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
Pumping Stations in Floresti, Cahul, Ungheni and Orhei

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Contents:

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Booster Pumping Station

1 General Information

1.1 Description of the Site and Equipment

1.1.1 Site “A”. Floresti PS 2

The PS 2 is used to provide water to the whole service area from the Main Water Intake in Gura Cainarului. Pumping equipment includes one main pump group built of 4 parallel pumps of types Д200/90 and 1Д 315-71 a. The pumps intake water from two (2) underground water tanks with capacity of 250 m^3 each, located at the PS2 territory, and pump water through two parallel pressure mains to the service area.

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

Parameters of the existing pumping equipment at the PS 2 in Floresti

Pump No	Model	Design Flow rate	Design Head	Design Motor Data					Control Panel	Operating
				P	Voltage	Speed	cosφ	In		
		m^3/h	m	kW	V	rpm		A		hrs /day
1	Д200/90	290	90	90	3x400	2,950	0.91	159	Y	Stand-by
2	Д200/90	290	90	90	3x400	2,950	0.91	159	Y	Stand-by
3	1Д 315-71 a	300	63	90	3x400	2,950	0.9	162	Y	7
4	1Д 315-71 a	300	63	90	3x400	2,950	0.9	162	Y	7

All installed pumps are in poor physical condition and are expected to have low energy efficiency rates.

Currently, due to low water demand, only two pumps are in regular use and the other pumps are used as reserve.

1.1.2 Site “B”. Floresti PS 3

The abstracted water delivered by the PS 2 is stored at PS 3 inlet tank with capacity of 2,000 m^3. This PS3 is equipped with 2 groups of pumps. First group is built of 2 parallel centrifugal pumps (1 – operating and 1 in stand-by), used to deliver water directly into the town network. The second group is used to supply water to the northern isolated district.

Parameters of the existing pumping equipment at PS3 in Floresti

Pump No	Model	Qty	Design Flow rate	Design Head	Design Motor Data					Control Panel	Operating
					P	Voltage	Speed	cosφ	In		
			m^3/h	m	kW	V	rpm		A		hrs /day
1	Д 320-50 a	2	320	50	55	380	1,500	0.87	104	Y	24/Stand-by
2	CO-3MHI-406/ER-RBI	3	10	50	1.1	380	2950		2.7	CO-ER3	24

The PS3 is operated permanently for up to 24 hours per day. Due to uneven daily consumption pattern, the pumps Д 320-50 a are equipped with a frequency converter „Danfoss” of type VLT6000HVAC which regulates the pump’s operation, function of end-point pressure, currently set to 26 m.
PS3 also supplies by gravity the northern part of the town, including areas of multi-storey buildings, as well as private house areas.

1.1.3 Site “C”. Floresti SPS Main

SPS Main is the biggest SPS in Floresti. It pumps all collected waste water to the WWTP. Parameters of wastewater pumps in use are presented in the following Table.

Design parameters of the existing pumping equipment

PS	Model	Qty	Design Flow rate	Design Head	Design Motor Data					Operating	Instal-lation
					P	Voltage	Speed	cosϕ	In		
			m^3/h	m	kW	V	rpm		A	hrs /day	
Floresti Main SPS	ФГ 144/46	4	144	56	37	380	1,450			4.5	dry
	ФГ 450/56	1	450	56	132	380	1,450			standby	dry

SPS Main in Floresti is in critical condition. Basically, due to its age and high level of use, all existing pumping equipment should be replaced by a modern one.

1.1.4 Site “D”. Cahul PS 3

The part of treated water from Cahul RWTP and PS 2 is stored at the PS3 inlet tanks with capacity of 1,000 m^3 each. This PS3 is equipped with 2 groups of pumps. First group is built of 3 parallel centrifugal pumps of type NP50/250V-22/2a, used to deliver water directly into Spirin District. This district includes private houses. It is of note that the pressure of 7.2 bar is used to supply the highest network points. However, a district of private houses has an excessive pressure, and Apa-Canal is reducing the pressure by a throttle valve.
The second group is used to supply water to the city center, XV District. This area consists of some twelve 9-floor buildings, 14 5-floor buildings and 949 one-level houses. Second group of pumps includes 3 parallel centrifugal pumps of type NP80/160-15/2aDM.

Design parameters of the existing pumping equipment at PS3 in Cahul

Pump No	Model	Qty	Design Flow rate	Design Head	Design Motor Data					Control Panel	Operating
					P	Voltage	Speed	cosϕ	In		
			m^3/h	m	kW	V	rpm		A		hrs /day
1-3	NP50/250V-22/2a	3	75	72	22	380	2940	0.91	38.1	VSD	24
4-6	NP80/160-15/2aDM	3	112	35	15	380	2910	0.91	27.2	VSD	24

Both pumping groups from PS3 are operated permanently for up to 24 hours per day.
It is of note that PS3 covers central part of the town (XV District), which is also supplied directly from the PS2. Several streets have two parallel pipes from different pumping stations. Furthermore, the western loop from the PS3 supplied network doesn’t have any main consumers. Still, the whole network loop is operated at the pressure of up to 6 bar with almost absent consumption.

1.1.5 Site “E”. Ungheni Water Intake PS

Surface water intake is located on the Prut River, some 1 km west from the Town border. Water abstraction is organized through two (2) parallel syphon pipelines of DN500 from the river bottom and is located at elevation of some 29 m a.s.l. The inlet is protected by screens.
The abstraction facilities were built in 1970 and haven’t been cleaned / repaired since. During the walk-through analysis, the Consultant noticed high level of silting of the existing inlet point, which is considered to negatively influence the raw water quality and consequently the whole treatment process.
Initially, the water was designed to be led through the syphon pipelines to the inlet chamber of the PS1, located at the Water Treatment Plant, some 600 m from the abstraction point. The inlet chamber was also used to settle turbid raw water and protect the installed pumps from damaging by abrasives. Two (2) submersible pumps were designed to pump the stored water directly to the WTP’s vertical mixer.
However, due to unknown technical reasons Apa-Canal has switched to a different pumping process, using vacuum pumps to bring the raw water to the PS1 and connecting 4 (2 operating and 2 stand-by) vertical centrifugal pumps directly to the syphon pipelines. Thus, the water is currently abstracted and pumped directly to the WTP without any intermediary storage.
The pumps are installed at the elevation of some 28 m a.s.l., having the syphon total head of approx. 3m.

Parameters of the existing pumping equipment at the Main water intake in Ungheni

Pump No	Model	Qty	Design Flow rate	Design Head	Design Motor Data					Control Panel	Operating
					P	Voltage	Speed	cosϕ	In		
			m^3/h	m	kW	V	rpm		A		hrs /day
1	FA 15.840-278	1	250	19.6	18.5	380	1430		39.5	Y	24
2	FA 15.840-278	1	250	19.6	18.5	380	1430		39.5	Y	24
3	СД450/22.5	1	450	22.5	37.0	380	1470	0.89		Y	24
4	СД450/22.5	1	450	22.5	55.0	380	1470	0.89		Y	24
5	BBH-12M	1	720	NA	30.0	380	980				2
6	BBH-12M	1	720	NA	30.0	380	980				2

As can be seen from the Table above, the vacuum pumps BBH-12M are used for up to 2 hours per day in order to recharge the syphon pipes and ensure safe start-up of the centrifugal pumps.
The existing centrifugal pumps FA15.84 DEMI are designed for wastewater pumping and were installed as measure to protect the pump wheels from the abrasive raw water.
All pumps are operated manually.

1.1.6 Site “F”. Orhei PS 6

Water from Jeloboc spring is delivered to the town reservoirs through two pumping stations, PS5 and PS6, and is distributed using PS3 and partially PS2 and PS4. PS7 was used for intermediary pumping from PS6 to PS3. However, in 2006 Orhei water utility optimized the hydraulic system through construction of a new by-passing water main and consequently PS7 was taken out of operation.

PS5 is used to pump water to PS6 from Jeloboc Intake.

PS6 is used to pump water to PS3. Water is stored into two reservoirs, having total capacity of 2x250 m^3. Pumping equipment includes one main pump group built of 2 parallel pumps of type NRG 100/315A-90/2. A separate stand-by pump is used as reserve. The pumps intake water from the water tanks located at the PS6 territory and pump water to the PS6 tanks.

Parameters of the existing pumping equipment at the PS6 in Orhei

Pump No	Model	Qty	Design Flow rate	Design Head	Design Motor Data					Control Panel	Operating
					P	Voltage	Speed	cosϕ	In		
			m^3/h	m	kW	V	rpm		A		hrs /day
1	ЦНС -180/212	1	180	212	160	380					as reserve
2	NPG 100/315A-90	1	200	100	90	380	2960	0.9	161	Y	
3	NPG 100/315A-90	1	200	100	90	380	2960	0.9	161	Y	

In 2006 all three PS 5, PS 6 and PS 3 were renovated under the Pilot Water Supply and Sanitation Project, financed by the World Bank.

1.1.7 Introduction

Contractor shall design, supply and install all necessary mechanical and electrical equipment for three (3) pumping stations in Floresti, one (1) pumping station in Kahul, one (1) pumping station in Ungheni and one (1) pumping station in Orhei.

All necessary 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.

1.1.8 Equipment requirements

Site “A” Floresti (PS-2)

Contracor shall replace two existing pumps D200/90 with two new pumps (one working and one standby) of following parameters of each pump;

Rated flow = 140 m^3/h

Rated head = 63 m*

*Pumping head of 63 m is calculated for present pumping regime PS 2 – PS 3. Any modification to the destination of trunk main from PS 2 will influence the pumping head.

Site "B" Floresti (PS-3)

Contractor shall replace existing pump D320-50 with two new pumps with the following parameters of each pump:

Rated flow = 60 m^3/h
Rated head = 25 m

Pump set shall be equipped with frequency converter to maintain the minimum required pressure in the system at various water demands during the day and night.

Site "C" Floresti (SPS Main)

Contractor shall install new sewage pump with the following parameters:

Rated flow = 180 m^3/h
Rated head = 46 m

New sewage pump shall be installed in dry room on existing foundation. New sewage pump shall be protected against flooding.

Site "D" Cahul (PS3)

Costache-Negruzzi pumping zone

New pumping regime anticipates supply of separate Costache-Negruzzi district by booster pump set of three pumps in order to maintain all possible hydraulic regimes. Contractor shall install new pump set of three pumps with the following parameters:

Rated flow = 30 m^3/h
Rated head = 35 m

Pump set shall be equipped with frequency converter (for each pump) to maintain the minimum required pressure in the system at various water demands during the day and night.

Central (Stefan cel Mare str.) pumping zone

Contractor shall install in each 9 story block along Stefan cel Mare street (in total 11 blocks) the new boosting pump with hydrophore Q = 3 m^3/h, H = 20 m.

Spirin pumping zone

New pumping regime anticipates reduction of pumping head and flow of Spirin pumping group to meet actual demand requirements without recirculation and head requirements to lift water to 5 story blocks at Spirin district.

Contractor shall install new pump set of two pumps with the following parameters:

Rated flow = 60 m^3/h
Rated head = 55 m

Pump set shall be equipped with frequency converter to maintain the minimum required pressure in the system at various water demands during the day and night.

Two 9 story blocks in Spirin area shall be equipped with separate boosting pumping sets Q = 3 m^3/h, H = 20 m with hydrophore (analogue Stefan cel Mare pumping zone).

Site "E" Ungheni Water Intake PS

New pumping regime anticipates substitution of two existing sewage pumps СД 250-22,5 and FA 15.850-278 by one new high efficient pump of horizontal dry installation. In order to pump turbid water from the river with high content of sand, new pump shall be sewage type. Nominal capacity of new pump will be equal to overall capacity of two existing pumps. Contractor shall install new pump with the following parameters:

Rated flow	= 540 m^3/h
Rated head	= 19 m

Site "F" Orhei PS 6

Contractor shall install new pump set of two pumps with the following parameters of each pump:

Rated flow	= 110 m^3/h
Rated head	= 80 m

1.1.9 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 switchboards, PLC and communications,
- Manufacture of materials, equipment,
- Delivery of all materials and equipment to the site,
- Supervision during the dismantling of the existing constructions, pumps and valves,
- Construction works related to the pumps foundations,
- Installation, installation supervision, testing, pre-commissioning and commissioning of all new materials and equipment for pumping stations installations
- Training of Water Utility staff in the operation and maintenance of equipment supplied and installed under this contract

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

1.1.10 Mechanical supply

- Centrifugal pumps including motors, as per item 1.1.8 above
- All necessary pipes, gate valves, check valves, rubber compensators and fittings for connecting the pumps to the existing pipe system inside the pumping station

1.1.11 Electrical supply

- Low voltage Main Switchboard
- Pressure sensors and manometers
- Electrical installation materials (incl. cables for pumps)
- PLC for the operation of pumps
- All other electrical supplies necessary for the completion of electrical system

1.1.12 Drawings and technical description

The Plant 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, low energy consumption and low disturbing impact on the environment.

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

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 existing 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, in accordance with Clause 20 of General Conditions of contract.

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 (pipes, flanges, compensators), 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, NPSH 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 stuffing box construction and lifetime.
- Description of coupling and lifetime.
- Description of noise level for the pump aggregate.
- 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 panels, boards and all other electrical-automatic equipment, including drawings showing the main dimensions of the switchgear cubicles and other electrical equipment as indicated in the contract. The drawings shall indicate cable sizes and provide complete information on type and production of the equipment.
- Details of the operation of radio modems and the PLC
- 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

As the work progresses and if Contractors design differs from Tender 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 the L.V. switchboard, control panels, etc.

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.
- Diagrams of connections between all items of equipment (e.g. main and auxiliary switchboards, control boards, motors, starters, meters, instruments, relays, electronic and allied equipment, etc., with component values and types suitably marked thereon).
- 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.

1.1.13 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 boards 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.

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.

1.1.14 Delivery of tools and spare parts

The Tenderer shall include in his price a 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.

1.1.15 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, but min. 3 days.
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 Plant, duration approximately 8 hours.
- 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.

1.2 Work Program

The Work Program for the equipment 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 V Safe keeping and commissioning period.

Part VI Maintenance manual submission 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 time limits stated above.

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

1.3 Work Requirements

1.3.1 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.

1.3.2 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, pumps, 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.

Type tests are not acceptable. Test Certificates shall be supplied for tests carried out on actual equipment being supplied.

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 500 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.

- Primary injection tests shall be carried out on restricted earth fault circuits, after pilot circuits have been completed, for stability and fault conditions. On transforming differential protection circuits where primary injection was not possible, at the place of manufacturing, the completed relay circuits are to be fully tested by secondary injection, and simulated fault conditions. Stability tests are to be carried out using normal load conditions after the system has been completed and energised.

- 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.

- On-load tap changer equipment shall be tested to ensure the correct operation from associated control relays mounted to the switch gear relay panels by voltage injection on the control relays.

- 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.

- Before rotating any machine under power, the mechanical alignment of the shaft with the driven load (or driver) shall be checked (and adjusted if necessary) and shall be in accordance with the manufacturer's recommended figure.

- 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.

1.3.3 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.

1.4 Climatic Conditions and Seismic Activity

The climate of Moldova is temperate-continental with little snow in winters and long warm summers. The annual average temperature is +9,6ºC. The warmest month is July, the average temperature of which is 21,5-22,0ºC. The absolute max temperature is +40ºC. The coldest month is January and its average temperature is –3,8ºC. The absolute min temperature reaches -30ºC. The average temperature of the coldest five-days is –15,6ºC, and the warmest -21ºC. The average duration of the frost-free period is 189 days. The annual average temperature of the soil surface is 12ºC. The max penetration of 0ºC into the soil is 87 cm. The max freezing through of the clayey soil is 80 cm. The annual average of precipitation is 480 mm. Most precipitation falls in the warm period (April-November), i.e. 74% of the annual 353 mm.

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.

If seismic activity (earthquakes) occurs in the area, the Contractor shall take this into consideration in the design of his pumping system (flexible couplings etc.)

1.5 Unit of Measurement

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

1.6 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.

1.7 Drawings of existing Buildings and Installations

Drawings of existing building and installations are "as built"-drawings and are for general information. The contractor is responsible for taking all necessary measurements on the plant for his production and installation before installation works.

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

For the purpose of being replace with the new installations, the existing pump installations inside pumping stations will be dismantled by the Water Utility staff under supervision of the Contractor. The exact location of pumps to be replaced and boundaries of responsibilities shall be agreed with Beneficiary.

The Contractor shall design, manufacture and submit through pipes going to casting works before the scheduled installation time.

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.

A flange adapter shall be included in the suction and discharge pipework of all pumps for easy dismantling, and provision shall be made for flexible joint arrangement to structures.

The adapter on the pump discharge shall be up-streamed of its respective check valve. Where the pump discharge pipework joins the pumping station manifold, the entry shall be horizontal.

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.

All small bore pipes shall be blown through with compressed air before connection to instruments and other equipment is made.

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 Floresti PS-2 site "A"

Single stage axially split, double –suction centrifugal pump – 2 pcs.

Pumps shall be in accordance with following parameters

Fluid	potable water, 0°C to 40°C
Flow	140 m3/h
Head	63 m
Efficiency in designed point	> 70% (pump + motor)
Casing	Cast iron (GG-25)
Impeller	Bronze
Shaft sleeve	Bronze
Shaft, shaft seal	Steel, Gland packing
Pressure	PN 10
Casing and Impeller wear rings	Bronze

Motor nominal power	reserve 10% from pump power
Voltage	400 V
Frequency	50 Hz
Enclosure class	IP 55

All stationary cast iron parts shall be dip-painted and spray painted with water based, ether –epoxy no lead painting. Thickness of the dry coating shall be at least 200 μm.
Pumps and motors shall be mounted on a rigid and robust cast or pre-fabricated common base plate. Plate shall be suitable for bolting onto a concrete foundation.
Pump shall be mounted with ball or roller bearings adequately sized and properly grease lubricated and suitable for 25 000 hours of trouble free operation.

Spare parts
Following Mandatory spare parts shall be supplied for specified quantity of pumps:
One impeller
Gland packing material 30 m
Two sets of casing and impeller wear rings
Two ball bearing
Two O-rings
Two sets of shaft sleeves

The motor shall have temperature overload protection built - in the stator windings.

2.4 Floresti PS-3 site "B"

Pump (vertical multistage pump) – 2 pcs.

Fluid	potable water, 0°C to 40°C
Pressure class	PN 10
Flow	60 m3/h
Head	25 m
Efficiency in designed point	> 60% (motor + pump)
Speed	< 2910 rpm
Casing	Cast iron GG 25
Impeller	Stainless steel
Shaft seal	Mechanical rubber bellows seal to DIN 24 255
Pump/motor coupling	Flexible spacer coupling
Motor nominal power	reserve 10% from pump power
Voltage	400 V
Frequency	50 Hz
Enclosure class	IP 55

All stationary cast iron parts shall be dip-painted and spray painted with water based, ether –epoxy no lead painting. Thickness of the dry coating shall be at least 35 μm. Pumps shall be mounted with ball or roller bearings adequately sized and properly grease lubricated for life and suitable for 25 000 hours of trouble free operation.

Spare parts

The following mandatory spare parts shall be supplied for the specified quantity of pumps:
- two sets of impellers
- two sets of neck rings
- two bearings
- two spacer couplings
- two sets of pump casing gaskets

2.5 Floresti SPS Main site "C"

Dry installation sewage pump – 1 pc

Fluid	waste water, 0°C to 40°C
Pressure class	PN 10
Flow	180 m3/h
Head	46 m
Efficiency in designed point	> 60% (motor + pump)

The pump shall be horizontal dry installation type.
The pump impeller shall be non-clogging type.
The pump shall have long term sustained high efficiency.
The pump shall be fully flood-proof against unexpected flooding.
The pump shall be dynamically balanced according to or proven equal to ISO 1940 class 6.3.

The pump shall have unbroken cable from the pump to the switchboard. . The cable shall be secured by fixation to the chain for hoisting the pump. It shall be possible to hoist the pump from the well without disconnecting the cable.

Motor cooling shall be performed by means of cooling jacket.
The motor of the pump shall be suitable for minimum 10 starts per hour.

2.6 Cahul PS 3 site "C"

Pumps for Costache-Negruzzi pumping zone

Pump (vertical multistage pump) – 3 pcs.

Fluid	potable water, 0°C to 40°C
Pressure class	PN 10
Flow	30 m3/h
Head	35 m
Efficiency in designed point	> 60% (motor + pump)
Speed	< 2910 rpm
Casing	Cast iron GG 25
Impeller	Stainless steel
Shaft seal	Mechanical rubber bellows seal to DIN 24 255
Pump/motor coupling	Flexible spacer coupling
Motor nominal power	reserve 10% from pump power
Voltage	400 V
Frequency	50 Hz
Enclosure class	IP 55

All stationary cast iron parts shall be dip-painted and spray painted with water based, ether –epoxy no lead painting. Thickness of the dry coating shall be at least 35 μm. Pumps shall be mounted with ball or roller bearings adequately sized and properly grease lubricated for life and suitable for 25 000 hours of trouble free operation.

Spare parts

The following mandatory spare parts shall be supplied for the specified quantity of pumps:

- two sets of impellers
- two sets of neck rings
- two bearings
- two spacer couplings
- two sets of pump casing gaskets

2.7 Cahul PS 3 site "C"

Pumps for Spirin pumping zone

Pump (vertical multistage pump) – 2 pcs.

Fluid	potable water, 0°C to 40°C
Pressure class	PN 10
Flow	60 m3/h
Head	55 m
Efficiency in designed point	> 60% (motor + pump)
Speed	< 2910 rpm
Casing	Cast iron GG 25
Impeller	Stainless steel
Shaft seal	Mechanical rubber bellows seal to DIN 24 255
Pump/motor coupling	Flexible spacer coupling
Motor nominal power	reserve 10% from pump power
Voltage	400 V
Frequency	50 Hz
Enclosure class	IP 55

All stationary cast iron parts shall be dip-painted and spray painted with water based, ether –epoxy no lead painting. Thickness of the dry coating shall be at least 35 μm. Pumps shall be mounted with ball or roller bearings adequately sized and properly grease lubricated for life and suitable for 25 000 hours of trouble free operation.

Spare parts

The following mandatory spare parts shall be supplied for the specified quantity of pumps:

- two sets of impellers
- two sets of neck rings
- two bearings
- two spacer couplings
- two sets of pump casing gaskets

2.8 Cahul PS 3 site "D"

Pumps for Central (Stefan cel Mare str.) pumping zone and two (2) blocks in Spirin supply area

Booster pump set with hydrophore (pressure tank) – 13 pcs.

Pumped liquid	water and clean, light, non-aggressive
Liquid temperature range	0 to 40°C
Flow	3 m3/h
Head	20 m
Speed	< 2910 rpm
Casing	Stainless steel
Impeller	Stainless steel
Supply voltage	Single phase 220-250V
Frequency	50 or 60Hz
Enclosure	IP54

Recommended maximum stop/starts per hour: 20
Maximum operating pressure: 6 bar
Pressure tank: 20 litre pressed steel with natural rubber diaphragm
Max operating pressure: 8 bar
Nominal pre-charge air pressure: 1.5 bar
Pressure switch adjuster range: 0.8 to 4.8 bar
Differential range: 0.7 to 2.0 bar
Pressure gauge: 0-10 bar

2.9 Ungheni Water Intake PS "E"

Dry installation sewage pump – 1 pc

Fluid	raw water with high sand content, 0°C to 40°C
Pressure class	PN 10
Flow	540 m3/h
Head	19 m
Efficiency in designed point	> 60% (motor + pump)

The pump shall be horizontal dry installation type.
The pump impeller shall be non-clogging type.
The pump shall have long term sustained high efficiency.
The pump shall be fully flood-proof against unexpected flooding.
The pump shall be dynamically balanced according to or proven equal to ISO 1940 class 6.3.

The pump shall have unbroken cable from the pump to the switchboard. . The cable shall be secured by fixation to the chain for hoisting the pump. It shall be possible to hoist the pump from the well without disconnecting the cable.

Motor cooling shall be performed by means of cooling jacket.
The motor of the pump shall be suitable for minimum 10 starts per hour.

2.10 Orhei PS-6 site "F"

Single stage axially split, double –suction centrifugal pump – 2 pcs.

Pumps shall be in accordance with following parameters

Fluid	potable water, 0°C to 40°C
Flow	110 m3/h
Head	80 m

Efficiency in designed point	> 70% (pump + motor)
Casing	Cast iron (GG-25)
Impeller	Bronze
Shaft sleeve	Bronze
Shaft, shaft seal	Steel, Gland packing
Pressure	PN 10
Casing and Impeller wear rings	Bronze

Motor nominal power	reserve 10% from pump power
Voltage	400 V
Frequency	50 Hz
Enclosure class	IP 55

All stationary cast iron parts shall be dip-painted and spray painted with water based, ether –epoxy no lead painting. Thickness of the dry coating shall be at least 200 μm.
Pumps and motors shall be mounted on a rigid and robust cast or pre-fabricated common base plate. Plate shall be suitable for bolting onto a concrete foundation.
Pump shall be mounted with ball or roller bearings adequately sized and properly grease lubricated and suitable for 25 000 hours of trouble free operation.

Spare parts
Following Mandatory spare parts shall be supplied for specified quantity of pumps:
One impeller
Gland packing material 30 m
Two sets of casing and impeller wear rings
Two ball bearing
Two O-rings
Two sets of shaft sleeves

The motor shall have temperature overload protection built - in the stator windings.

2.11 Check Valve

Resilient seated swing check valve with lever and weight shall comply with the following specifications:

- Body, bonnet and hinge of GGG-50
- Pressure rating PN 16
- 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.

2.12 Gate Valve

Resilient seated gate valve shall comply with following specifications:

- Body and bonnet of ductile iron GGG-50 to DIN 1693
- Flanges and drilling to ISO 7005-2, PN 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 DIN X 20 cr 13
- Stem sealing consists of a EPDM rubber manchette, 4 O-rings in a nylon bearing and a wiper ring.
- Bonnet gasket EPDM rubber
- Indicator nut and housing of dezincification resistant brass
- Valve coating of electro-statically applied epoxy resin to DIN 30677 internally and externally

2.13 Expansion Joints

Each pump shall be equipped with two expansion joints on suction and pressure side respectively to axial, lateral and angular movements. Expansion joints shall be flanged and made of rubber or stainless steel for pressure class PN 16

2.14 Pipe works

Under this item the Contractor shall evaluate and include in his tender all costs related to the manufacturing of equipment ready for installation, and welding pipes and pipe components for necessary pipe work for pumps and collectors replacement in this particular pumping station. Tender Price shall include pipes, flanges, bolts, nuts, washers, gaskets, supports and whatever additional material necessary for proper installation of the above equipment and fittings on site.

2.15 Flange Adaptors/Couplings

Flange adapters should correspond to the range for pipe size and materials:

- For PE, Steel and Iron pipes. Krammer Armaturen Type 2000 (Fig. 851) and Type 2050 (Fig. 852) or approved equivalent.
- The adapters and couplings should cover ranges of the outside diameters of the specified pipes,
- Epoxy coating DIN 30677 - internally and externally.

2.16 Pressure Sensors and gauges (manometers)

Pressure monitoring shall be suitable for the medium and specified pressure range by a transducer. Each transducer shall be ranged to provide adequate sensitivity over the working range and be capable of sustaining a 400% overpressure without damage. They shall be of rugged and waterproof design to IP 57 with a stainless steel enclosure having an isolation diaphragm, suitable for either free wire suspension in the medium or provided with an internal pipe connection.

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

A transmitter shall be provided either integrally with the transducer or separately mounted as specified, suitable for operation from the mains or specified battery supply (not greater than 24V) and conversion of the signals received from the transducer to a 4-20 mA signal proportional to the specified range. The transmitter shall have provision for range and zero adjustment.

Technical data:

Type of sensor	ceramic
Measuring range:	pressure pipe: 0…10 bar suction pipe –1…1,5 bar
Ambient temperature for probe:	-30 ° C +50 ° C
Ambient temperature for converter	+5 ° C +50 ° C
Fluid temperature	0 ° C +50 ° C
Material of measuring cell:	SS 1.4571
Protection class:	IP 57
Accuracy:	0.5%
Power supply:	12/24 (≤24VDC) for probe
Output signal:	4-20 mA

Installation:

Pressure sensors and manometers shall be supplied and installed with socket, isolating valve and tee including test valve. Valves are to be ball type.

Installation set to be provided with each pressure sensor shall include all equipment for necessary power supply (220 V) and indicator of the measurement results. Indicator shall be installed in the Switchboard.

The sensor shall be supplied and installed as a rigid assembly comprising a stainless steel tube, a tube holder (both as used for control electrodes) and the transducer) with the cable passing through the tube. The transducer shall be a close fit located completely within the tube at the lower end. The assembly shall be fixed at not less than two places to the sump wall and installed with the bottom of the tube just clear of the sump invent.

For all installations the cable between the transducer and the controller/transmitter shall

be a continuous length and kept as short as is reasonably possible. This cable shall be run in conduit and installed well clear of all AC mains and power cables.

All fixings. brackets, etc as required for the complete installation shall be provided.

2.17 Float Switch (for site "C" only)

The float switch shall be free-hanging type.
Minimum three switches at different levels:
Start pump
Stop pump
High level

Float switches shall be mounted on a support for three switches with 400 mm distance between each other.
Support for float switches shall be grouted into the cover of the water reservoir.

Float switch shall be equipped with embedded ball shock proof double throw micro switch and counter weight.
The float body shall activate start/stop at 45 degrees level.
Material: Rubber coating suitable for waste water
Ambient temperature: 0 - 60°C
Cable length – 30 m.

2.18 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 of the communication system and PLC for monitoring, delivery of all needed equipment, materials and electrical installation works performance.

The scope of supply is minimum and as follows:

- Detailed design of complete power supply and electrical system
- *Design, manufacturing and delivery of Low Voltage Switchboard, including soft starters and frequency converters*
- *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.
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 signal isolators. amplifiers, converter, filters, 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 interlocks, 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

Specified materials or products – specified as products or catalogue numbers of a specific company – may not be changed, unless they are defined by 'such as product ……' or by 'such as catalogue ……'. In general, materials other than those defined may not be used, unless the Engineer approves them in each individual case.

Main and sectioning switch gear in the switchboards shall be lockable in 0-position.
RCD's shall be prepared for AC- and pulsating DC fault currents.
Contactors shall be with isolated potential free auxiliary switches (NO and NC).
Minor relays shall normally be in plug-in version with 11 pole socket and with minimum 3 pcs. isolated auxiliary switches. Relays shall be with transparent enclosure and mechanical indication of actual position.

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 MCB's, section switches etc. shall be marked with group number as well as belonging.

Sections/feeders in the switchboard for motors that are controlled by frequency converter shall be clearly labeled with the exact location of the individual frequency converter if this is installed outside the switchboard.

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 Boards, panels and general principle for pumping

3.6.1 General information

The general principle for pump operation and control is that the pumps shall be started or stopped manually from the Control Board pushbuttons when selected for “Local” control.
The selector switches shall be located on Control Board. Control Board shall be installed and located in the pumping room close to pumps.

All alarm and position lights shall be provided with engraved text. Text shall be in Romanian language. Alarms should be duplicated by alarm bell sound.

3.6.2 Boards and Panels

The board for pumping station shall be built from factory made zinc-phosphate standard size steel plate (minimum 1,5 mm thick) cubicles, which together with steel framework shall form a robust structure for cables and equipment. The surface treatment shall be epoxy powder painting. Color is to be the manufacturer’s standard color.

Number of starts in 24 hours shall be suited to operation conditions, min. 2 times per hour, and all equipment used for construction of boards shall give possibility for this frequency of starts for sustained periods without any form for damage of equipment.

The internal wiring shall be identified with reliable markers having the same information as the point to be connected to the drawings. All equipment shall be clearly marked following the codes on the Drawings. Terminal blocks used for different voltages shall be clearly and reliable separated.

3.7 Cables

The minimum size of conductors used shall be 0,75 square mm for control circuits wiring and 1,5 square mm for power circuits.

Power cables shall be grades for 600-1000 Volt for Low Voltage (LV) application for installation outside booster pumping stations shall be AXPK 4G95 1kV or AXPK 4G16 1 kV .

The following types of cables shall be used inside pumping stations:

- Cables for general power distribution within buildings, and cables underground, shall be copper cored PVC armoured cables, complying with IEC-standard.
- Cables run in conduits and pipe systems and shall be copper cored PVC insulated cables, complying with IEC-standard.
- Cables for motor installations shall be copper cored PVC armoured cables with screen, complying with IEC-standard.
- Cables for instrumentation and PLC input/output signals shall be twisted pair copper cored PVC armoured signal cables with screen (shielded), complying with IEC-standard.

Cables, except those laid in ground, shall run in horizontal cable troughs or in ducts and shall be firmly supported and fixed.

Single runs of PVC armored cables shall be supported by use of PVC cable clips. Multi-cable runs of PVC armoured cables shall be fixed into heavy gauge galvanised steel cable trays and supporting steel work.
Non-armoured PVC cables shall be installed in conduits or plastic pipes.

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 shown on the drawings. Where multiple cables are laid in troughs, ducts, clipped on ladder over long runs through several rooms in buildings, or laid in the ground closely together, intermediate markings to identify specific cables shall be applied.

Where cables are installed in ducts, the cables shall be identified with the cable reference number within each cable draw chamber.

In the cables the individual conductors must be identifiable either by colour or conductor number.

Color codes for cables shall be as follows unless otherwise is agreed with the Engineer before the cable works are started:

Earth: Green/Yellow
Neutral: Blue

3.8 Low Voltage Switchboard

Switchboards must be made with 10% expansion capacity.
Surface treatment: A very high corrosion resistance is desired. The frames shall be of 2,5 mm steel. Side plates and front plates shall be of 2,0 mm steel.

Switchboards must be divided into cubicles. 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 (MCB's, contactors, relays, etc.) and their connection terminals.

The switchboard must be ventilated so that the interior temperature in the switchboards does not exceed 40 °C under normal conditions.

Each part of the switchboard shall be fitted with an anti-condensation heater with an adjustable thermostat. The heaters shall be rated to maintain the interior temperature 5° above the air temperature outside the switchboard.

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

The Switchboard must be fitted with DIN rail (except for main feeders). Switchboards must be equipped with a section for cable trunking for at least every two modules with switchboard equipment.

All wires/cores for any automatic system as well as for the PLC-system shall be terminated to separate terminal blocks. Terminal blocks must contain 10% available extra terminals. Terminal blocks to PLC must be of segregation type.

All electrical switchboards 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 each cable trunking section).

The main switchboard shall be divided into relevant sections and with separate section switches according to this dividing.

A clear physical separation shall always be kept so that electrical installations belonging to the building are always separated from installations belonging to the process. Minimum enclosure in switchboards between the different types of installation is IP 2X.

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 switchboard a surge arrester shall be installed according to the actual earthing system to protect against lightning and other electromagnetic influences.

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

In general, the Switchboards will be installed inside pumping station control room. Switchboard shall include at least the following devices:

- Selector /Operating Switches
- Motor control Remote – 0 – Local - Auto
- Push Buttons (Green for start, reset and open; Red for stop and close
  Motor control "Start", "Stop" "Emergency Stop"
- Voltage monitoring device
- mA- meters for monitoring motor's current in one phase
- Indicator for monitoring pressure
- Indicator for monitoring flow rate (if necessary)
- Indicator for monitoring water level in reservoirs (if necessary)
- Alarm Bells, sound level of minimum 100dB when energized. Reset button
- Graphical display

- PLC or other equipment necessary for pumping station operation and pumps work monitoring (if necessary)
- Extra space for future communication system

3.8.1 Short circuit calculations

The Contractor shall calculate the short circuit level for the switchboard. For the entire power installation a compensation according to the demands of the local authorities shall be calculated, however, not less than Cos phi = 0.9.

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 Contractor and agreed with Engineer. 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 Switchboard shall be free standing with rigid base on the floor.
- the power distribution inside the Switchboard shall be made with copper busbars.
- the Switchboard will be supplied from the existing 10/0.4 kV substation

3.8.2 Packing and care of Switchboard

The switchboard 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.

The space available for storage on site and for maneuvering the switchboard into its installation position shall be taken into account in designing and, if necessary, sub-dividing it for delivery. Account shall also be taken of the need to remove or temporarily reposition any existing control equipment from the building while the new switchboard is stored here.

If, after the switchboard is unwrapped, any dust generating operations arise, the switchboard shall be completely sheathed in polythene sheet to the Engineer satisfaction. It shall remain protected until dust-free conditions are restored to the Engineer's satisfaction

3.9 Frequency Converter

Frequency converter shall be micro processor based, fully configurable and fitted with an internal multilingual alphanumeric control panel with keypad display for user interface for monitoring, adjusting parameters, manual control and configuration of the converter. Frequency converter shall have an extensive library of pre-programmed application macros to allow rapid configuration of its in and outputs.

Voltage	400 V
Enclosure class	IP 55, self cooling

Frequency converter shall include following components:

Low voltage air circuit breaker
Semiconductor fuses
Current transformer 4-20mA transducer and A-meter in one phase
V-meter

Ventilation unit
Auxiliary relays

3.10 Soft starter

Softstarter with electronic overload relay shall include the following components:
low voltage air circuit breaker
bypass contactor;
semiconductor fuses;
running time meter;
terminator relays or PT100 monitoring;
auxiliary relays;
current transformer, 4-20 mA transducer and A-meter in one phase;
ventilation unit;

3.11 General requirements for PLC. Properties of PLC Software

During normal operation all pumps shall be controlled automatically by the PLC system installed in the Switchboard.

It shall be possible to switch each pump (with on/off) individually between local mode (control from the Switchboard) and automatic mode (control from the PLC). The choice between local and automatic mode shall be carried out locally at the switchboard respectively at the frequency converter. The choice of mode for a pump shall be communicated to the PLC by a binary signal (the signal contact shall be closed when the pump is in automatic mode). Local is mode only to be used for testing purposes.
Each pump motor (both on/off controlled motors) shall be monitored by a binary signal, normally closed contact, to the PLC. The signal shall be activated by a hardware error in the motor.

If automatic mode has been chosen for a motor, and if the above-mentioned fault signal is not active, then the motor shall be automatically controlled from the PLC. Manual control of a motor from the operation panel is not required.

If one or more motors becomes unavailable for the automatic control, because of a fault or because of switching into local mode, then the automatic control shall continue to function in a suitable way for the other motors that remain available for automatic control.

The booster pumping stations and borehole pumps shall be able to operate in a fully automatic mode and in fully or partly manual mode.

It shall be possible to control the automatically controllable components (the components that can be controlled by a program, for example a pump or a sectioning valve at the three levels A, B and C:

The software in the PLCs that takes care of the process control and monitoring shall preferably be based on the IEC 1131-3 standard. Graphic programming should be possible.

The PLC programs shall to the largest possible extent be composed of standardised modules that can be individually tested and documented.

The variables that correspond to the standardised components (for example sectioning valves) shall be organised in standardised structures that correspond with the standardised program modules that carry out the functions for the individual components. These program modules shall be compatible with the corresponding functionalities of a future SCADA system (for example symbols for display and commands, alarm presentation, and data logging). The same applies to the data structures for the standardised control functions (for example analogue regulation).

Functions for Process Components

The following sections specify general requirements. The Contractor shall design the data structures and program modules so that these requirements are fulfilled in the best possible way.

3.11.1 Analogue Measurements

The signal level for analogue measurements shall be 4-20 mA as a standard.

The raw value from the A/D converter shall be converted to an internal representation in the process station with technical units and sign, if relevant. The conversion shall in most cases take place by linear operations, offset and scaling, but it shall also be possible to apply non-linear operations, for example square root extraction.

If the signal falls below 4 mA or rises above 20 mA, the measurement shall be regarded as being invalid, and an alarm shall be generated. The state “Invalid” shall be shown on the display, for example by a different colour. An invalid signal cannot be used in automatic functions, in analogy to a passivated signal (see above).

3.11.2 Monitoring of Transition Time

If the PLC issues a command for switching a process component from one discrete state to another, it shall monitor, on the basis of feedback signals that the state of the component changes according to the command within a predefined time, the transition time. This applies for example to sectioning valves (open/close) and pumps (start/stop).
If the state of the component does not change within the defined transition time, an alarm shall be generated in the PLC.

For each component type a default transition time shall be defined. It must be possible to change this time later, by a simple procedure, without recompiling the program.

Monitoring of the transition time is not required for commands that cause the change of an analogue state, for example the degree of opening of a regulating valve or the rpm of a pump with speed regulation.

3.11.3 Monitoring of Operating Hours and Number of Starts

For all rotating machines (for example pumps), which are controlled by a PLC, the operating hours and the number of starts shall be monitored, preferably in the process station.

The operating hours shall be displayed and recorded. For each component it shall also be possible to define upper limits for the operating hours and the number of starts from a future SCADA system. When such a limit is exceeded, an alarm shall be generated.
It shall be possible for an authorised operator to change, and especially to reset, the recorded operating hours and number of starts.

3.11.4 Sequence Control

A PLC shall be able to carry out automatic sequence control. An automatic sequence consists of a number of steps that are executed in a predetermined sequence. It can for example be the sequence for starting a pump and running it into parallel operation with the other pumps of the well-field or booster pumping station.

Each step of the sequence represents a switching action. When a step becomes active, one or more commands are given, and the execution of these commands is monitored by logical criteria that are based on feedback signals from the process. When all criteria for a step have been fulfilled, the next step of the sequence is activated, either at once or after a predefined delay time.

For each step a run time is defined. If not all criteria have been fulfilled at the end of this time, the sequence stops and an alarm is generated.