the delivery of this material to the site against corrosion.

  The coatings shall neither blister nor peel between paint layers or between the coating and the surface to be protected.

- *The supplied equipment meets the requirements of performance, capacity, efficiency, starting current and noise level, as stated in his tender.*

In case the tests performed prove that these requirements are not met, the Engineer is entitled to demand remedial actions to be taken immediately in order to meet these requirements.

1.4.3 Warranty period

If any repairs and/or alterations of the equipment are required, the warranty period for these specific parts will not commence until these repairs/ alterations have been brought to a successful conclusion and the Beneficiary or Engineer has been duly notified in writing.

The Contractor commits himself to carry out any remedial works immediately. The necessary time limits for these works shall be agreed with the Engineer as soon as a malfunctioning or defective component has been discovered. But all defects shall be liquidated or spare parts delivered within 72 hours.

If the Contractor does not carry out the remedial works within the agreed time limits, the Employer is entitled to require the performance of the necessary works by others at the Contractor's expense.

The Contractor shall present all details in his Tender about the location of the nearest pumps manufacturer/supplier representative. Procedures and conditions, on which the assistance will be provided to the Beneficiary during warranty and after warranty period, if there will be need for advice, remedy of defects or pumps repair , shall be explained in the Tender.

1.5 Climatic Conditions

The Contractor shall be responsible for the progress of the work regardless of weather

conditions. The Contractor shall take appropriate steps to protect equipment, materials and personnel during all phases of construction. The Contractor shall be responsible for any damage caused to equipment and materials due to adverse weather, or whether due to negligence.

1.6 Unit of Measurement

The Metric units of measurements (Système Internationale) shall be employed in all correspondence, in all technical schedules and on all drawings.

1.7 Working Environment, Safety and Noise

The design of the plant and equipment shall include provisions to ensure the best possible working environment for the operation and maintenance staff. Attention shall be paid to:

- *Easy operation and access to instruments and other components which require regular attention.*
- All moving and rotating parts shall be protected against contact by shields, gratings or alike.
- Warning signs in Romanian, Russian and English shall be placed on all machines that present a danger of injuries.
- Vibration and noise shall be reduced to a minimum, adequate steps for reduction shall be taken, and described in the proposal. Special care shall be taken to isolate vibrations from the civil structures. As a minimum, the pump units shall comply with ISO 10816-1 class IIIa.

2 Mechanical Works

2.1 General Technical Specifications

Unless otherwise specified, the following applies to the mechanical equipment described herein:

2.1.1 Materials and Protective Coatings

The chosen materials, components and protective coatings shall ensure the easy maintenance and cleaning of the moisture, temperature, dust and other adverse conditions expected at a facility of this type.

Wrought Steel
Where not otherwise specified, wrought steel parts shall be selected from appropriate grade of BS 970 and be free from blemishes, shot or hammer marks.

The Contractor shall submit the grade number selected for various components for the approval.

Cast Molybdenum
Cast Molybdenum steel shall be supplied to BS 3100.

Cast iron
All grey iron castings supplied shall be close to the appropriate grade in BS 14452. All castings are to be free from blowholes, flaws and cracks.

The Contractor shall replace any casting which the Engineer considers not of first class appearance or, any way, is not the best which can be produced, although such a casting may have passed the necessary hydraulic or other tests.

Only sound castings shall be incorporated in the plant. Welding, building up, filling or any

other processes to repair castings will not be permitted in respect of any casting associated with engines, compressors, pumps, gear boxes or other such plant subjected to pressure or vibration.

Bronze

Where not otherwise specified, bronze shall be made of strong and durable zinc free mixture to BS 1400.

Stainless Steel

Stainless steel shall be provided in accordance with Grade 304 according to BS 970 if not specified otherwise.

Stainless steel shall be handled and stored so that the corrosion properties are not impaired.

All non-stainless steel surfaces shall therefore be appropriately surface treated to prevent corrosion or deterioration under the rigorous environmental conditions experienced during plant operation.

Iron and steel members shall be protected against corrosion plates in accordance with classification of ISO R 944-2.

Small iron and steel parts (other than stainless steel) the cores of electromagnets and the metal parts of relays and mechanisms are to be treated in an approved manner to prevent rusting. Cores, etc., which are built up of laminations or cannot for any other reason be anti-rust treated are to have all exposed parts cleaned and heavily enamelled or lacquered. The use of iron and steel shall be avoided in instruments and electrical relays wherever possible.

When it is necessary to use dissimilar metals in contact, these should be selected so that the electrochemical potential difference is not greater than 250 millivolts. Where practicable the two metals are to be insulated from each other by an approved insulating material or by a coating of an approved varnish compound.

Steel screws when used are to be hot-dip galvanised. Hot dip galvanization shall be made in accordance with ISO 1459, 1460 and 1461 or approved similar.

Sanitary fixtures are to be chromium plated. Springs are to be of brass, bronze or non-rusting material. Pivots for which non-ferrous material is unsuitable shall be of an approved corrosion resisting steel.

2.1.2 Vibrations, Monitoring Equipment

The Contractor shall include as an option in his tender a monitoring system with a hand-held condition tester, to survey vibrations (see page 15, section 1.7 "vibrations".

2.2 Particular Technical Specifications

2.2.1 Existing Facilities and Pipeworks

Boreholes well head buildings will be ready for pumps and pipes installation, where pumps will be dismantled by the Beneficiary's staff during the time agreed with Contractor.

All pipes and assembling parts selected under this Contract must be of first quality, truly circular, and of uniform thickness, free from scale, lamination, honeycombs and other defects, and shall be designed and suitable for the stated pressures and temperatures.

The pipework installation shall be arranged so as to ease the dismantling and removal of pumps or other major items of equipment.

Ends of pipes for use with flange adapters and couplings shall be faced, squared and sized to the tolerances required by the manufacturer of the coupling.

All loose flanges shall be secured to fixed flanges by suitable tie-bolts.

All pipework shall be adequately supported with purpose made fixings. When passing

through walls, the pipework shall incorporate a puddle flange.

Flange adapters and unions shall be supplied and fitted in the pipework runs wherever necessary to permit the simple disconnection of flanges, valves and other equipment without the need to disturb long runs of pipes.

Flanged joints shall be made with 3 mm thick, full face, rubber gaskets, pierced to take the bolts, and the face of all flanges shall be machined to give a true angle of 90° to the centre line of the pipe or fitting.

The whole of the jointing and materials necessary to fix and connect pipes including adequate and efficient pipe supports, are included in the Contract.

The hydraulic test pressure applied on the manufacturer's works shall be the normal test pressure for the kind of materials used. However, if approved by the Engineer, the test pressure may be reduced to one and a half times the maximum working head of that particular installation.

After completion of any fabrication, all pipes shall be hydraulically tested. If any alterations involving additional fabrication are made after shipment, a further hydraulic test will be required on the pipe or piping assembly concerned.

The Contractor shall be responsible for ensuring that internal surfaces of all pipework are thoroughly cleaned before and during erection and before commissioning. Cleaning shall include removal of all dirt, rust, scale and welding slag due to site welding. Before shipment from the Contractor's works, ends of pipes, branch pipes, etc. shall be suitably capped and covered to prevent accumulation of dirt or damage. This protection shall not be removed until immediately prior to connecting adjacent pipes or valves at site.

Flexible joints, collars and cut pipes shall be provided on all pipework where necessary to allow for some margin of error in the building work or differential settlement. The pipework system shall be so designed to ensure that anchorage at blank ends, bends tees and valves is kept to a minimum. The Contractor shall show thrust blocks that are required to anchor pipework supplied by him on his working drawings.

In general DIN/ISO shall apply for tolerances on wall thicknesses and diameters.

Fittings, such as elbows, tees and reducers, shall be in accordance with DIN/ISO.
All fittings shall be factory made.

Elbows shall be of pressed manufacture. The elbows, tees and reducing cones shall be manufactured using one grade thicker plate than the pipe. The wall thickness of tees with single or dual neck enlargement shall always be dimensioned individually. Tees shall be factory made or produced using the collaring draw method. Elbows shall be designed as long, smooth bends with a radius of about 1.5 times the nominal size of the pipe.

Reducers shall, unless otherwise specified, be made with a length L = 3*(OD - Od), where L is the construction length, OD the outer diameter of the large end and Od that of the small end. Unless otherwise stated, the wall thickness of a reducer shall be the same as that of the adjacent large straight pipe.

Flanged connections shall, unless specified otherwise, be lapped type joints with weld-on rings with necks and loose flanges. The bolt circle, number of bolts and bolt dimensions shall all be in accordance with DIN 2642.

Loose flanges shall be made in accordance with DIN 2642. All loose flanges of steel shall be hot-dip galvanised in accordance with BS 719 with a minimum thickness of 80 microns. Loose flanges located in water shall be made of stainless steel. Gaskets for flange joints shall be 3 mm thick, full face, rubber gaskets, pierced to take the bolts.

The bolts, nuts and washers inside pumping stations PS-2 and PS-3 building's shall be of hot dip galvanized steel. Outside booster stations buildings acid proof steel (AISI 316) shall be used. Bolts, nuts and washers shall comply with ISO standards for selected application and excess length of bolts in tightened joint shall be no more than 1 mm.

All pipes with or without flanges shall be clearly marked for location referring to the accepted drawings. All pipes and details shall be designed and manufactured in a way that will allow fast and proper mounting works on site with minimum use of external materials and welding equipment.

The Contractor shall specify in his tender the type and number of welding machines, amount of consumables, other local materials and equipment and also estimate the manpower that will be used by him during installation works. It is recommended that the Contractor employ experienced Moldovan specialists and local staff to assist him during mechanical-electrical installation works.

All flanges shall conform to ISO standards and pressure classifications PN 10 and PN 16. Proper selection of the pressure classifications shall be made by Contractor based on the pumps, valves parameters and location.

The Contractor shall describe in the Tender pipe materials and in Detailed Design pipes wall thickness. This shall be calculated and designed in accordance with required pressure classification in pumping stations.

In general, extra welding joints shall be avoided by selecting and adjusting the tees and all other fittings to fit in pipe works lengths.

Pipes shall be designed installed such that air pockets are avoided. Special attention shall be given to having the further possibility of draining pipes and fittings using proper sloping of the pipes and relevant ball valves.

The Contractor shall also include in his design smaller pipelines and hosepits. The pipes shall be installed in uniform groups in vertical or horizontal position. These groups shall be properly supported or installed on fixed pipe through.

The supports and supporting surfaces shall be shaped to surround the pipe. Supports shall be designed to facilitate possible thermal movements of pipes. No loading or other stress shall be allowed for pumps. The supports and pipes shall be insulated from each other by strip of reinforced rubber and shall allow valves (equipment) installation and replacement without dismantling the supports

2.3 Borehole Pumps and accessories

The borehole pumps shall be submersible type. All bearings shall be water lubricated and have a shape enabling sand particles, if any, to leave the pump together with the pumped liquid. The pumps shall be so designed that dry running is prevented and the bearings are always lubricated.

Each shall be equipped with an inlet strainer and a non-return valve preventing back flow in connection with pump stoppage. The non-return valve shall have short closing time. The pump shall also be designed with protection against thrust.

The embedded stator windings shall be hermetically enclosed for high mechanical stability, optimum cooling and elimination of the risk of short circuit of the windings caused by condensed water. Cooling of the pump motor shall be made by cooling chambers and internal circulation of motor liquid.

The borehole pump shall be installed with all necessary accessories for pump operation.

The Contractor shall, based on his own detailed design, manufacture and supply all necessary equipment, pipes etc.

Table… Pump Design Parameters

Site	Causeni		Floresti			
Borehole number on scheme	1	2	5	7	10	12
Dynamic water level, m	30	33	18	20	19	20
Pump installation depth (m)	50	50	50	50	50	50
Rising pipe diameter, inch	4	5	4	4	4	4

Rated pump capacity (m3/h)	30	80	45	45	45	45
Rated pump head (m)	38	40	50	50	50	50

2.3.1 Submersible Pump (6 pcs.)

Capacity : In accordance with parameters described above
Rated Head: In accordance with parameters described above
Efficiency: Above 60%

Length of submerged cable (power supply to pump) shall be selected also in accordance with the data presented in the table above. Each pump shall be equipped with a level sensor. Motor insulation class B. Phases 3. 50 Hz. n= 2900 rpm. Pump and Impeller stainless steel AISI 304.

2.3.2 Pump column (riser pipe) and adapter

- made of Stainless Steel AISI 304. Length of each pipe section shall be not more than 6 m. The total length to be supplied for each borehole is shown in table above
- Pump column shall have special flanges with O ring seals and grooves for dive cable.
- Pipes shall be supplied with stainless steel bolts, nuts and washers.

2.3.3 Flanged Stainless Steel Pipes inside well head building

- Flanged elbows and pipes inside wellhead building DN100 and DN150 accordingly
- Flanged pipes shall be supplied with gaskets, stainless steel bolts, nuts and washers

2.3.4 Cold water meter DN100 - 150

- Cosmos WP type or similar. Measuring of cold water up to 40°C
- Woltmann type, dry dial,
- Flange coupling DIN 2501 PN16.
- Metrological class: Class B
- Removable measuring element
- Hermetically sealed register (IP67or IP68)
- Pulse outlet for data logger including pulser type REED R001.
- Body cast or ductile iron. PN16.
- Electro statically applied epoxy resin to DIN 30677 internally and externally

2.3.5 Flanged Check Valve DN 100 - 150

Resilient seated swing check valve without lever and weight shall comply with the following specifications:

- Body, bonnet and hinge of GGG-50.
- DN 50 PN 10.
- Disc fully vulcanised with EPDM rubber.
- Flanges to BS EN 1092-2: 1997, face to face to BS 5153.
- Full bore. Disc and hinge assembled on a stainless steel shaft fitted in the bonnet.
- Bonnet gasket of EPDM in groove between body and bonnet.
- Epoxy coating to DIN 30677 - internally and externally.

2.3.6 Gate valve including handweel

Gate Valves shall comply with the specifications, as set out below:

- Resilient seated gate valve.
- Body and bonnet of GGG-50, DN 40-300.
- Flanges and drilling to ISO 7005-2, (BS EN 1092-2: 1997, DIN 2501), PN 10/16.
- Short face to face to DIN 3202 part 1, F4.
- Wedge of ductile iron with fixed wedge nut, fully vulcanized with EPDM rubber.
- Stem of stainless steel 1.4021 with rolled threads and wedge stop ring.
- Stem sealing consists of a rubber machete, 4 O-rings in a nylon bearing and a

wiper ring.
- Bonnet gasket in groove between body and bonnet. Countersunk bonnet bolts encircled by the bonnet gasket and sealed with hot melt.
- Epoxy coating to DIN 30677 - internally and externally.

2.3.7 Pressure gauge (mechanical) with ball valve

Pressure gauge body shall be made of stainless steel and scale of manometer to be installed on the pressure pipe shall correspond to measurement range closest to the maximum pumping head.

2.3.8 Ball valves DN15

Ball valve DN 15 shall correspond to the following technical specifications:

- Body made from dezincification resistant brass CZ 132 or BS 2872
- Ball shall be full bore, chromed zinc stable brass
- Handle made of steel, covered with plastic
- Working pressure PN16
- Temperature 0…100°C
- Coupling – internal thread ½".

3 Electrical Works

3.1 Scope of supply

The scope of supply for the electrical installations shall include detailed design, delivery of all needed equipment, materials and electrical installation works performance.

The scope of supply is minimum and as follows:

- Design, manufacturing and delivery of Pump Control Units
- Selection and delivery of all necessary cables (power and instrumentation)
- Delivery of necessary measurement equipment and supervision of installations
- Delivery of necessary tools for installation and spare parts
- Installation or installation supervision
- Testing
- Running in
- Training
- Preparation of operation and maintenance manuals

Within the contract sum, the Contractor shall design, supervise performance of installation works and deliver all supplies necessary for the complete finishing of the work in the pumping stations irrespective of any flaws and defects in the drawings and descriptions, unless such work or supplies are specially indicated to be excluded from the contract.

All notifications, approvals, tests, completion declarations, etc., and payments in this connection shall be included in the tender.

The Contractor shall be responsible for:

- all aspects of design application and, where applicable, subsequent operation of the equipment, monitoring facilities and control
- liaison between sub-contractors, to ensure complete compatibility of all equipment at both component and system interface levels,
- overall systems Project Management to ensure that all equipment, components and systems together form a consistent, rational and fully integrated electrical installation.
- ensuring that each system is handed over complete in all detail and in perfect

working order,

- the supply and installation of all components including line/equipment protection devices, voltage stabilizers, inverters, power supplies and similar items which may be necessary to achieve the correct functions and to provide a safe and reliable installation, whether or not such items are specifically called for in the requirements,
- providing protection on all relevant circuits and equipment against the effects of lightning and other induced disturbances,
- the supply and installation of all alarms and other facilities which may be considered necessary to ensure safe and efficient operation whether or not such items are specifically called for in the requirements.

The approval by the Engineer of any electrical or mechanical drawing shall not absolve the Contractor from his complete design responsibility.

Particular attention shall be paid to the appearance of the electrical installations of which shall be agreed with the Engineer before the commencement of installation. The Contractor shall ensure that the installation is completed and of the highest standard and neatness with respect to visible cable runs and the arrangement and alignment of apparatus and fittings.

It shall be stressed that the Contractor shall exercise the outmost caution in case of discrepancies between the indications on the drawings and those in the descriptions or between the indications on different drawings.

During the measuring and the performance of the installations, (provided that no other contract work is interfered with) the shortest distance shall be chosen regardless of the fact that other routes may have been indicated for drawing reasons.

All materials for which delivery periods are expected to be long shall be ordered immediately by the Contractor upon receipt of approval.

All cables and fittings are to be positioned so that they can be replaced without damaging parts of the structures.

All cables and fittings used shall be new and without defects. All fittings and parts of iron shall be hot dip galvanized after their manufacture.

It is the responsibility of the Contractor that all motors connected by him rotate in the correct direction and that all thermal overload relays are adjusted correctly (Dry test).

Upon termination of the work and prior to the completion declaration, a testing of all electrical installations shall be performed in the presence of the Engineer.

The plant shall only be put into operation in agreement with the Engineer. All installations, boards/panels, and fittings shall be cleaned before final acceptance.

The Contractor is responsible for the safety on the site of his own personnel and 3rd persons during the erection works. The Contractor is also liable for damage to things damaged or destroyed by him.

Stored equipment shall be kept under Contractor's surveillance and/or in carefully locked rooms. The Contractor shall be present at the commissioning, which is to take place prior to the taking over - including start-up of plant -and the Contractor shall immediately repair installations instructed by the Engineer.

3.2 General Technical Specifications

In general, the Contractor must guarantee that all materials and components used in connection with the work are of such a quality that they can be characterized as perfect first class commodity with characteristics, quality and performance that is specially adapted to installations and use under the present conditions.

The equipment shall be guaranteed as suitable for operation under the specified environmental conditions and shall be designed and constructed according to the highest available standards of manufacture, accuracy, repeatability and reliability. Furthermore it shall be designed for the following:

- to reduce the routine and occasional maintenance throughout its life to a practical minimum, compatible with the preservation of maximum reliability,
- to withstand the electrical, mechanical, thermal and atmospheric stresses to which it may be subjected under operational conditions, without deterioration or failure.

When more than one component or item of equipment is supplied to perform a particular function, all such items shall be identical and interchangeable.

The degree of protection for equipment enclosures shall be as follows:

- IP44 for indoor applications,
- IP54 for outdoor applications
- IP67 for transducers and other equipment

3.3 Mounting and Connecting

- Where no phase distribution for the parts to be mounted is indicated on the drawings, the Contractor is to distribute the loads equally over all phases
- Before mounting switchboards, cable trays, etc., the Contractor shall, through supervision, make sure that they are not obstructing the mounting of other equipment in the buildings, among these being also the heating, water and sanitary installation.
- It shall be ensured that the phases are connected in the order L1-L2-L3 from left to right in all electrical switchboards.
- Any part (or its base) is to be fixed by at least 2 screws or equivalent.
- It should be noticed that the performance for which the Contractor on the electrical works is responsible also comprises the connection of motors.
  The mounting also includes the supply and mounting of all necessary packing and connectors in boxes and branching-off equipment as well as screwed connections for cables for all equipment.
- Clearly legible signs of resistant material shall indicate which appliance any given switch serves.
- All connections in the motor terminal boxes are to be equipped with cable clips.
- Rubber-enclosed cables from the motors shall be tightened, shortened and relieved of pull.

3.4 Labels and Labelling of Electrical Installations

All motor protection devices, starters, contactors, relays, indicating lamps etc. shall be labeled according to the documentation with their belongings.

Labels on electrical components (motors, valves, instrumentation etc.) shall be performed by the use of signs.

All cable cores, control cables, terminal blocks as well as terminals shall be marked according to the switchboard manufacturer's number system.

Electrical installations, i.e. insulators, starters, switchboards, junction boxes, timers, fuses, etc., shall be clearly labeled to correspond with the appropriate schematic or wiring diagram.

Earth conductors/protective and equpotential bonding conductors and bus-bars shall be marked with yellow/green colors and the necessary signs for display of warning against unintentional disconnection.

A warning label shall be provided if the equipment may start automatically.
Labels shall be fixed to equipment prior to tests on completion being carried out.

In addition, all labeling shall be performed according to current standards.

A list of labels with Romanian and English inscriptions shall be submitted to the Engineer for approval before manufacture. All visible labels and signs throughout the installations shall be in Romanian.

Labels on front of switchboards:

3 mm thick transparent plastic labels like make Resopal, rear engraved, the color shall be black letters on a light grey background. Letters shall be sized 6 mm for number/identification of switchboard, other labels with 3 mm letters.

The labeling regarding the switchboard must include:

- Name of supplier
- Type and identification data
- Nominal voltage and frequency
- Rated current and maximum/minimum short-circuit current
- Type of earthing

All electrical switchboards shall be marked with their name in the upper left corner, and behind the front door a pocket for switchboard documentation shall be fitted.

All components and instruments led to the front of the switchboard shall be marked with their function and belonging.

Labels internally in switchboards:

3 mm thick laminated plastic, engraved with black letters on white background. Internal labels must be visible and must not be obscured by switchboard wiring, etc.

All section switches etc. shall be marked with group number as well as belonging.

Relays with plug-in socket shall be labeled on both relay and socket.

Where several voltage levels apply to the same component, for example contactors, these shall be marked with present voltage levels.

Indicating Instruments and Meters

Indicating instruments shall comply with BS 89 industrial grade, enclosed in dust tight cases with provision for zero adjustment. The scales shall be white, clearly divided and marked in black. The pointers shall have clean outlines. Instruments shall not be less than 72 mm size and the operation reading shall be at least 50 % of he full scale deflection.

Motor Ammeters

Ammeters shall be of class 1.5 according to IEC 51. The ammeter shall read true motor current independent of power factor correction. The instrument shall be suitably scaled in amps such that full load running current is approximately three-quarter scale, with 6 times overload figured for motor starting.

Voltmeters

Voltmeters shall be of class 1.5 according to IEC 51 and shall have expanded scales. The range shall be 90-120 % of the nominal value and zero shall be marked.

Hours run meters

Hours run meters shall be flush mounted synchronous clock devices with a digital indicator registering 9999.9 hours. The meter shall be fitted with a mechanical push-to-reset button.

Indicating Lamps

Switchboard indicators shall be of transformer type, having lamps rated at least 6 V, 1 watt, or alternatively powered from a voltage of not higher than 48 V. The lamps shall be adequately ventilated and arranged for the easy removal of the lamp from the front of the switchboard, without the use of special tools. Indication lamps shall be provided with a lamp test facility.

The lenses shall be thermoset plastic.

The colors of lamps shall normally comply with the following requirements:

WHITE - Ready or Power Supply Available (i.e. The plant is capable of being run; interlocks, etc. are made, e.g. Supply on, Ready to Run, Stopped, Closed).
GREEN- System Running/On/Normal Condition
AMBER- Abnormal Plant Condition (i.e. Action may be required by the operator. May be

used as a first stage alarm when RED used as second stage alarm).

RED- Severe Plant Alarm Condition/Failed (i.e. Urgent operator action required to normalize conditions). May be used as a second stage alarm when AMBER used as first stage alarm.

BLUE - Other Functions - as specified.

3.5 Standard Regulations

The electrical supply includes all services necessary for the execution and installation of the described electrical equipment and for a good functioning of the electrical system.

All electrical equipment shall be carried out in accordance with the requirements of:

- Present tender documents
- Drawings according to drawing list
- IEC regulations
- IEEE standards
- DIN standards
- EN standards
- Moldavian laws and regulations on electrical installations
- All later arrangements made between employer and electrical contractor

A non-exhaustive list of standards to fulfill in the present work will contain the following standards:

- IEC 204-1
- IEC 364
- IEC 439-1
- IEC 445
- IEC 1024-1
- IEC 1312-1
- EN 50081-2
- EN 50082-2

Drawings, enclosures and requirements apply individually, so that every item of the entire work is included in the contract even though it is only mentioned in one of these documents. Moldovan laws and regulations must always be observed even if the following descriptions and drawings are not in accordance with the local legislation.

3.6 Particular Technical Specifications

3.6.1 General information

The power supply of Causeni and Floresti wellfields shall be examined by Contractor prior to design activities. Connection points of the power cables shall be selected in accordance with local requirements (priority the to existing connection points).

3.6.2 Connecting power transformers

The connection between the secondary (low-voltage) side of the transformers and the incoming cubicle of the 0.4 kV pump control unit shall be established through overhead power line or cable as per local requirements.

3.6.3 Earthing connection and lightning protection

For the transformer substation existing ground loop shall be tested and established if no existing loop. Ground loop shall contain electrodes. The measured loop resistance should not be higher 4 Ohm at any time.

The earthing device shall be made of strip steel, laid in the trench bottom nearby the pole and vertical electrodes, which shall be connected with strip steel. All supporting metal constructions joints and butt ends should be welded.

3.7 Cables

Low voltage cables for underground power distribution shall be copper cored armoured

cables, complying with GOST 16442-80 and IEC-standard.

The design load of all power cable installations shall not exceed 75% of the current-carrying capacity of the conductors.

Power cables shall be grades for 600-1000 Volt for Low Voltage (LV) application for installation outside well buildings shall be AXPK 4G… 1kV.

Cables and cable cores shall be identified at both ends by means of sleeve bands like Partex PK bearing the cable/core reference number, which shall relate to the reference number.

Color codes for cables shall be as follows unless otherwise is agreed with the Purchaser:

Earth: Green/Yellow
Neutral: Blue

3.8 Pump control unit

Surface treatment: A very high corrosion resistance is desired.

Door structures and hinging shall be designed to ensure that doors do not deflect, drop or distort due to their own weight and/or the weight of mounted equipment on the doors.

There must be shielding plates between all components (contactors, relays, etc.) and their connection terminals.

The total switchboard shall perform a total selectivity at maximum and minimum short-circuit currents.

The control unit must be fitted with DIN rail.

All control units shall be fitted with a separate Protective Earth (PE) bus-bar (fitted in the full length of the bottom of the switchboard and the full height of cable trunking section).

Short-circuit protection, overload protection and other thermal protection shall be based on MCCB's (Moulded Case Circuit Breakers) and MCB's (Miniature Circuit Breaker).

At each control unit a surge arrester shall be installed according to the earthing system to protect against lightning and other electromagnetic influences.

The switchboard shall as far as possible be built as a non-fuse installation.

Switchboard shall include the following devices:

- Selector /Operating Switches
- Motor control "Start", "Stop" "Emergency Stop"
- Voltage monitoring device
- Indication Lights for pump operation (Green for run; Amber and Red for power failure, overheating and dry run). Indication lights shall be provided LED
- A- meters for monitoring motor's current in one phase
- Indicator for monitoring flow rate (pulse counter module)
- Alarm reset button

3.8.1 Short circuit calculations

The switchboard is to be built-up and equipped in accordance with IEC standard as well as the demands of local authorities to short circuit protection.

The following information shall be included in panel labels:

1) Manufacture and the type of construction
2) Un (V), In (A), fn (Hz), Ith (kA), Idyn (kA), IP

The insulation test shall be carried out at 2 500 V for 1 minute

The final lay-out design of the Switchboard shall be made by the Supplier and agreed with Purchaser. Following minimum requirements described below:

- each circuit breaker and other items of equipment shall be logistically in one

group in their own cubicle and on the door shall be clearly marked the purpose of the group.
- power cables shall be connected directly to the apparatus cubicles through the gaskets
- doors shall be provided with a rubber gaskets, fixed lock either handles and hinges to enable doors to opening at least 120 °.
- the construction shall ensure high operating reliability and personnel safety, The Control Unit shall be wall mounted installation.
- the power distribution inside the Switchboard shall be made with copper busbars.

3.8.2 Packing and care of Control Unit

The Control Units shall be delivered to site totally enclosed in protective packaging, reasonably proofed against the entry of dust and rainwater during unloading and against the entry of dust prior to installation. Provision shall be made for lifting and handling the protective packaging in position.

3.9 Monitoring and control of the submersible pumps operation

The general principle for borehole pumps operation and control is that the pumps shall be started or stopped manually from the Control Unit pushbuttons.

Emergency automation stoppage of pumps shall be performed in case of following power faults:

- If the voltage is lower or higher than preset value, pump shall be stopped automatically.
- Phase disbalance shall be monitored. If disbalance exceeds preset limits, pump shall not start.
- Motor load shall be monitored. If average current measured on all three phases is higher than preset value, pump shall be stopped automatically to avoid overloading of motor.

If the water level in a borehole is lower than the minimum level for the pump to run, the pump shall be stopped automatically.

If after 10 seconds from starting the pump the consumed motor current is lower than 60% of preset current value for pump operation, the pump shall be stopped automatically.