Technical Specifications

Supervisory Control and Data Acquisition System for Ungheni Water Supply and Wastewater Facilities

TABLE OF CONTENTS

TERMS AND DEFINITIONS

ACRONYM	DEFINITION
TS	Technical Specifications.
SCADA	Supervisory Control and Data Acquisition. A SCADA System is a computer (typically a personnel computer), or a group of computers and servers running a software dedicated for SCADA purposes. This SCADA software can exchange over industrial networks, with PLC's, VFD's, and other industrial devices. Typically, the SCADA software will allow for trending, graphic display, alarm tracking, and reporting of data.
CPU	Central Processing Unit.
DACE	Data Acquisition and Control Equipment.
DCO	Dispatch and Control Office.
HMI	Human-Machine Interface.
PLC	Programmable Logic Controller.
I/O	Input and/or Output.
DI	Digital Input.
DO	Digital Output.
AI	Analog Input.
AO	Analog Output.
VFD	Variable-frequency drive.
Alarm	Alarms are meant to alert the operator of an abnormal condition. They are logged, and often require operator intervention.
Trends	Collection of data points over time. When viewed over time, the trends will indicate general progression of the data.
Cluster	A group of SCADA Servers dedicated to a specific scope of monitoring and control.
Server	A SCADA station that performs background tasks necessary for data acquisition, evaluation, storage, and distribution to Clients.
Client	A SCADA display station that is used for operator monitoring and/or control. Clients acquire their data from Servers.
PC	Personal Computer.
Station	One Computer on a Network.
Operator Station	A terminal that runs a commercially available operating system such as Windows. An Operator Station will usually execute the SCADA software. Operator Stations are usually desktop mounted personal computers. However, they may be computers that are designed to be embedded in the doors of control panels.
Node	A network connection point. Examples include a PLC, PC, Operator Interface Terminal, Switch, Server, etc.
I/O Tags	Data being read/written from a Field Device. I/O Tags are usually addresses within the field device that contain variable data.
Open Protocol	A network protocol whose configuration code is available with or without a fee or license.
Tags	A name used to reference variable data. Tags are most often used to identify data being read/written from a Field Device (I/O Tags).
PS	Pumping Station.
BPS	Booster Pumping Station.
WTP	Water Treatment Plant (station).
WWTP	Wastewater Treatment Plant (station).
WWPS	Wastewater Pumping Station.

1. GENERAL

1.1. Introduction

In accordance with the objectives of the Socio-economic Development Strategy of the Ungheni Municipality for the period 2019-2025 and the Water Supply and Sewerage Sector Development Plan in the Ungheni district for the period 2018-2025, one of the priorities is to develop and strengthen the capacity of the regional operator through the implementation of automation systems and SCADA systems for the monitoring and control of water and sewage technological processes.

In this context, this Technical Specification ("TS") has been prepared to provide the Contractor details about Plant and Equipment to be properly designed, supplied, and installed, as well as the best practice and requirements of the Beneficiary about materials and installation methods to be used. Should part of the specifications conflict with other part of these specifications the Contractor shall obtain written instructions from the Beneficiary before proceeding with Supply and Installation works affected by the discrepancies.

The Specification for installation services is written primarily in terms of the performance required, leaving the Contractor, as far as it is possible, free to decide his methods of working. The following definitions shall be used in applying the relevant clauses of the current Technical Specification:

- "Employer" stands for the contracting party – UNDP's EU4Moldova: Focal Regions Programme.
- "Beneficiary" stands for the representatives of I.M. "Apa-Canal" Ungheni.
- "Facilities" means the Plant and Equipment to be supplied and installed, as well as all the installation services to be carried out by the Contractor.
- "Site" means the land and other places upon which the Facilities are to be installed, and such other land or places as may be specified as forming part of the Site.
- "Installation Services" means all services necessary for the full delivery of Plant and Equipment for the Sites, e.g. transportation and insurance, inspection, shipment, site preparation work, installation, testing, pre-commissioning, commissioning, operation, maintenance, provision of operation and maintenance manuals, training, etc.

1.2. Background Information

I.M "Apa-Canal" Ungheni is the largest operator of drinking water supply and sewerage services in the Ungheni region. It aims to provide services at the regional level, in accordance with high quality standards and is in a continuous process of expanding the area of service provision. The Operator provides its services on the entire territory of Ungheni municipality, and in Zagarancea and Semeni neighbouring localities. The length of the functional water supply networks extends over 155.4 km and 66.5 km of sewer networks.

The water supply in Ungheni is divided between different pressure zones and control of the water supply is currently made mainly using phone connections. Along the entire length of the aqueduct network at critical points (the highest points compared to the pumping station within the treatment station) pressure gauges are installed to record the water pressure in the pipes, but the intervention team travels to these points daily and checks the existing pressure.

There are 2 Pump Stations (PS), one for pumping the water form Prut River to Water Treatment Plant (WTP), and last one for pumping the treated water into main hydraulic system of Ungheni. In the Ungheni city there are 9 Buster Pumping Stations (BPS) which are located near multi-storey buildings for the necessary adjustment of the pressure at the upper levels. Also, there are 8 repumping Wastewater Pumping Stations (WWPS) and one central WWPS with local management and monitoring. The

drinking/wastewater repumping plants, the main sewage pumping station and the drinking water treatment plant are individually daily monitored by the employees who service these stations, but not remotely.

The liquidation of a damage or disturbance to the water and sewage network is carried out by moving the intervention team to the site to identify the cause that produced the disturbance and to identify the possible methods of its removal. Alerts/incidents are registered following the telephone or physical addresses of consumers regarding lack of pressure, lack of water, etc. This whole process takes a long time and is not efficient.

These methods lead to an inefficient use of the power and can create high pressure and pipes bursts. New system to monitor water flows, online control of the pressure in water networks and installed pumps operation will allow the Operator of the pump station to optimize pumping regimes that lead in reduction of power, costs, and a smaller number of the staff to be employed in large number of facilities.

1.3. Objective of the Contract

The objective of this contract is to implement a new full functioning SCADA system to allow instant monitoring and control of the selected system operating parameters, as provided in this TS.

The system shall be extensive, with a capacity to add and monitor new sites, such as additional pumping stations and/or remote monitoring and control stations. This Plant and Equipment shall meet the indicated SCADA requirements, as well as provide sufficient capacity to accommodate additional pumping stations (control points) to handle future system demands, as provided in the TS.

1.4. Scope of Works

The Contractor shall successfully design, manufacture, supply, install, program, integrate, test, commission and conduct training on a fully operational extensive SCADA system, including software and hardware for measurement and data communications, monitoring and control, historical data recording, analysis and reporting system, covering the following main system components:

1. Central Dispatch Control Office ("DCO"), including:
   - SCADA Server with redundancy.
   - One (1) Primary Operator Workstation.
   - Network hardware.
   - SCADA Software for Server and Workstations.

2. Local Data Acquisition and Control Equipment ("DACE"), including specified measurement equipment, PLC with Ethernet TCP/IP network infrastructure, for:
   - two (2) water pumping stations (PS),
   - one (1) water treatment plant (WTP),
   - nine (9) booster pumping stations (BPS)
   - four (4) wastewater pumping stations (WWPS).

Some sites are already partially equipped with measurement equipment, which will be provided at the Contractor's disposal by the Employer, as described in this TS.

Each site shall be connected to the Central DCO through a new data interconnection using secured data transmission via a wide area network (WAN)/Internet, as specified in the TS. The WAN/Internet connection will be provided by the Employer.

A summary of the distribution of responsibilities for main activities between the Employer and the Contractor is provided below:

Table 1 - Distribution of responsibilities

Activities	Employer	Contractor
Providing rooms for installation of new SCADA equipment at Central and Local DCOs, facilities	**X**	

Prepare detailed design of SCADA system Central DCO and plant and equipment		**X**
Supply and installation of SCADA Server equipment to Central DCO		**X**
Installation and development of SCADA Server software		**X**
Installation and development of SCADA software for the Operator Workstation		**X**
Providing sites with the existing measurement equipment for Local DACE	**X**	
Installation and configuration of Local DACE for facilities, including setting of communication paths, to collect and transmit telemetry data to SCADA server		**X**
Provide sustainable access to WAN/Internet connection for the sites and Central DCO	**X**	
Installation of measurement instruments (such as Pressure, Level, Flow, Turbidity, Chlorine) and sensors (Open Door)		**X**
Testing of all installations		**X**
Training		**X**
Commissioning of SCADA system installations		**X**
Handing-over of all installations		**X**

The detailed description of the activities is provided in the respective chapters of this TS below.

1.5. Information Pertaining to the Site

1.5.1. Climate Conditions for External Works

The climate in Moldova is temperate continental, with hot long summers and short mild winters. There are approx. 240 sunny days per year in Moldova.

Report below (Source: https://weatherspark.com/y/94995/Average-Weather-in-Ungheni-Moldova-Year-Round) describes the typical weather at the Ungheni over the course of an average year.

Ungheni has a humid continental climate with warm summers and no dry season. Over the course of a year, the temperature typically varies from -5°C to 29°C and is rarely below -14°C or above 34°C. The warm season lasts from May 21 to September 7 with an average daily high temperature above 24°C. The hottest day of the year is July 26, with an average high of 29°C and low of 17°C.

The cold season lasts from November 28 to March 6 with an average daily high temperature below 7°C. The coldest day of the year is February 2, with an average low of -5°C and high of 1°C.

The probability that precipitation shall be observed at this location varies throughout the year. Precipitation is most likely around January 7, occurring in 71% of days. Precipitation is least likely around September 11, occurring in 42% of days. Over the entire year, the most common forms of precipitation are light rain, thunderstorms, light snow, moderate snow, and moderate rain. Light rain is the most severe precipitation observed during 33% of those days with precipitation. It is most likely around October 6, when it is observed during 28% of all days. Thunderstorms are the most severe precipitation observed during 20% of those days with precipitation. They are most likely around July 9, when it is observed during 33% of all days.

Light snow is severe precipitation observed during 17% of those days with precipitation. It is most likely around January 18, when it is observed during 30% of all days. Moderate snow is the most severe precipitation observed during 14% of those days with precipitation. It is most likely around January 7,

when it is observed during 24% of all days. Moderate rain is the most severe precipitation observed during 12% of those days with precipitation. It is most likely around November 4, when it is observed during 10% of all days.

During the warm season, which lasts from May 21 to September 7, there is a 52% average chance that precipitation shall be observed at some point during a given day. When precipitation does occur, it is most often in the form of thunderstorms (53% of days with precipitation have at worst thunderstorms), light rain (35%), and moderate rain (9%). During the cold season, which lasts from November 28 to March 6, there is a 67% average chance that precipitation shall be observed at some point during a given day. When precipitation does occur, it is most often in the form of light snow (37% of days with precipitation have at worst light snow), moderate snow (30%), light rain (17%), and moderate rain (8%).

The Contractor should be aware that temperatures may fall below zero for a significant part of the year during the winter months. Temperatures in winter have been known to fall to – 25°C. The Contractor shall take account of such extreme temperatures in his design, programming and proposed working methods. The freezing depth is 0.8 m.

There is a meteorological station in the region and the Contractor shall be deemed to have acquainted himself with all additional weather records available and prevailing climatic conditions in the region.

1.5.2. Environmental Conditions of Server and Workstations Rooms

The Beneficiary shall make at the Contractor's disposal clean, ventilated, and secured rooms, properly equipped with permanent power supply (230V, 50Hz), network outlets, and air conditioning system maintaining the following environmental parameters regardless the external weather conditions:

- Temperature range: +10 …+30° C.
- Relative humidity: 30...70%.

The rooms shall be water leakage proofed and equipped with fire alarm system.

1.5.3. Environmental Conditions at Water and Wastewater Sites

The Beneficiary shall make at the Contractor's disposal sites for installation of local equipment. The environmental conditions at the sites differ due to different operational factors (water/wastewater PS, wet/dry pump installation, exposure to floods, presence of operator's room, internal/external installation of pump control board etc.).

For external installations outside buildings, external weather conditions shall be considered, as provided above.

For internal works, the following environmental conditions shall be considered:

- Temperature range: 0 …+40° C.
- Relative humidity: 20...80%.

The sites shall be provided with permanent power supply 230V, 50Hz.

The equipment shall be designed and supplied with appropriate Ingress Protection (IP) Marking, as required in the TS. Noise and vibration conditions due to pumps operation shall be considered by the Contractor.

1.5.4. Seismic and Geological Conditions

According to the Seismic Zoning Map of Moldova, approved by the Ministry of Regional Development and Construction ("Monitorul Oficial", No 72-74 of May 14, 2010), seismicity of Ungheni varies from 7 to 8 points.

To ensure earthquake resistance of buildings provided the following activities as minimum in accordance with NCM E.03.02 - 99 "Design and calculation of masonry structures" shall be followed: the presence of reinforced belts in the levels of floors and coverings and compliance with minimum legal size of partition walls.

The Contractor (including his sub-Contractors, if any) is obliged to follow National and Local standards and regulations related to the seismicity and difficult soil conditions in his detail design of facilities.

1.5.5. Existing Measurement Equipment

As mentioned above, some sites are already partially equipped with measurement devices. For these sites, the new SCADA equipment shall rely on the existing measurement equipment, while the new Data Acquisition and Control Equipment shall be supplied, installed, and properly connected to the equipment by the Contractor. The existing measurement devices shall be provided at the Contractor's disposal by the Employer.

Where additional devices are required, the Contractor shall supply and install these measurement devices, as further provided in this TS.

The existing measurement devices are shown in below table:

Table 2 - WWPS with existing measurement devices

No.	Name of Station	Address	Parameter
1	WWPS-3 (SPAU-3)	Or. Ungheni, str. Ion Neculce	The flow of output wastewater (RS485)

Table 3 - WTP with existing measurement devices

No.	Name of Station	Address	Parameter
1	WTP	Or. Ungheni, str. Oranjeriei	The flow of 2x input and 2x output water (RS485)
2			Hydrostatic Level Transducer (4…20mA)

1.6. Standard of Materials and Works

All equipment and materials shall be of the best quality appropriate to each category of work. All materials and equipment shall as a rule meet the appropriate international standards (ISO) or approved similar standards regarding material, quality, workmanship, and performance. All equipment and materials shall have ISO 9001 certificates.

These technical specifications refer both to locally applied and international specifications with the following clarifications:

- With reference to the SCADA equipment and generally to all materials, which are expected to be procured on the international market, these specifications make large use of international norms and standards. However, the Contractor may propose material and equipment produced according to equivalent locally applied norms and standards if he demonstrates that these are equal or better than the specified norms.

- With reference to materials which are expected to be procured on the local market, such as all materials required for the civil works, or with reference to the general and requirements for workmanship, supplying and installation of SCADA and equipment, these specifications refer generally to the prevailing

norms and standards applicable in Moldova as defined and listed below. In the case that the Contractor elects to supply such materials from the international market, he shall prove that the quality of such materials are equal or higher compared to the specified norms.

The Employer will determine whether the equivalent standard or requirement proposed by the Contractors considered equal or better than the specified standard.

1.7. Unit of Measurement, Labelling and Symbols

Metric units of measurements (Système Internationale) shall be applied in all correspondence, in all technical schedules and on all drawings, part of this document.

All material and equipment shall be referred to in the metric/SI international standards regarding their weights and measures.

Machines, equipment, control valves and panels shall be fitted with a non-corrosive label setting out the item number, make, model, serial number, key performance data and the like. The size and shape of the label shall be as defined in EN standards. All text shall be in **English** and **Romanian** languages.

Warning signs and colours shall be no substitute for protective appliances and devices. The warning signs and colours (for instance, electric hazard) shall all be approved by the Beneficiary.

2. DESIGN REQUIREMENTS

This section provides description of the Work and System Design Requirements for this Contract. The intention is to give the Tenderer a solid understanding of the design requirements associated with the SCADA system.

2.1. Applicable Standards and Codes

Wherever reference is made in the Contract to specific standards and codes to be met by the materials, plant, and other supplies to be furnished, and work to be performed or tested, the provisions of the latest current edition or revision of the relevant regulations, standards and codes in effect shall apply, unless otherwise expressly stated in this or other parts of the Contract documents.

Where such rules, regulations, standards, and codes are related to a particular region (such as seismicity), other authoritative standards which ensure a substantially equal or higher performance than the standards and codes specified, shall be accepted, and shall be used subject to the Employer prior review and written approval.

Differences between the standards specified and the proposed alternative standards must be fully described in writing by the Contractor and submitted to the Employer at least fourteen (14) days prior to the date when the Contractor desires the Employer's approval. In the event the Employer determines that such proposed deviations do not ensure substantially equal performance, the Contractor shall comply with the standards specified in the documents.

European Codes (EN) and International Standards (ISO) are referred to where an appropriate code or standard has been published. Otherwise, reference is made to the appropriate German and British Standards or its equivalent.

The Contractor shall be responsible for obtaining these standards and their timely translation if required by the Employer.

If specific codes such as EN, DIN or ISO are specified, then the Contractor shall submit a Certificate of Origin certifying that the material, equipment, or goods purchased is in conformity with such standard and submit the same for the Employer's approval.

Local laws and regulations concerning installation works shall be used. In case of more restrictive provisions of the international regulations, the latter shall prevail.

The following national standards and norms shall be used, but shall not be limited to:

- SNiP III-4-80* - Техника Безопасности в Строительстве (Eng – Construction safety).
- SNiP 3.05.04-85 - Наружные сети и сооружения водоснабжения и канализации (Eng – External water and wastewater networks and facilities).
- SNiP 3.05.07-85 - Sisteme de automatizare (Eng - Automation Systems.).
- SNiP 3.01.01-85 – Организация строительного производства (Eng – Organization of construction works).
- SNiP 2.04.02-84 – Водоснабжение. Наружные сеть и сооружения. (Eng – Water supply network. External network and installations).
- SNiP 3.05.06-85 - Instalații electrotehnice (Eng - Electrical works).

The design shall be prepared by a licenced entity, in compliance with the following legal provisions:

- Types of design works for different structures (Nomenclatorul lucrărilor de proiectare pentru toate categoriile de construcții, urbanism, instalații și rețele tehnico-edilitare, reconstrucții, restaurări, care se practică în bază de licență, Anexa 1 la ordinul Agenției Construcții și Dezvoltare a Teritoriului nr.1 din 15 iunie 2006 (Monitorul Oficial nr. 1460149 din 15.06.2006)
  https://www.legis.md/cautare/getResults?doc_id=43772&lang=ro.

- Law No116 of 18.05.2012 on the industrial security of dangerous industrial facilities (Securitatea industrială a obiectelor industriale periculoase) https://www.legis.md/cautare/getResults?doc_id=120652&lang=ro.
- Law No235 of 01.12.2011 on accreditation activities and conformity assessment (Activităţile de acreditare și de evaluare a conformității) https://www.legis.md/cautare/getResults?doc_id=100065&lang=ro.

2.2. Design Philosophy

Control systems with multi-tier architecture usually built on object principle, when the structure of the system selects a similar structure of the automation object, and each subsystem is local, that is, feedback is closed within this subsystem. Each local subsystem performs a separate function that, given the logic of the whole system. Object principle of construction can simplify the design of a multi-level and to ensure its structural (architectural) reliability.

The Contractor shall prepare the detailed design basing on the following scheme provided in the Figure 1 below.

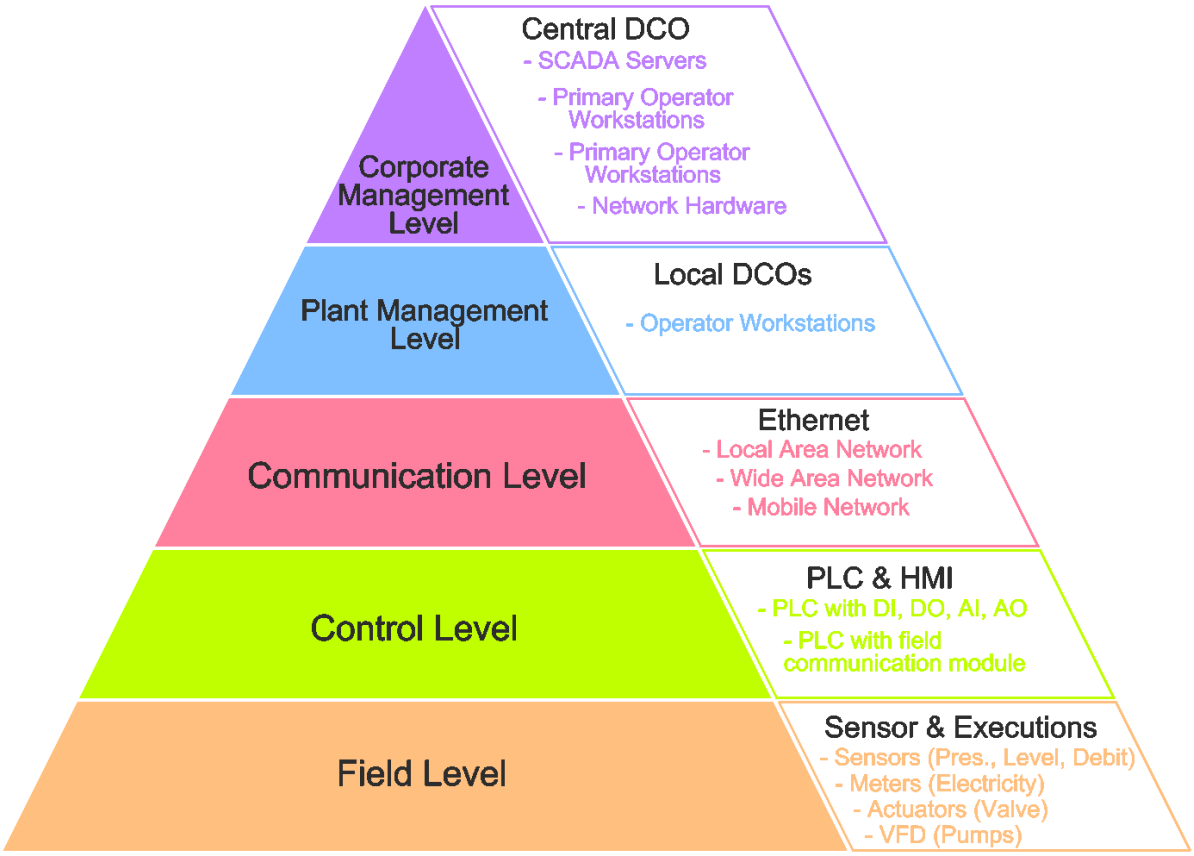

Figure 1 - The Proposed hierarchy of the New SCADA System

The philosophy of the design shall be simplicity and reliability such that the equipment shall have long trouble-free service with low maintenance cost, low energy consumption and low disturbing impact on the environment.

Particular attention should be paid to avoiding short-circuit effects and easy access to facility inspection, cleaning, maintenance, and repair.

All equipment supplied shall be designed to meet the needs for satisfactory operation under all variations of operating loads, pressures and temperatures including variation in the 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 affecting the efficiency and reliability of the facility.

It shall be the responsibility of the Contractor to ensure that the SCADA equipment is completely satisfactory for use with the existing instrumentation and metering equipment.

Each component or assembly shall have been proved in service in a similar application and under conditions no less arduous than those specified herein. The Employer shall have the right to request the Contractor to justify his selection of peripheral equipment.

The choice of materials and finishes shall consider the atmospheric conditions at the Facility. Equipment shall be protected against the entry 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.

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

2.3. Design Drawings and Reports

The Contractor shall submit reports, drawings, and other details for the approval of the Employer as detailed below.

The design reports and drawings shall include, but not limited to:

- System schematics / functional scheme.
- Communication schemes at DCO and each site.
- Wiring diagrams of each Local Data Acquisition and Control Equipment.
- Equipment installation drawings.
- Human-Machine Interface (HMI) development data to include tag-name database with corresponding Input / Output (I/O) list.

The Contractor shall provide the Employer with paper copies of all reports and drawings for review and / or one electronic copy in an editable format. The electronic version of the reports and drawings shall be in the following editable format or equivalent:

- Drawings – AutoCAD 2007 or updated version, or alternative version of programs, which works with DWG format.
- Tables – MS Excel 2010 or above.
- Documents – MS Word 2010 or above.

All documents and drawings shall be made in both English and Romanian.

The drawings must be prepared according to all valid Moldovan rules and standards for the design documentation and ISO “Technical drawings”.

The Contractor shall ensure that drawings, submitted for approval are on internationally recognized sizes of paper. The following sizes are acceptable:

- A1 (594 mm x 841 mm).
- A2 (420 mm x 594 mm).
- A3 (297 mm x 420 mm).
- A4 (210 mm x 297 mm).

Drawing sizes larger than A1 shall not be used unless prior agreement has been obtained from the Employer.

All calculations shall be submitted on A4 size paper.

Every drawing shall have a title box in the bottom right corner showing:

- Employer’s name.
- Title of scheme and Section number.
- Title of Contract and Lot number.
- Beneficiary’s name.
- Contractor's name.
- Title of work location.
- Drawing number.
- Designer name and date.
- Scale.
- Separate revision box with revision number.
- Space for the signature and remarks of the Employer and/or Beneficiary.

2.4. Design Review by the Employer

Upon finalization of the detailed design, all drawings and documents submitted by the Contractor to the Employer for review shall be checked by the Contractors Representative before submission and signed also by a Senior member of the Contractor’s staff responsible for design works in accordance with approved QA procedures, to confirm that the check has been conducted.

Where it is considered that the submitted design and /or technical documents do not comply with the requirements of this Contract, the Employer shall return one copy to the Contractor indicating on the drawing(s) in red color in handwritten where the Contractor solutions or proposals are noncompliant. No extension of time is accepted by the Employer, nor by the Beneficiary, if design is returned to the Contractor by the Employer.

Where a design solutions or proposed materials requires alteration, the Contractor shall make the necessary alterations at **no-cost** and submit a copy of the altered document to the Employer. Any revisions to drawings and documents shall be clearly highlighted by the Contractor. Drawing amendments shall be listed in the title box. Amendments shall either be redlined, struck out or marked in the margin.

2.5. Coordination of the Design and Approvals

The Contractor shall be responsible for securing all necessary approvals of the designs produced by himself, as required by the relevant Moldovan (National and Municipality of Ungheni - Local) authorities and from all related to the Works utilities incl. organizations.

The Contractor shall prepare his Programme and schedule his activities considering time necessary for obtaining relevant approvals, coordination’s and fulfil procedures established by the relevant organizations, institutions needed for receipt of approvals and coordination’s.

No time extension and additional cost shall be accepted by the Employer if the Contractor is unable to perform or complete detailed design documents due to the delays in obtaining requested approvals.

All cost for obtaining requested by the National or Local legislation shall be considered by the Contractor and already included into the Unit rates specified in the Price schedule.

3. CENTRAL DISPATCH AND CONTROL OFFICE

The requirements defined in this section apply to the computer-based components of the SCADA System.

All servers and workstations shall be from a single manufacturer.

The warranty period must be **at least 24 months.**

3.1. Server Equipment

SCADA servers shall be installed at server room located at the address: str. Mihai Eminescu 37A, Ungheni, Moldova. Server room is equipped with all necessary condition equipment to maintain temperature and humidity, to work in great condition of the server. Server design shall be rack mount hardware to get all needed performance and stability of the system.

The server shall serve to provide all SCADA System functions.

Hardware requirements of the server equipment are the following:

3.1.1. Rack IT Enclosure

Rack shall be designed, manufactured, supplied, and installed inside a server room and shall include all equipment needed for operation for SCADA and related hard and software.

Rack IT Enclosure shall meet the following minimum criteria:

- Sheet steel.
- 85% of vented surface area
- Dimensions – enough to install the necessary equipment, plus 30%.
- The industry standard rack cabinet - 19”
- All needed accessories for mounting.

3.1.2. Server

The SCADA System Server shall interface to networked devices, remotely connected RTUs, PLCs via networked connections. The SCADA System Server shall gather, log, store and display available SCADA data and reports, and enable modification of data points. A server supplies connected clients with process data, archive data, messages, screens, and reports. This requires a network connection (TCP/IP) between the server computer and the connected clients. Server shall meet the following minimum criteria (or at least the equivalent):

- Form factor - Rack Server.
- Processor CPU Xeon® (or equivalent).
- Memory 32 GB DDR4.
- SSD 2x256GB in RAID-1 as a boot disk.
- HDD 2x1.2TB for data storage.
- RAID 5 configuration support.
- Power supply 2xPSU, redundant 550 W AC.
- Network interface 1 x IMM and 4 × 1 Gb.
- Platform Module built-in USB Ports / VGA Ports Up to 3 front (1 x USB 3.0, 2 x USB 2.0) and 4, 1 internal (USB 3.0) / 1 front and 1 back
- **Server shall be from the same manufacturer as all workstations.**
- Operating System:
  - Windows® Server x64 bit – English.
  - Licences - Windows® Server x64 bit– Multilanguage.
- Microsoft ® Office tools: Office Home & Business 2023 64 English or higher.

- Limited warranty 3-year and upgrades available.

3.1.3. Network Hardware

The communications topology of SCADA System shall be based on TCP/IP protocol transported over an Ethernet network. Network components shall support 10/100/1000 Mbit/s Ethernet as appropriate. Network interface hardware shall have sufficient processing capacity and bandwidth to cater for peak throughput without affecting overall performance. At plant level, the network equipment shall be of the industrial hardened type and be capable of continuous operation under the facility environmental conditions. Managed Ethernet network components, such as the network switches in Central DCO shall support SNMP. Devices shall be able to restart and initialize automatically according to the restart configuration. Appropriate critical alarms from these devices provided via SNMP shall be accepted and reported to the SCADA alarm system.

One of the main security issues facing more networks that are complex today is remote access. Virtual Private Network (VPN) is a secured way of connecting to remote SCADA networks. With VPN, all data paths are secret to a certain extent, yet open to a limited group of persons, such as employees of a supplier company.

A VPN is a network constructed by using public wires (using the Internet as the medium for transporting data) to connect nodes. Based on the existing public network infrastructure and incorporating data encryption and tunnelling techniques, it provides a high level of data security. A VPN router or server will be installed either as part of the firewall or as a separate machine to which external users will authenticate before gaining access to the SCADA networks. VPN router shall meet the following minimum criteria:

- 19” Rack-mount VPN router.
- Minimum of 8x 1Gb/s Ethernet ports; 1x1Gb/s WAN port.
- All needed accessories for mounting in server enclosures.

To minimize collisions, at a minimum the system will utilize switch for network control. This switch will ensure that in SCADA networking will not cause collisions with the overall network.

3.1.4. Uninterruptible power supply (UPS)

Uninterruptible power supply (UPS) shall provide necessary power to all equipment installed in the Rack and shall meet the following minimum criteria:

- The UPS shall ensure minimum of 1-hour backup time for server.
- At least 3000VA.
- 160 to 280 VAC Input with automatic 50/60 detection, with full time multi-pole noise filtering, 0.3% IEEE surge let through, zero clamping response time.
- The UPS shall have audible alarms, automatic internal bypass, and automatic load restart after UPS shutdown, automatic self-test, and predictive failure notification.
- Continuous battery recharging, even if the power button is set to OFF. The UPS shall have a battery replacement indicator, disconnected battery notification, and shall allow batteries to be replaced with equipment energized.
- WEB/SNMP connectivity device.
- All needed accessories for connection of both servers.

3.2. Operator Workstations

Operator Workstation shall be supplied and installed at the Central DCO (Primary Operator Workstation – 1 pcs).

The workstation shall be from a single manufacturer.

The Operator Workstation shall serve all SCADA functions for water and sewage pumping stations and provide a graphical user interface (GUI) developed via the specified HMI software.

The Operator Workstation is a position from which an operator can monitor and control the entire process and view all real-time data and all historical data via displays including all network activities.

The Operator Workstation shall be designed for secure interactive Operator capability for the following functions, including but not limited to:

- Provide point and click actions required for the Operator to interact with the system, such as cursor positioning, display selection, menu selection, menu item selection, etc.
- Select and execute process and equipment control functions, including but not limited to, start, stop, raise, lower, auto, manual, alarm acknowledge, etc.
- Select any display for any monitor, and select display combinations of process control displays, trend displays, group displays, bar chart displays, and other graphic displays, on any monitor.
- Select points and assign parameters for trend displays, group displays, and bar chart displays.
- Assign points, collection periods, and print periods for reports and data storage functions.
- Enter numerical values and alphabetic characters.
- Copy any display to colour hard copy (paper).

The Supervisory Control and Data Acquisition system workstation should have the following minimum functionalities:

- Monitoring Function. The system shall be capable to provide an effective visual interface between the process and the operator, displaying process values and incorporating them into animated graphic that shall represent the process on the screen of a personal computer to be installed in the Central and Local DCOs.
- Alarming Function. Integrated into the data and graphical displays alarm functions should be present. The system shall be tied into Auto-Phone-dialling that will automatically notify operating personnel of the occurred alarm (GSM-SMS).
- Data Logging Function. Once data has been brought into the system, the SCADA system will archive selected data into electronic records. The historical data should be able to be exported from the SCADA system as a Comma Separated Variable or .CSV file, which can then be drawn into a different application like Microsoft® Word or Microsoft ® Excel for further analysis and formatting into reports.

The system shall receive the data and the alarm acquired by the following on-field devices: Programmable Logic Controller (PLC) / Remote Terminal Unit (RTU) from the different pumping stations.

The SCADA system shall utilize one Personal Computer (PC) located at the Central and Local DCOs to provide the graphical display as well as the necessary computational and networking power. The SCADA software shall be installed on PC and will operate under the operating system Windows®.

The Operator Workstation shall include a 3xMonitors (three), Keyboard, Mouse, Printer, UPS and Business Productivity Software.

Workstations shall meet the following minimum criteria (or at least the equivalent):

- Processor: i5 Core last generation.
- Operating System: Windows® 11 Professional.
- Memory: 16GB, DDR4.
- SSD 1x256GB as a boot disk
- Hard Drive: 500GB.
- Network Adapter: 1GbE NIC, Dual Port.
- At least three (3) USB ports.

- 3xMonitor: Minimum 27-inch full QHD screen, VGA/DVI with incorporated (or separate) speakers.
- Keyboard: USB Entry Quiet key, No Hot Keys.
- Mouse: USB Optical Mouse with scroll, All Black Design with mouse pad.
- UPS 1000VA.
- Productivity software for PC shall be Microsoft® Office.
- Laser printer, colour, with A4 paper format.
- **Workstation shall be from the same manufacturer as server**.

The Operator Workstations shall be supplied with preinstalled system and all configured drivers.

3.3. SCADA Software for Server

3.3.1. Overview

The Main software package shall consist of a SCADA software, a PLC and HMI development software, I/O interfacing software (drivers).

The SCADA software will read and write data to field controllers, archive and display historical data and provide graphics screens and reports so that operators, supervisors, and maintenance personnel can quickly and easily maintain and operate the system.

The Employer highly intends to purchase a Main software package from one vendor / manufacturer to reduce support requirements. It is expected that all the core SCADA functionality offered, such as communications drivers, graphics capabilities, reporting, historical storage, trend and alarm displays, and the development environment are offered as a single integrated software package or suite of packages. If software from multiple vendors is required to meet the requirements of this specification, the software components and vendors must be specifically listed.

Any additional software required to meet the specifications, other than a standard Windows® operating system and internet explorer shall be listed and included within the Contractor's pricing proposal.

The SCADA software shall have the following minimum features:

- Open system architecture with relational database management system.
- Feature for checking the healthiness of the system and communication links.
- Sufficient capacity in terms of memory and I/O to perform the required functions.
- User-friendliness using 'Windows' based applications.
- Keeping of statistics of errors encountered in communication.
- Prioritization of tasks like alarm processing.
- Database for storing and retrieval of various parameters, historical data etc.
- Historical data archiving on hard disk as well as on removable media for at least 4 years. Multiple levels of security for users with predefined access rights and password protected access. Alarm generation with timestamping.
- Trending of real-time and historical data in different user configurable formats.
- Flexible reporting system providing pre-formatted standard reports for common requirements as well as generation of free format reports configurable by the user, available on demand, event/ application initiation or at pre-set time intervals.
- Information display in various formats including bar graph, chart etc.
- Possibility of mobile client integration.
- Historian part will have to be included.
- Integrated GIS system or option for interoperability with Geographic Information System (GIS).

3.3.2. Performance

The software shall secure performance of a system with a single, common database with:

- 25 concurrently connected workstations.
- 5,000 Runtime Tags read from field devices (upgradable).
- 2,500 Archiving Tags read from field device (upgradable).

3.3.3. Scalability

The future SCADA system must be open system, which will allow the future extension of device number, implemented solution not to limit any other extension.

The software shall be having a scalability solution. Growing a system from small to large requires another dimension of scalability in addition to functionality. True scalability demands that a solution can be easily extended from a single, simple application, to a comprehensive networked solution serving the needs of an entire multi-plant industrial enterprise.

Consider the common requirement to have multiple HMI or SCADA applications that are different but have similar components, which must be kept separate but benefit from each other's design and standards. Also, consider the requirement for those applications must be able to operate, evolve and grow independently. This is a typical real-world scenario which requires underlying system architecture to support such evolution. Such architecture needs to combine powerful object-oriented modelling capabilities, integrated and equally powerful graphical HMI and visualization capabilities as well as comprehensive device integration capabilities.

The software shall be scalable such that the user can start with a small system and expand the database simply by upgrading the license. Stations shall be able to be added to the system simply by adding licenses and configuring the station.

3.3.4. System for information acquisition

Subsystem must provide data acquisition from supervised facilities according to different standard protocols, periodically or per some occurrence. Subsystem for information acquisition includes all kinds of sensors and controllers. It takes charge of data collection and devices controlling of local facility.

3.3.5. System for processing and monitoring alarm and occurrence

The possibility of alarm classification is required in terms of priority and their storage in predefined base, which has the option of creating chronological reports.

Subsystem for alarms that serves to define and display alarm conditions in the system. The alarm condition may constitute an illegal or critical size value as an invalid action or operator command. Each alarm has its own properties such as the severity level of the alarm, place of origin, category, a message that is related to the alarm, and the like. The subsystem for alarms allows the change of alarm state operations through confirmation and deletion.

3.3.6. System for activation of information

Relevant process values must be recorded in real-time database, periodically, at request, or per occurrence. Module must provide data storage for immediate access, for off-line analysis as well as for their permanent recording in backup unit. Each record must be accompanied with suitable timing. System must support the existence of independent buffer for disasters with the possibility of replication of data into real-time base. Access to recorded data must be possible from all client stations.

3.3.7. System Security and Access

The SCADA system shall provide a high level of inherent security. To this end the SCADA software shall provide security access down to data point level, and support individual Users, User Groups and a matrix of system capability and access to any level of the SCADA database.

Client interfaces shall provide the ability to restrict access to sensitive system information based on user privilege.

System Administrators shall have the ability to allow/restrict client access to specific system interfaces by IP Address. IP Address Range, and/or CIDR (Classless Inter-Domain Routing) notation.

Web interface facilities shall provide the capability to operate the Web interface using SSL and encrypted data. The Web functionality shall be provided in an integrated way with the web server facility tightly coupled with the SCADA database. It is not acceptable for the system to require web pages to be "published" from the SCADA system. Changes in configuration to the SCADA system shall not require additional steps to provide modified information to the SCADA Web interface.

3.3.8. Operator Interfaces

- SCADA software shall provide the ability to support multiple local and remote display clients.
- Display facilities shall be available via LAN, WAN, and dial-up connection.
- Integrated Web Server capability shall be available, providing all display and operational facilities of the client without the need for third-party software to be installed.
- Web Clients shall allow users to view Mimics, Trends and Plots, Database Objects, and Reports as well as perform control functions using a standard web browser.
- Web Clients shall allow users to connect from any phone, tablet, or laptop to view data, alarms, events, trends, and query results.
- Common user interface items such as operator menus and dialog boxes shall be available in the set language of the logged-in user when English or Romanian languages.
- Web Client shall provide support for Internet Explorer™ 11 web browser, Google Chrome™ web browser, Firefox™ web browser, Edge™ web browser and Safari™ web browser.
- On-screen keyboard support shall be provided (important for HMI installations).
- Display client shall support Embedded Web Pages.
- SCADA Software shall provide an Android™ mobile OS and iOS™ mobile OS-based mobile client and server system:
    - Communications between the Mobile Server and the Android mobile OS and iOS mobile OS devices shall employ Transport Layer Security to ensure appropriate encryption is used on all transmitted data.
    - Users of Android shall be notified of new alarm conditions relevant to their area of responsibility.
    - All Mobile device users shall be able to action those alarms using a built-in alarm and event lists.
    - The database browser shall provide detailed status information related to any database object to allow more in-depth problem diagnosis.
    - Trends shall provide users with the ability to review historic data to make the right operational decisions for the future.
    - User favorites shall allow user to store the most used views on their phone for easy retrieval.
    - Users shall have access to tabular data providing easy analysis and comparison.
    - Overall system Key Performance Indicators for management, production summaries, system water flows, reservoir levels etc. shall all be easily added and made available to users as custom queries.

- Users can find field devices and points by searching for part of a name.
- Administrators can assign extended functions to be available for execution on objects by users with specific privilege attributes.

3.3.9. Alarms & Events

The number of Alarms supported shall not be limited by the software. The software shall be capable of storing alarm summary events in the native alarm archive and retain them in memory, to recall through standard alarm display screens.

Alarm events shall also be written to logging files and stored indefinitely on a rolling file basis for archiving purposes.

The SCADA software shall monitor analogue and discrete tags (variables), and calculated conditions to determine if the variable is in an alarm condition.

3.3.9.1. Analog and Discrete Alarms

For each Analog Tag, an alarm shall be able to be configured with limits available for each of the following conditions:

- LOW-LOW.
- LOW.
- HI.
- HI-HI.
- Deviation LO.
- Deviation HI.
- Rate of Change.

All Analog alarm limits shall be adjustable without shutting the system down. Changes shall automatically be saved to the database so that if the system is restarted then the Alarm Settings will be correct.

Analog alarms shall also support the use of a dead band value and delay timers to minimize nuisance alarms.

Discrete alarms shall have an assignable alarm for each of the following:

- Variable ON.
- Variable OFF.

Multi-Digital Alarms based on a combination of discrete tags. Any combination of states of the discrete tags may be configured to be an alarm. Furthermore, alarming will occur whenever a new alarm state is encountered.

All alarm processing shall have the facility for time stamping and can track time to a precision of 1 millisecond.

3.3.9.2. Alarm Display

With appropriate user's log-in privileges, it shall be possible to display or acknowledge any alarm and/or the most recent alarm on any page.

The software shall provide multiple levels of alarm priority or category. The priority of an alarm shall be identifiable by the colour and font settings of the alarm message on the screen. The colour coding of prioritized alarm messages shall be configurable by operators.

Sound indication for each alarm category shall be configurable. This must be possible at each operator workstation. It shall be possible to have the alarm sound either by internal or external speaker. The sound indication shall support the playing of any standard .WAV file.

The software shall have a standard alarm display page that can be modified for the project. The standard alarm page shall have the facility for scrolling through multiple pages of alarms and for acknowledgment and disablement of individual alarms.

It shall be possible to display the following information for each alarm as it appears on an alarm display page:

- Alarm Tag Name.
- Alarm Description.
- Value of the Tag or result of any calculation.
- Trip limit.
- Alarm Status - Disabled, Acknowledged, Unacknowledged.
- Alarm Category.
- Alarm Priority.
- Time & Date in International Formats.
- Privilege.
- Category.
- Operator Comments.

It shall be possible to display each alarm category in a different font and colour (including flashing colours) dependent on whether the alarm is Active Unacknowledged, Active Acknowledged, Acknowledged Cleared, Unacknowledged Cleared or Disabled.

The alarm display shall support both proportional and fixed fonts with all alarm fields displayed in properly aligned columns.

Based on user's privileges, it shall be possible to disable alarms on individual basis, by page, by alarm category, or for all alarms. When an alarm is disabled, the alarm will be displayed on a separate disabled alarms page so every user of the system can easily determine which alarms have been disabled.

At any station on the system, it shall be possible to acknowledge alarms individually, by category or by page.

Based on user's privileges, the software shall allow for operator comments to be attached to any alarm when it is acknowledged or later. These operator comments shall either be displayed with the alarm or displayed by clicking on the alarm.

It shall be possible to automatically display any graphic display when an alarm occurs or to dynamically change the appearance of any graphical object based on whether an alarm is On, Off, Acknowledged, Communications Error, or Disabled.

The alarm display shall have a mechanism for operators to dynamically define filtering of alarms by alarm tag, alarm name, alarm description, date/time range, state including sub-states for analogue alarms, type, area, category, and priority.

3.3.9.3. Alarm Sorting

It shall be possible to sort (ascending and descending) Alarm displays by one or more alarm fields without grouping restrictions. Alarm fields that can be used for sorting include:

- Tag.
- Name.
- Category.
- Priority.
- Area.
- Privilege.
- State.
- On Time.

- Off Time.
- Ack Time.

3.3.9.4. Alarm Delay

It shall be possible to set a time period on individual alarms such that the alarm must be active for the time period before it is annunciated to the operator. The time stamp of the alarm must be the time when the alarm first became active, not at the completion of the time delay.

3.3.9.5. Alarm Logging

The alarms shall be able to be logged to a designated printer, disk file or database with alarm text and time and date labels. Alarms shall be printed or filed in a user-configurable format.

The SCADA software shall allow logging to any printer on the network. The software shall be able to redirect printing to another printer while the system is on-line.

It shall be possible to define a different method of logging alarms for each alarm category (if alarms are to be logged when the alarm transitions to ON, to OFF or on Acknowledgement).

Alarms that are logged to disk shall be available for viewing while the system is on-line or off-line without causing any interruption to data collection. The number of alarms logged to disk shall not be limited by the software.

3.3.10. Trends

3.3.10.1. Trend Collection

The number of trends collected shall not be limited by the software.

The software shall be capable of logging historical trend information at configurable sample periods from 1 Second to 24 Hours. Trend data shall be stored in a circular file system with the number of files, the size of each file, the sample period, file location, privilege, and area configurable for each Trend Tag.

Total storage shall only be limited by available disk space.

It shall be possible to collect trend data on a periodic basis, i.e., one sample every sample period, or on an event basis, i.e., sample is read each time a condition goes true. It shall also be possible to start and stop the storage of trend information-based variety of conditions such as on a process condition, time, or manually by an operator.

Trend values shall be stored in floating point resolution, and not require rescaling for retrieval and display purposes. This prevents a loss of accuracy, and also allows tags to be configured for new scaling ranges without compromising the integrity of their storage repository.

3.3.10.2. Trend Display

Graph displays shall be offered and shall be requested through a menu driven system and/or embedded within displays. These shall display data in engineering units or as percentage of full scale with the appropriate units stated on the display. Displays shall be in the form of line-graph, step (-first and -last) line, and bar graph form. These display types shall be able to be mixed on one display.

The Trending System shall include facilities to display pre-configured and ad-hoc graph displays.

The user shall be able to choose the display type for each variable separately. These variables shall include analogue values, integrated values and digital (status) values e.g. it shall be possible to produce a graph showing flow rate, total flow and flow regulator position (i.e. gate open/shut) as one display for correlation.

The colours of variable traces shall be allocated automatically, which may then be changed by the user. The colour of X and Y axes shall also be configurable.

It shall be possible to combine data from different parameters, from different time/days and different data sources, in order to perform calculations within the trending display (e.g. display the result of subtracting variable B from variable A). It shall be possible to apply a configurable multiplier to the variable. It shall be possible to select from a number of pre-configured algorithms including (but not limited to) Average, Max, Min, Time Average, Start, End, Sum, Count, Total, Variance, Standard Deviation, Moving Range and Delta. It shall be possible to configure additional accumulating or moving algorithms for selection within the trending interface. It shall be possible to select from a number of pre-defined columns to display algorithm data for all configured traces, including Count, Sum, Total, Minimum, Maximum, Mean, Range, Delta, Standard Deviation, and Variance.

The trending system shall support display of multiple separate Y-Axes, without imposing an artificial limitation. A facility shall be provided to change both X and Y axis scales and zero for each point graph without the need for reconfiguration. The facility to select logarithmic scales and/or inverted scales for the Y-axis shall be provided. The Y axes shall apply auto-ranging scale unless manually overridden.

In respect of the time axis, the start times of overlaid graphs shall be configurable separately, if it is required that they differ. The initially configured scales shall be kept as default conditions. It shall be one option to superimpose the same data points from a different time period e.g. today and yesterday's reservoir levels.

The trending system shall support recording of annotations, or text comments, on variable traces, which will be available for viewing by other users when the variable trace is in display.

It shall be possible to manually insert, modify, and/or delete recorded data using facilities available within the trending system. It shall be possible to modify a range of values via application of a formulae or replacement with a single value.

It shall be possible to superimpose more than 50 variables onto graphs showing the trace with its alarm limits. It shall be possible to enable/disable the display of any configured variable without the need for reconfiguration; it shall also be possible to show/hide individual elements of configured variables (trace, alarm limits, markers, annotations) without the need for reconfiguration.

It shall be possible to select a sub-range in time of a graph display and to expand this to a full-screen picture. It shall be possible to manually set the displayed range for each individual variable plotted within a graph. It shall also be possible to obtain a read out of the time or value of any point in a graph display through the position of the movable cursor. It shall be possible to roll a graph forward and backwards in time.

It shall be possible to display from both historic and current data on the same display. The time-axis shall support continuous scrolling mode to display new data as it comes into the system.

It shall be possible to export the data displayed within a graph, for example to CSV, Microsoft Excel spreadsheet software, Microsoft Word processor software.

Having configured a particular graph display with a selection of data, reference data, colours, scaling etc. as above, the user shall be able to save this configuration for later re-use.

3.3.10.3. Historical Data

The SCADA system shall provide a built-in data historian with the following facilities as standard features. These shall be provided without the addition of external software modules:

- Time-series relational database
- ODBC / SQL interface to historical (trend) data
- Historical data to be stored with timestamp, point quality, alarm status

• Historic storage is to be stored raw, based on configurable criteria including time between samples and alarm state change

• Compression capability, with an option to filter based on configurable criteria including time between samples and value change

Historical data shall be stored with variable interval sampling.

Where historic data can be retrieved through communication devices such as PLC/RTUs, the historic data sub-system shall natively provide the capability to backfill this data into the historian.

The historic data subsystem shall provide fixed and user configurable views of the historic data tables. These views are required to provide SQL pre-processing and present historic data in aggregate format, such as Min, Max, Average, Standard Deviation, Moving Averages, Quality etc.

The SCADA server shall provide Historian functions including the capability to validate historic data prior to exposing it externally to the SCADA system, selectable archiving rates, point-by-point storage compression regimes, annotation on history samples for tracking comments on operational conditions, modification of historic data for normalisation and correction (tracks previous value and modifying user and is subject to user privilege), auditing of modified or annotated history.

3.3.11. Reports

The SCADA software shall perform all report generation, scheduling, and management internally and shall not require a third-party package to perform these functions.

The software shall permit reports to be scheduled for a specific time of day, on a periodic basis, upon operator request, or event initiated (e.g., alarm condition or end of batch).

The software shall support printing to the designated report printer. The software shall also have the capability to log all reports to a disk file or database (SQL, ODBC, DBF) or to a Web Server in a rich text file format such as HTML.

The software shall have the capability to display all reports on the screen, in user definable fonts and colours.

The software shall permit reports to be defined based on archived data. Single-point-in-time reporting (online and historical) and time-range reporting are both essential, as is the ability to report on an unlimited number of tags in one report.

Reports shall include extensive calculations on either instantaneous and historical data, or any other data from the system.

Reports shall have the ability to write to any tag in the system during the execution of the report.

The Contractor shall develop a minimum of 10 reports coordinated with and approved by the Employer during project execution.

For instance, the SCADA software shall provide, but not limited to the following data and curves:

- Daily/Monthly/Annual water flow Q (m3/h and l/s) with a step of 1 hour/1 day/1 month (adjustable parameter).
- Daily/Monthly/Annual water volume (m3) with a step of 1 hour/1 day/1 month (adjustable parameter) and cumulated value.
- Daily/Monthly/Annual discharge pressure P (bars) with a step of 1 hour/1 day/1 month (adjustable parameter).
- Daily/Monthly/Annual hydraulic power consumption (kWh) = 9.81 x Q x P with a step of 1 hour/1 day/1 month (adjustable parameter) and cumulated value.
- Daily/Monthly/Annual electrical power consumption (kWh) = $\sqrt{3}$ x U x I x cos φ, with φ = arctan (reactive power/active power) with a step of 1 hour/1 day/1 month (adjustable parameter) and cumulated value.

- Daily/Monthly/Annual system efficiency (hydraulic power/electrical power) with a step of 1 hour/1 day/1 month (adjustable parameter) and cumulated value.
- Daily/Monthly/Annual electrical power consumption / water volume (kWh/m3) with a step of 1 hour/1 day/1 month (adjustable parameter) and cumulated value.

3.3.12. Operator Event Logging

The software shall support logging of all operator actions to disk, printer, or screen.

The software shall be capable of logging the following information, Username, Action, Time, Date, Value, and Comment in a user definable format.

3.3.13. Web Browser Clients

The SCADA software shall include all the necessary software including the internet server to provide full operator display functionality via the internet without any loss of functionality. It shall not be necessary to export, compile or recreate graphics specifically for the Web Clients. Instead they shall operate from the same project configuration as the rest of the SCADA system, minimizing maintenance overheads and version control risks.

Changes made to the SCADA software database will be automatically provided to the users via the internet without the need for any action on the part of the user or the person making the changes.

Changes will be automatically uploaded to the internet user's PC only when the user accesses a display that has been modified so as to conserve bandwidth and optimize performance. The addition of new displays shall be treated as a change to the database and shall be seamlessly provided to the internet user.

The SCADA software will operate in conjunction with firewalls and provide security to reduce the possibility of unauthorized access.

Web browser client shall be possible "view only" access to SCADA software.

The application users shall be able to access their supervisory system using smartphone and table with Apple iOS, Android, and Windows platform.

The Contractor shall ensure provision of minimum two (2) web-clients.

3.3.14. Development environment

The development environment is the area that allows generation of graphic screens, alarms screens, tag database, trend screens etc.

The SCADA software shall include a development environment with the following:

- An integrated development package-utilizing menu driven, fill in the forms style configuration to develop the runtime system.
- Comprehensive on-line help shall be available for all development functions, the on-line help shall contain all information provided in the hard copy manuals.
- A utility to back-up or restore an entire database including all graphic displays, configuration data and source code, as well as online configuration (such as menu navigation, trend groups and alarm groups), via a simple point and click method. The backup/restore utility shall prompt the user prior to over writing any existing files. The utility shall employ automatic file compression/decompression.
- Ability to import field controller tag definitions shall be included as a standard feature. Automatic updating upon a change of a definition in the I/O device tag names, addresses, ranges etc will

automatically be imported into the SCADA software database. In addition, it shall be possible to manually initiate the import of tag definitions at any time. The Tag import function shall be user configurable such that a user can specifically define which definition fields must not be overwritten or define how the import will operate. The import function shall support generic OPC data sources and CSV file imports in conjunction to native field controller programming software database imports.

The SCADA software shall include development environment with an integrated development package utilizing menu driven, fill in the forms style configuration to develop the runtime system.

Commonly used features shall be supplied inherently in the system without requiring any engineering effort. As a minimum this shall include:

- Default display layouts including:
  - Current date/time.
  - Most recent 3 alarms.
  - Navigation bar.
  - Prompt and echo.
  - Alarm status indicators.
  - Security login/logout.
  - Print.
  - Help.
- Alarm displays including:
  - Active Alarms.
  - Historical Summary Alarms.
  - Disabled Alarms.
  - System Diagnostic Alarms.
- Fully functional Trend displays including:
  - Single Trend display.
  - Multi-Trend display (as example, water production and power consumption trend in single pump and pumping station in general per hour, per day, etc.).
  - Popup Trend display.
  - Instant Trend display (for monitoring tags which are not configured for historical trending).
  - The ability to fully configure the trend display at runtime (see Trends).
  - The ability to add trend pens to displays at runtime.
- Administration Tools including:
  - Tag Debug utility.
  - Diagnostics statistics, including communications statistics.
  - Error logs.
  - Memory utilization.
  - Disk utilization.
  - SCADA License utilization.
  - SCADA version.
  - Date/Time controls.
  - Online configuration of the navigation bar.

The same configuration interface shall be used for SCADA stations and Web clients, with the ability to reuse configuration between all systems without any additional engineering, including automatic rescaling of runtime graphics when different clients use different screen resolutions.

Test licenses providing time-limited runtime capabilities shall be provided to aid in development and testing of the system.

Comprehensive on-line help shall be available for all development functions, the on-line help shall contain all information provided in the hard copy manuals. The on-line help shall have hot spots that explain meanings for all technical terms, in everyday language. The on-line help shall have the facility to search by word or logical expression, including all words in the entire help system.

A utility shall be included to back-up or restore an entire database including all graphic displays, configuration data, source code, runtime navigation menu configuration, runtime trend group configuration, runtime alarm group configuration and so on, via a simple point and click method. The backup/restore utility shall prompt the user prior to over-writing any existing files. The backup/restore facility shall employ automatic file compression/decompression and shall be capable of operating with either floppy disk or any drive on the network. If the database requires more than one disk, the utility shall automatically prompt the user to insert the next disk of the set and shall have in-built checking to ensure correct loading of disks.

3.3.15. Database Development

The software shall be menu driven. It shall be easy to configure, and context sensitive on-line help shall be available throughout the system.

The software shall be configured using either nested or pop-up menus, and fill-in-forms.

The software shall provide configuration tools and wizards to simplify and significantly reduce the initial configuration by minimizing data entry.

Fields for tag names, loop names and equipment names shall accommodate at least 32 characters. Configuration databases shall be in an open standard file format, to allow editing and manipulation by other database or spreadsheet editing packages. Database management shall be configurable by engineers but transparent to the operators.

Importing of Tag definitions from field device configuration/programming packages shall be included as a standard feature such that upon change of a definition in the field device tag names, addresses, ranges etc will automatically be imported into the SCADA software database. In addition to automatic tag definition, importing it shall be possible to manually initiate the import of tag definitions at any time.

Tags shall be defined only once across the entire SCADA database and a utility shall be provided to identify all unused tags in the database.

The software shall support exporting of Tag definitions directly to field device configuration packages along with export to generic interfaces such as CSV files and OPC data sources.

3.3.16. Graphics Builder

The graphic builder allows for development of graphic screens.

General Graphic Builder functionality is that the graphics builder shall be interactive and menu-driven, requiring no programming.

The software shall have the ability to directly import graphics and text from the following file formats: BMP, DIB, DXF, DCX, EPS, GIF, IMG, JPG, JPEG, JGE, JFI, JFF, PCD, PCX, PNG, RLE, TGA, TIF, WPG, TXT.

Imports using different colour palettes and depths shall support both dithering and non-dithering at the user’s discretion.

The graphics builder shall be an ActiveX container allowing ActiveX objects to be inserted and edited in a visually interactive manner. It shall be possible to connect ActiveX properties to tags, allowing

read/write between properties and tags without the need for scripts or code. ActiveX objects must have the same security as native graphics objects allowing ActiveX objects to be visible or hidden based on the privilege level of an operator.

The graphics builder shall be capable of creating screens composed of both static and dynamic objects. To create these objects, the software shall provide sample screens and a set of standard shapes or symbols in a library at no charge. The developer shall be able to include these symbols by reference or create new symbols/objects.

The graphics builder shall provide the following tools:

- Grid and guidelines (which can be displayed on screen) together with snap to grid and snap to guidelines to assist in aligning objects precisely.
- Horizontal and vertical alignment together with even spacing.
- Infinite layering with Send to Front/Back; Bring Forwards one Layer; Send Backwards one Layer.
- Bitmap editing including pixel drawing, image resizing, image cropping.
- Colour swap from one colour to another for a group of selected objects including colours within a bitmap. Colour swap shall also include swapping a range of colours such as all reds to all greens so that shaded objects can be colour changed without redrawing or re-rendering.
- Editing of nodes on polylines that provides the addition or removal of nodes plus movement of nodes.
- The graphics builder shall support 100 "undo" and "redo" feature.

The graphics system shall support full 32-bit (65 million) colours and supply a palette of ‘favourite’ colours for ease of development. It shall allow user defined flashing colours.

Display sizes shall be definable from 1x1 to 4000x4000 pixels, or combination within these limits.

Common static and dynamic objects shall be stored in libraries, and ‘linked’ such that changes to the master objects (including dynamic configuration changes), in the library are propagated to all instances of the object throughout the project without needing to access each object instance.

Pages shall be based on Templates, and ‘linked’ such that changes to the master template in the library are propagated to all pages throughout the project without needing to access each page.

Pages shall have access to objects within other Included Projects at both design time and runtime. Commonly used pages such as Alarm and Trend pages shall be included with the software and not require any development to use them at runtime.

The software must be designed with the ability to make changes to the graphics while the system is running. Shutting down the system shall not be required to make changes.

The Graphics Builder shall be able to modify all displays in the system including standard displays supplied with the software such as alarm, trend, startup, tag, reports, and utilities displays.

3.3.17. Custom scripting language

The scripting language shall be used to develop custom routines, and algorithms not supplied as part of the standard package.

As standard functionality, scripting shall not be needed to develop any custom code to achieve standard functionality including redundancy failover, recovery, and backfilling of historical data.

As general custom scripting functionality, the SCADA software’s scripting functionality shall include the following:

- An integrated high-level language specifically designed for SCADA applications that shall be inherently multi-tasking and multi-threading.
- Fully integrated and multi-threaded Visual Basic (VB) scripting.

- Access to all field tags, alarms, graphics displays, database and ASCII files. The languages shall include functions with clear and precise syntax. The languages shall support user written functions and function libraries supported by the computer's operating system. The language shall have the capability to export or import data from other applications.
- Creation of calculated (inferred) variables based upon formulae including constants, measured variables, and other calculated variables. All facilities available for logging, reporting, trending, monitoring, controlling, alarming, and displaying measured variables shall also be available for calculated variables.
- Support of mathematical and Boolean operators including: Addition, Subtraction, Division, Multiplication, AND, OR, XOR, NOT, Greater Than, Less Than, Equal, Parenthesis.
- Support for the following mathematical functions: Absolute, ArcCos, ArcSin, ArcTan, Cos, DegToRad, Exponent, Factorial, HighByte, HighWord, Ln, Log, LowByte, LowWord, Max, Min, Pi, RadToDeg, Random, Round, Sign, Sin, Sqrt, Tan.
- Prevention of any functions from interfering with proper SCADA functionality.
- Permit users to create their own functions and integrate them in the language; functions shall be reusable without the need to copy and paste. It shall be possible to call the same function multiple times from different locations, with different parameters simultaneously.
- Provisions to run functions automatically on startup, on page entry, on page exit, while a page is open, on button down, while button down, embedded in reports, alarm on, alarm off, on any keystroke, any keyboard entry on any mouse button click, etc.
- Ability to test and debug the languages online. The debug tool shall display the source code as it executes with a pointer identifying the current line of code being executed, the value of local and global variables and any output as the user single steps through the code. Facility to set break points, single step, step over sub functions, step out of sub functions and continue execution shall be included.

3.3.18. SCADA System Clock

The SCADA shall support a Master clock and calendar function for synchronisation. This function shall be available for access by all devices connected to the SCADA Control Network including:

- Controllers.
- Interfaces.
- Operator's and Engineer's Stations.
- Trends.
- Reports.
- Event logs.
- Disk drives.
- Third party interfaces.

The Master clock and calendar must be immune to failure of the device which is currently responsible for its maintenance. If that device is unable to continue support, responsibility must be passed automatically to another device without interruption. The transfer must be recorded in the event log and enunciated. The master clock/calendar function shall generate an audible alarm if corrupted (e.g., restart from total system power outage).

The clock function shall incorporate the following features:

- 24-hour display format.
- 1 second resolution.

3.3.19. Documentation

The software shall provide extensive documentation on configuration and system development in a hard copy format. This documentation shall also be available on-line.

Technical manuals shall include an Introduction and Setup manual, User's Guide, and High-Level language guide. On-line documentation shall include a comprehensive field device guide for all supplied protocols and drivers.

3.4. SCADA Software for Operator Workstations

The following paragraphs discuss the specific Operator and Network Management Workstations requirements for this project. This specification applies to Operator Workstation.

Operator Workstation is a position from which an operator can monitor and control the entire process and view all real-time data and all historical data via displays on a Computer Display Screen including all network activities. The workstation shall be equipped with Ethernet network interface cards to allow communications to the Local Area Network (LAN).

The Operator Workstations shall consist of the previously specified minimum hardware configuration, with the following additional requirements:

- Triple monitors, sized as indicated above.
- Include a graphics card that makes the triple monitors work together for these stations.

The Operator Workstations shall have the SCADA Software loaded as specified in this TS.

4. LOCAL DATA ACQUISITION AND CONTROL EQUIPMENT

Contractor shall supply set of Local Data Acquisition and Control Equipment in following composition:

- Wall mounted panel (incl. Mounted accessories and necessary wiring).
- PLC with all necessary modules (please refer to particular specification).
- HMI (please refer to particular specification).
- Measurement equipment.
- All necessary consumable for installation.

4.1. Communications

SCADA system shall be designed to collect/control data/signal from field devices and transfer it to Central Dispatch and Control Office. Communication between Local Data Acquisition and Control Equipment and SCADA Server shall be done through Ethernet TCP/IP communications.

PLCs shall have a built-in Ethernet interface to communicate with the top-level application of different protocols, for example, to exchange data with OPC-server communication protocols Modbus TCP and IEC- 104 data exchange with IT-applications on the protocol SNMP, for notifications by e-mail, direct interaction with databases SQL, and programming of the controller.

4.2. Quality management

The requirements of Business Operating System ("BOS") ISO 9001 shall apply. All requirements in BOS ISO 9001 shall be mandatory for material supplied against this specification.

The Contractor shall be in possession of ISO 9001 valid more than twelve months prior to contract award.

Contractor shall compile and submit a quality plan which shall be approved by the Beneficiary's Quality Assurance Manager prior to commencement of manufacture.

The quality plan shall list all major operations, specifications, verifications, tests, method of test and equipment to be used and acceptance/rejection criteria.

4.3. Panel

New Panels shall be mounted to the local of BPS and WWPS Stations.

The Panel shall be an anti-corrosion design, at least IP54 / IP65 protection, including accessories for wall assembly, with the following equipment:

- Over-voltage protection on the power supply.
- 2xService socket 230VAC, 10A, with residual current protective switch 30mA.
- Open door sensor for panel.
- PLC (programmable logic controller) with a touch panel HMI (human machine interface) at least 7" display, digital and analogue inputs and outputs, and communication modules, described in the TS.
- Swich with key for choosing the Local-0-Remote operating mode.
- All the necessary components to ensure the remote control of the equipment.

The panels must be equipped with all the components necessary to ensure the microclimate inside it (temperature, humidity, pressure) so that it can function normally even in the conditions of installation outside (in some cases).

Each panel shall be designed for all necessary modules, accessories, and space for modules, which can be mounted in future by the Contractor according to the TS.

4.4. Panel wiring

All single core non-sheathed PVC insulated cables, including flexible cables for switch, control, relay, and instrument panel internal wiring shall comply with International standard IEC 60364 and shall have a rated voltage 600/1,000V.

Unless otherwise specified, all conductors shall be of stranded copper.

Cabling between compartments passing through or over metal parts shall be protected against insulation damage.

Cables to doors shall be contained within a plastic sleeve or shall be spiral wrapped.

Protective devices, control, instrumentation, and signal wiring passing from one compartment to another shall be provided with separate cable trunking and shall be arranged and identified so that circuits can be easily recognized.

All wiring shall be held securely in position and shall not be directly cleated to earthed metal.

All cables shall have identification markers with numbers, etc., corresponding to the wiring diagrams.

Markers shall be of a design for inserting over the cable without special tools for cable sizes up to $4mm^2$. Markers for cables of $6mm^2$ and above shall be heat shrink or adhesive applied.

Legends when written or typed or larger cable markers to be protected by a transparent overwrapped.

4.5. Protection and control circuits

The satisfactory operation of all operated protection circuits over their whole operating range shall be tested by secondary current injection, where primary injection tests have been previously carried out on manufacturers premises.

4.6. Ground

Each electrical enclosure containing analogue signals shall be equipped with an isolated "Instrument Ground" terminal connector in addition to the conventional “protective earth” PE protection ground required in all electrical enclosures.

The Instrument ground terminal shall be connected to the conventional PE ground using only one conductor, at the minimum gauge of $10mm^2$. The terminal shall use the standard green / yellow colour of ground and in addition, be clearly identified as "INSTRUMENT GROUND".

At the instrument end of the loop, or in any marshalling box along the loop path, other connections to ground or other conductors are strictly prohibited. PE ground connections for chassis of marshalling boxes along the path of an instrument loop shall be separately connected using a minimum of $4mm^2$ gauge wire running to the nearest PE ground terminal.

All Conduits, enclosures and marshalling boxes are not accepted as ground references or conductors, either for PE or instrumentation purposes.

If the ground terminal at an instrument has other connections to ground, e.g., through the chassis of its body, all methods shall be used to isolate the instrument from that ground, or the shield of the signal cable shall not be connected to the ground terminal of the instrument.

4.7. Cable Trunking (Panel Compartment Internal)

PVC cable trunking and Snap-On covers shall be formed of self-extinguishing material.

All PVC trunking shall be slotted type and to have 50% spare cable capacity to allow for possible future modifications to the wiring.

Trunking shall be secured to the panel by fixing screws except on doors, etc., where screws would be visible.

4.8. Cables

The Contractor shall supply and install all cables necessary to complete the installations and make the telemetry system operational according to the Contract requirements.

The Tenderer shall state the make and type of all cables in the Tender.

The Contractor shall before installation takes place submit cable lists specifying marking, type and dimension of each cable in the installations.

4.9. Signal Cables

Cables for instrumentation signals shall be twisted pair copper-cored signal cables with screen (shielded), complying with GOST 1508-78 and IEC-standard.

4.10. Cable identification

Cables and cable cores shall be identified at both ends by means of sleeve bands cable/core, which shall relate to the reference number shown in the drawings. Where multiple cables are laid in troughs, ducts, and intermediate markings to identify specific cables shall be applied.

4.11. Labels

Labels are to be provided for all relays, timers, pushbuttons, indicating lamps and other equipment mounted on the face of the panel and internally. A label shall be provided adjacent to each fuse indicating the circuit and fuse rating.

The panel shall be labelled at the front and rear, showing the panel number and designation. These labels are to be permanently fixed to a non-removable portion of the panel.

4.12. PLC Hardware

4.12.1. General

The PLC manufacturer must have ISO 9001 Quality Assurance Certificate for his products.

Programmable logic control devices (PLCs), where specified, shall be used to effect the monitoring and control of the station or treatment process.

The general characteristics of the installation of the PLC will be as follows:

- Interface for programming and panel mounted HMI (cabled back to PLC) display for information: measurements, defaults, parameter settings, etc.
- Analogical Input protected with galvanic isolator.
- The Software and licenses for the PLC programming, including documentation, and all cables required will be supplied with the equipment.

They shall be capable of operating as either a standalone unit providing local operator interface information or form part of a supervised system complete with communications facilities.

Distributed and local input/output racks shall be configurable via the software as dedicated I/O. Each I/O rack shall be supplied with a minimum 20% additional I/O capacity for future expansion.

The programmable controller shall have adequate memory and I/O ports to receive all control and sequencing signals and drive all indicator lamps, relays or solenoids as may be required to accurately control all the necessary functions of the control system. If not required the Output module for control, it will be design for future and provide space to mount these for control applications. These parameters are described in particular specification of each station.

The controller shall indicate the operating state of the outputs by means of light emitting diodes (L.E.D.s) and be equipped with sets of L.E.D.s to indicate the controller status and to notify of any internal faults.

An integral means of turning all outputs off and ceasing the processor operation shall be fitted.

The PLC shall perform the majority of sequential functions and shall drive, either directly or by interposing relays, all the necessary outputs as detailed elsewhere.

Where the output load exceeds the rated capacity of an output port of the controller, suitably rated, D.I.N. rail mounted interposing relays shall be installed in the cabinet to amplify output controls signals. The maximum control voltage of the relays shall be 230 V A.C.

D.I.N. rail mounted terminals shall be fitted in the bottom of the cabinet to allow the termination of all control and sequencing cabling. The terminals shall accept up to 4mm2 stranded conductor.

All output ports from the controller shall be correctly fused in order to protect the controller (by means of fused terminals).

The PLC shall be capable of supporting all the component parts either inherently or via expansion when required and shall support all the required process I/O.

- Voltage supply: 24VDC.
- Memory capacity shall allow the controller to use not only for telemetry issues, but also to serious process control.
- Discrete I/O: in sufficient numbers to process the data corresponding to the equipment indicated in the Particular Specification with an additional 20% reserve, connected via modules equipped with LEDs for status indication.
- Analogical I/O: in sufficient numbers to process the data corresponding to the equipment indicated in the Particular Specification with an additional 20% reserve, connected via modules equipped with LEDs for status indication.
- Communication through standard protocol TCP/IP, Ethernet, JBus/Modbus/ ProfiBus, RS 232 Modem, RS 485, etc.
- Rack for communication card.
- PID controller, adjustment of the PID loop parameters.

4.12.2. PLC configuration

Each installed PLC shall have the following configuration:

- Ethernet TCP/IP interface for communication with SCADA server .
- I/O module (please refer to the relevant part of the TS).

The Contractor shall conduct a detailed functional analysis of automation system, to confirm the list of inputs / outputs. This will be submitted to the Employer for approval.

4.12.3. I/O Connections

All analogue I/O signals shall be carried in shielded twisted pair cables all the way from the field devices to the PLC I/O rack, and no power currents or digital signals are allowed to run within the same cables as the analogue signals.

The shield of the instrument cables must be only connected to ground at one end, at the Instrument ground terminal close to the PLC I/O rack. The shields must be consistent through the entire length of the cable, all the way to the field device and is not allowed to be grounded or share other cables grounding. Analog signals may be run without the screen, within the PLC enclosures if they are carrying current signals, however for voltage signals, shielded cables must be used.

The Contractor is requested to install at least 20% more I/O's as he intends to use, for future expansions of the system. Example if number of digital I/O's used is 100, 120 shall be installed and if analogue inputs are 20, 24 shall be installed.

4.12.4. I / O Racks

Distributed and local input/output racks shall be configurable via the software package as dedicated I/O. Each I/O rack shall be supplied with a minimum 20% additional I/O capacity for future expansion.

All input signals shall be OPTO isolated fuse and lightning protected and incorporate software digital filters configurable as required as specified earlier. OPTO isolation shall additionally be provided on all outputs to prevent shorts. All analogue outputs shall have a + 1% full-scale accuracy. The Tenderer's attention is drawn to the necessity to prevent any interference in operation or data quality due to switching noise, or voltage spikes from field equipment. All critical outputs shall also be inputs to cascade PID loops.

4.12.5. Analogue Input Requirements

The preferred input signal is 4-20mA; continuous; linear supporting a fully floating max 250-ohm input impedance load. Analogue/Digital conversion shall have a minimum 8-bit resolution, linear to ±1%, accepting signals in the range 0-10mA and 0-20mA and voltages 1-5V, 0-1V and 0-100mV as required.

4.12.6. Analogue Output Requirements

Analogue output shall be 4 to 20mA D.C. electrical signal with a linear increasing output for increasing measure and value, complying with the requirements of BS 5863 Part 1 "Analogue Signals for Process Control Systems Part 1: Specification for Direct Current Signals".

When the load resistance across the output terminals is varied from 0 to 1000 ohms the output signal current shall not change by greater than 0.1% of span, over the full output range.

4.12.7. Requirements of Serial Communication Port

As a serial communication shall use RS485 port, which can work with variety devices and protocols such as Modbus RTU etc.

4.12.8. PLC Configuration Software

The Contractor shall provide software allowing the configuration of the PLC features. This shall be MS Windows based, intuitive, easy to use and flexible.

A standard library of drivers and tools for connection to PLC shall be provided by the Contractor.

At the end, the contractor will make available to the beneficiary all the logical programs developed and loaded into the PLC.

4.13. Human Machine Interface (HMI) Requirements

4.13.1. Overview

The Contractor shall provide a consistent interface, which maintains identical procedures from one application to another. The new SCADA system HMI shall enable the following:

- A modern 'windows' approach shall be provided for HMI with moveable, sizable and scrollable windows.
- Drop down and pop-up context sensitive menus.
- Context sensitive tool bars, with buttons or icons, to access more commonly used functions.
- Pop-up tips that provide abbreviated help for a feature when the screen cursor hovers over the button, icon, or symbol.

- Drag and drop capability.
- Availability of many different fonts and letter styles.
- Manual ‘hand-dressed’ status points and objects.
- Configurable alarms. The alarms shall be able to be filtered, prioritised, and inhibited.
- Static and dynamic, context-related function keys
- Colour Display update frequency of no more than 100ms
- Operator inputs and database changes logged and checked for validity before updating database.

The operator shall be warned about invalid inputs.

4.13.2. Specific Display Requirements

4.13.2.1. System Status

The HMI shall show the following system status information in a corner on all screens:
- Workstation operational mode.
- Server connection status (main / standby).
- Logged in person and access level.
- Date / Time.

The HMI shall include dedicated screens showing the following system status information:
- A communications block diagram and real-time status of the communication system, including the status of each link.
- A control system display.

4.13.2.2. Function Keys

The HMI screens shall contain large function keys symbols representing the function keys on the workstation keyboard. Special commands shall be assigned to each key, such as invoking commonly viewed screens, initiating special functions, launching an application or execute a control command.

4.13.3. HMI Configuration Software

The Contractor shall provide software allowing the configuration of the HMI displays. This shall be MS Windows based, intuitive, easy to use and flexible.

A standard library of common Water system objects shall be included as well as the facility to create customized objects. It shall include a feature where global changes can be applied. For example, a change to an object should automatically follow through to all objects of that type. It shall be easy to toggle between development mode and test mode. In test mode, the ‘live’ version of the screen under development shall be displayed. Manual forcing of database points shall be enabled whilst in test mode which will show the effect on the HMI displays.

At the end, the contractor will make available to the beneficiary all the configuration programs developed and loaded into the HMI devices.

4.14. Level Transmitter

Level transmitter shall be placed in the potable water reservoirs. Level transmitter shall be mounted above the water level in the reservoir.

Transmitter shall transmit level on the Local Data Acquisition and Control Panel for transfer it to central SCADA server. The distance between level transmitter and PLC shall be considered and all wiring shall be provided by the Contractor.

Type: Hydrostatic level transmitter, including all necessary brackets and fixings for mounting in the reservoir.

- Range: 6 m.
- Enclosure: IP68.
- Water temperature: 0-35 °C.
- Ambient temperature: -30 to +50°C.
- Standards and Guidelines: DIN EN 60770 (IEC 60770); IEC 60529; DIN 16086.

The level transmitter shall be of rugged construction, suitable for the application:

- Have an electrical output of 4 - 20 mA proportional to water level.
- Have an accuracy within ± 0.5 % of the span, repeatability within ± 0.2 %of the span and a dead band not exceeding 0.5 % of the span.

The installation set shall include all equipment for necessary power supply (230/24 V).

4.15. Pressure Transmitter

These sensors will be used to monitor of pressure in the pipeline. Technical data of pressure sensors:

- Type of sensor: ceramic.
- Measuring range: suction pipe: 0…10 bar, pressure pipe: 0…16 bar.
- Process temperature: -20 °C +50 °C.
- Fluid temperature: 0 °C +50 °C.
- Media resistance: high.
- Media environment: water.
- Protection class: IP 67.
- Accuracy: 0.5%.
- Power supply: 12/24 (24VDC) for probe.
- Output signal: 4-20 mA.
- Standards and Guidelines: DIN EN 60770 (IEC 60770); DIN EN 61003-1.
- Edition: 1993-12; IEC 60529; DIN 16086.

The distance between pressure transmitter and PLC shall be considered and all wiring shall be provided by the Contractor.

4.16. Water detection

These sensors will be used for the detection of water-based liquid in pipeline. Technical data of pressure sensors:

- Type of sensor: Capacitive.
- Medium temperature: -20 °C +50 °C.
- Fluid temperature: 0 °C +50 °C.
- Pressure rating: 16 Bar.
- Media environment: water.
- Protection class: IP 67.
- Power supply: 24VDC.
- Output signal: Transistor (NPN/PNP).

The distance between water detection transmitter and PLC shall be considered and all wiring shall be provided by the Contractor.

4.17. Water meters

Water meter will be used to monitor volume of water through pipeline. Technical data of pressure sensors:

- Type of sensor: Water meter.
- Medium temperature: -20 °C +50 °C.
- Fluid temperature: 0 °C +50 °C.
- Pressure rating: 16 Bar.
- Accuracy (in the measuring range): One pulse per Liter.
- Media environment: water.
- Protection class: IP 67.
- Output signal: 24VDC PNP.

The distance between water meter and PLC shall be considered and all wiring shall be provided by the Contractor.

4.18. Open Door sensor

Each booster stations shall be equipped with open door sensor to monitor activities on the stations. Each Open-Door sensor shall meet the following requirements:

- Protection class: IP54.
- Output signal: Discrete.

5. PARTICULAR SITE REQUIREMENTS

5.1. Potable Water Pumping Stations

Pumping stations supply water to the treatment plant from Prut River and to the distribution system and are located near the water treatment facility.

Existing pumping stations to be covered by the Contractor are listed in the bellow table:

Table 4 - List of Water Pumping Stations for installation of DACE equipment.

No	PS Name	Address
1	PS-1 – Pump Station Stage I	str. Oranjeriei
2	PS-1 – Pump Station Stage II	str. Oranjeriei

5.1.1. PS-1 – Pump Station Stage I

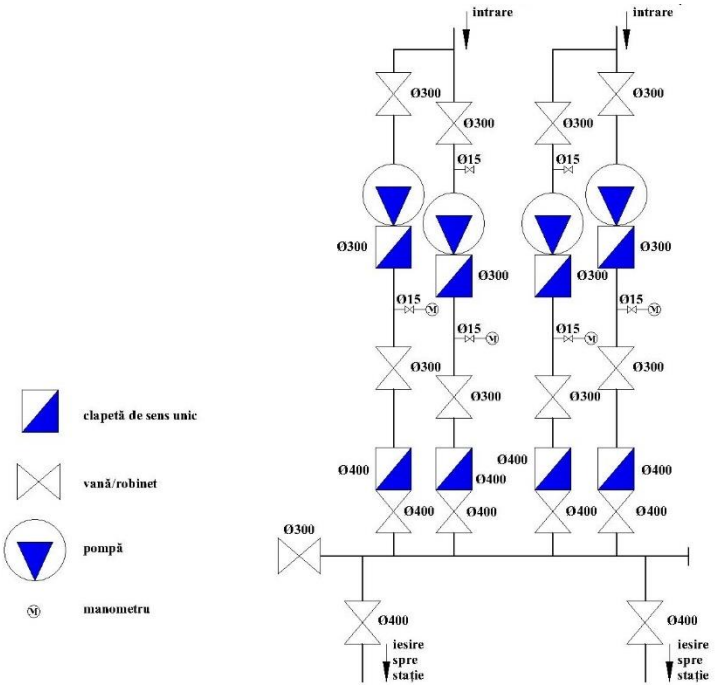

Figure 2 - Hydraulic Scheme with existing equipment of Pump Station Stage I

The list of existing equipment on the station from which the signals to DACE must be received:

No.	Type	Model
1	Pump	FA 15.84 DENI
2	Pump	FA 15.84 DENI
3	Pump	FA 15.84 DENI
4	Pump	FA 15.84 DENI
5	Pump	СД 250/22,5
6	Pump	Sewatec K200-400G3EN225MOM
7	Compressor	BBH 1-12CX compress
8	Compressor	BBH 1-12CX compress
9	Fan	

Local Data Acquisition and Control Equipment to be delivered by Contractor (new equipment):

- DACE Panel with the following specific requirements (general requirements are described in section 4.3.):
    - Inside mounting type.
    - Local and remote-control functionalities.

- HMI at least 10 inch.

- PLC with the following specific requirements (general requirements are described in section 4.12.):
  - Communication: Ethernet TCP/IP, RS-485 (Modbus RTU).
  - Digital Input – 24.
  - Digital Output – 16.
  - Analog Input – 8.
- Pressure transmitter: 4 pcs. Requirements are described in section 4.15.
- Water detection transmitter: 2 pcs. Requirements are described in section 4.16.
- Power meters with all needed accessories: 2 pcs. For 2 existing power sources.
- All necessary cable, wiring and accessories for mounting: Yes.

Estimated total list of signals to be transmitted to the SCADA system (not limited to):

Type	DI	DO	AI	RS485
Energy data (voltage, current, power, consumption, power factor, etc.)				2
Pump status (Run / Ready, Ready / Trip)	18			
Pump control (Start / Stop)		9		
Water detections signal on suction	2			
Water pressure signal on suction			2	
Water pressure signal on discharge			2	
Total	**20**	**9**	**4**	**2**
Total (with reserve)	**24**	**16**	**8**	**x**

The contractor must provide all necessary accessories for mounting, wiring, and connecting the equipment listed above to the DCAE panel.

5.1.2. PS-2 – Pump Station Stage II

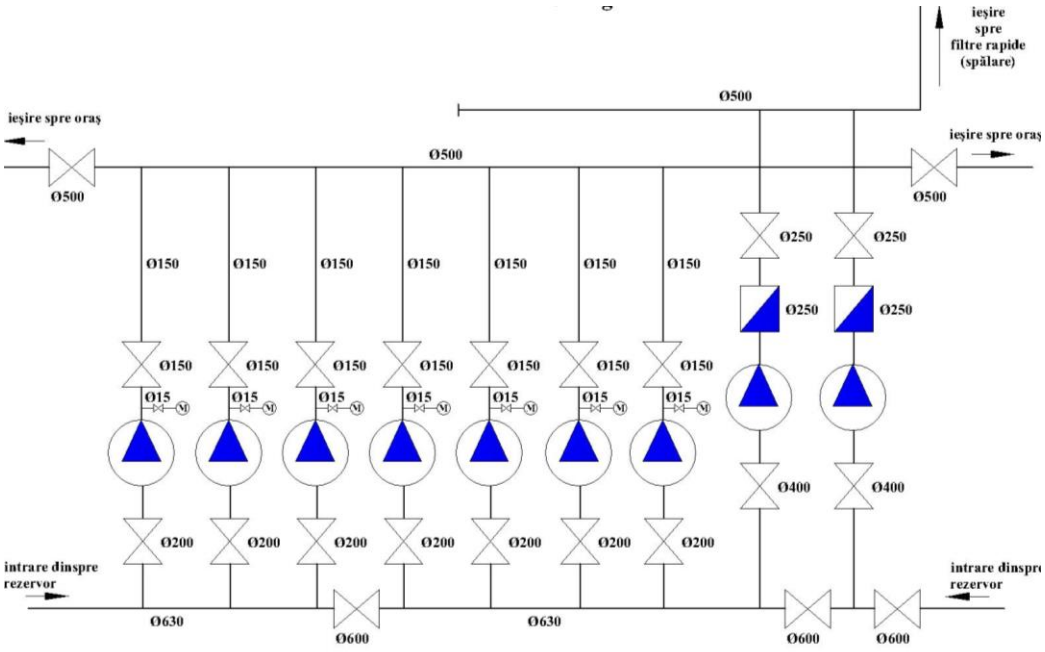

Figure 3 - Hydraulic Scheme with existing equipment of Pump Station Stage II

The list of existing equipment on the station from which the signals to DACE must be received:

No.	Type	Model
1	Pump	CVE-250
2	Pump	CVE-250
3	Pump	NP 80/200 WILO
4	Pump	NP 80/200 WILO
5	Pump	NP 80/200 WILO
6	Pump	NP 80/200 WILO
7	Pump	NL 80/250-37-2-05 WILO
8	Pump	14 НДн
9	Pump	16 НДн

Local Data Acquisition and Control Equipment to be delivered by Contractor (new equipment):

- DACE Panel with the following specific requirements (general requirements are described in section 4.3.):
    - Inside mounting type.
    - Local and remote-control functionalities.
    - HMI at least 10 inches.
- PLC with the following specific requirements (general requirements are described in section 4.12.):
    - Communication: Ethernet TCP/IP, RS-485 (Modbus RTU).
    - Digital Input – 32.
    - Digital Output – 24.
    - Analog Input – 16.
- Pressure transmitter: 4 pcs. Requirements are described in section 4.15.
- Power meters with all needed accessories: 2 pcs. For 2 existing power sources.
- All necessary cable, wiring and accessories for mounting: Yes.

Estimated total list of signals to be transmitted to the SCADA system (not limited to):

Type	**DI**	**DO**	**AI**	**RS485**
Energy data (voltage, current, power, consumption, power factor, etc.)				2
Pump status (Run / Ready, Ready / Trip)	18			
Pump control (Start / Stop)		9		
Water pressure signal on suction			2	
Water pressure signal on discharge			2	
Total	**18**	**9**	**4**	**2**
Total (with reserve)	**24**	**16**	**8**	**x**

Estimated total list of signals to be transmitted to the SCADA system from WTP (not limited to):

Type	**DI**	**DO**	**AI**	**RS485**
Data from debit meters (all relevant data)				4
Pump status (Run / Ready, Ready / Trip)				
Pump control (Start / Stop)				
Temperature and PH signal on suction			2	
Water turbidity on the entrance to the station			1	
Water turbidity on the outlet of the station to the storage basins			1	

Residual chlorine in drinking water storage tanks			1	
Level transmitter in drinking water storage tanks				1
Total	**0**	**0**	**5**	**5**
Total (with reserve)	**8**	**8**	**8**	**x**

The contractor must provide all necessary accessories for mounting, wiring, and connecting the equipment listed above to the DCAE panel.

5.2. Water Treatment Plants.

Existing water treatment plants to be covered by the Contractor are listed in the bellow table:

Table 5 - List of Water Treatment Plants for installation of DACE equipment.

No	PS Name	Address
1	WTP - Water Treatment Plant	str. Oranjeriei

5.2.1. WTP - Water Treatment Plant

The list of existing equipment on the station from which the signals to DACE must be received:

No.	Type	Model
1	Debit meter for water input 1	«ВЗЛЕТ РС» (УРСВ-010М)
2	Debit meter for water input 2	«ВЗЛЕТ РС» (УРСВ-010М)
3	Debit meter for water output 1	«ВЗЛЕТ РС» (УРСВ-010М)
4	Debit meter for water output 2	«ВЗЛЕТ РС» (УРСВ-010М)
5	Level transmitter in drinking water storage tanks	output 4…20mA or RS485

Local Data Acquisition and Control Equipment to be delivered by Contractor (new equipment):

- Temperature and PH transmitter: 1 pcs. At the entrance to the station (combined sensor for 2 parameters). According to the requirements of the technological process.
- Water turbidity transmitter: 2 pcs. At the entrance to the station and at the outlet of the station to the storage basins. According to the requirements of the technological process
- Residual chlorine transmitter: 1 pcs. At the outlet of the station. According to the requirements of the technological process
- Level transmitter: At the moment, the level transmitter is connected to an indicator that displays the level for the operators. It is necessary to replace this indicator with a model with input 4...20mA and output RS485 type, so that the local display remains, but at the same time this signal will be transmit to the SCADA system via RS485.
- All necessary cable, wiring and accessories for mounting: Yes.

Since WTP is in close proximity to PS-2 – Pump Station Stage II, it is possible to transmit signals to the DACE panel of the PS-2 – Pump Station Stage II station.

The Contractor must provide all necessary accessories for mounting, wiring, and connecting the equipment listed above to the DCAE panel.

5.3. Buster Pumping Stations

A Booster Pump Station is a pump station designed to maintain the required pressure of water for a certain limited-service area, typically residential multi-storey buildings.

Existing buster pumping stations to be covered by the Contractor are listed in the bellow table:

Table 4 - List of Water Pumping Stations for installation of DACE equipment.

No	PS Name	Address
1	BPS-1 – Nicolae Iorga	str. Nicolae Iorga
2	BPS-2 – Romană 26	str. Romană 26
3	BPS-3 – Romană 66	str. Romană 66
4	BPS-4 – Națională 33	str. Națională 33
5	BPS-5 – Romană 112	str. Romană 112
6	BPS-6 – Ungureanu 9	str. Ungureanu 9
7	BPS-7 – Cristiuc 11	str. Cristiuc 11
8	BPS-8 – Boico 5-7	str. Boico 5-7
9	BPS-9 – Porumbescu 3	str. Porumbescu 3

5.3.1. BPS-1 – Nicolae Iorga

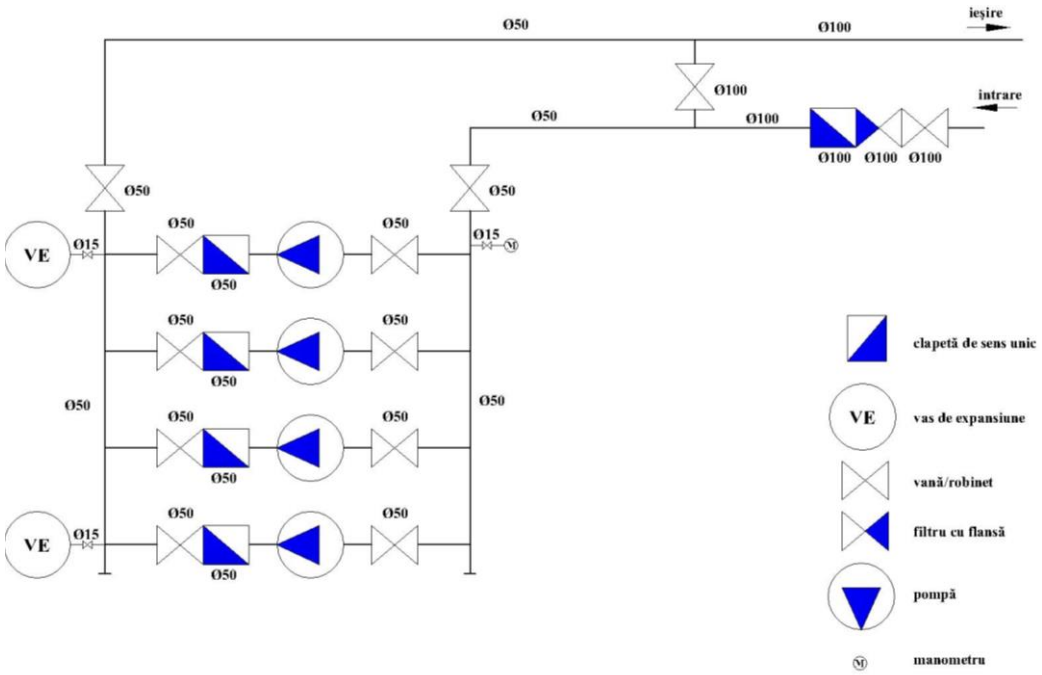

Figure 5 - Hydraulic Scheme with existing equipment of BPS-1 – Nicolae Iorga

The list of existing equipment on the station from which the signals to DACE must be received:

No.	Type / Model
1	Control System Pedrollo for 4 x Pumps 2.2kW (2 work pumps + 2 reserve pumps)

Local Data Acquisition and Control Equipment to be delivered by Contractor (new equipment):

- DACE Panel with the following specific requirements (general requirements are described in section 4.3.):
    - Inside mounting type.
    - Local and remote-control functionalities.
    - HMI at least 7 inches (or another web access solution).
- PLC with the following specific requirements (general requirements are described in section 4.12.):
    - Communication: Ethernet TCP/IP, RS-485 (Modbus RTU).
    - Digital Input – 14.

- Digital Output – 10.
- Analog Input – 4.

- Pressure transmitter: 2 pcs. Requirements are described in section 4.15.
- Power meters with all needed accessories: 1 pcs. For 1 existing power source 8kW.
- Water meter: 1 pcs. Pipe – DN110, on discharge pipe. Requirements are described in section 4.17.
- Door sensor. Requirements are described in section 4.18.
- All necessary cable, wiring and accessories for mounting: Yes.

Estimated total list of signals to be transmitted to the SCADA system (not limited to):

Type	DI	DO	AI	RS485
Energy data (voltage, current, power, consumption, power factor, etc.)				1
Pump status (Run / Ready, Ready / Trip)	8			
Pump control (Start / Stop)		4		
Door sensor	1			
Water pressure signal on suction			1	
Water pressure signal on discharge			1	
Water meter on discharge pipe	1			
Total	**10**	**4**	**2**	**1**
Total (with reserve)	**14**	**8**	**4**	**x**

The contractor must provide all necessary accessories for mounting, wiring, and connecting the equipment listed above to the DCAE panel.

5.3.2. BPS-2 – Romana 26

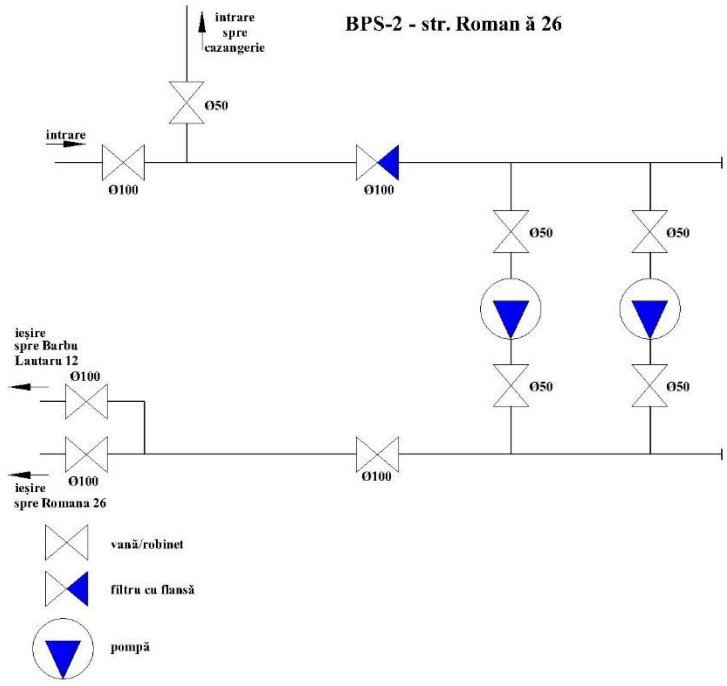

Figure 6 - Hydraulic Scheme with existing equipment of BPS-2 – Romana 26

The list of existing equipment on the station from which the signals to DACE must be received:

No.	Type / Model
1	Control System COR – 2MVIE 1604 6/CR - EB for 2 x Pumps 2.2kW

Local Data Acquisition and Control Equipment to be delivered by Contractor (new equipment):

- DACE Panel with the following specific requirements (general requirements are described in section 4.3.):
    - Inside mounting type.
    - Local and remote-control functionalities.
    - HMI at least 7 inches (or another web access solution).
- PLC with the following specific requirements (general requirements are described in section 4.12.):
    - Communication: Ethernet TCP/IP, RS-485 (Modbus RTU).
    - Digital Input – 9.
    - Digital Output – 7.
    - Analog Input – 4.
- Pressure transmitter: 2 pcs. Requirements are described in section 4.15.
- Power meters with all needed accessories: 1 pcs. For 1 existing power source 5kW.
- Water meter: 1 pcs. Pipe – DN110, on discharge pipe. Requirements are described in section 4.17.
- Door sensor. Requirements are described in section 4.18.
- All necessary cable, wiring and accessories for mounting: Yes.

Estimated total list of signals to be transmitted to the SCADA system (not limited to):

Type	DI	DO	AI	RS485
Energy data (voltage, current, power, consumption, power factor, etc.)				1
Pump status (Run / Ready, Ready / Trip)	4			
Pump control (Start / Stop)		2		
Door sensor	1			
Water pressure signal on suction			1	
Water pressure signal on discharge			1	
Water meter on discharge pipe	1			
Total	**6**	**2**	**2**	**1**
Total (with reserve)	**9**	**4**	**4**	**x**

The contractor must provide all necessary accessories for mounting, wiring, and connecting the equipment listed above to the DCAE panel.

5.3.3. BPS-3 – Romana 66

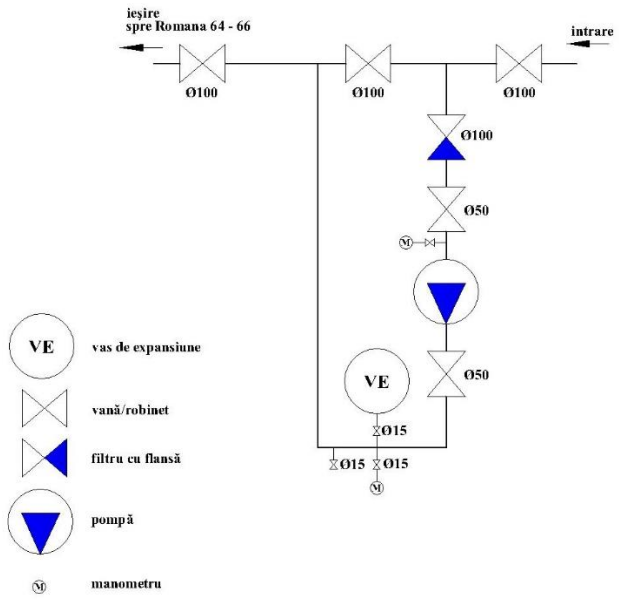

Figure 7 - Hydraulic Scheme with existing equipment of BPS-3 – Romana 66

The list of existing equipment on the station from which the signals to DACE must be received:

No.	Type / Model
1	Control System COR-1MHIE1602-2G-GE - EB for 1 x Pumps 2.2kW

Local Data Acquisition and Control Equipment to be delivered by Contractor (new equipment):

- DACE Panel with the following specific requirements (general requirements are described in section 4.3.):
    - Inside mounting type.
    - Local and remote-control functionalities.
    - HMI at least 7 inch (or another web access solution).
- PLC with the following specific requirements (general requirements are described in section 4.12.):
    - Communication: Ethernet TCP/IP, RS-485 (Modbus RTU).
    - Digital Input – 9.
    - Digital Output – 7.
    - Analog Input – 4.
- Pressure transmitter: 2 pcs. Requirements are described in section 4.15.
- Power meters with all needed accessories: 1 pcs. For 1 existing power source 5kW.
- Water meter: 1 pcs. Pipe – DN110, on discharge pipe. Requirements are described in section 4.17.
- Door sensor. Requirements are described in section 4.18
- All necessary cable, wiring and accessories for mounting: Yes.

Estimated total list of signals to be transmitted to the SCADA system (not limited to):

Type	DI	DO	AI	RS485
Energy data (voltage, current, power, consumption, power factor, etc.)				1
Pump status (Run / Ready, Ready / Trip)	2			
Pump control (Start / Stop)		1		

Door sensor	1			
Water pressure signal on suction			1	
Water pressure signal on discharge			1	
Water meter on discharge pipe	1			
Total	**4**	**1**	**2**	**1**
Total (with reserve)	**9**	**4**	**4**	**x**

The contractor must provide all necessary accessories for mounting, wiring, and connecting the equipment listed above to the DCAE panel.

5.3.4. BPS-4 – Națională 33

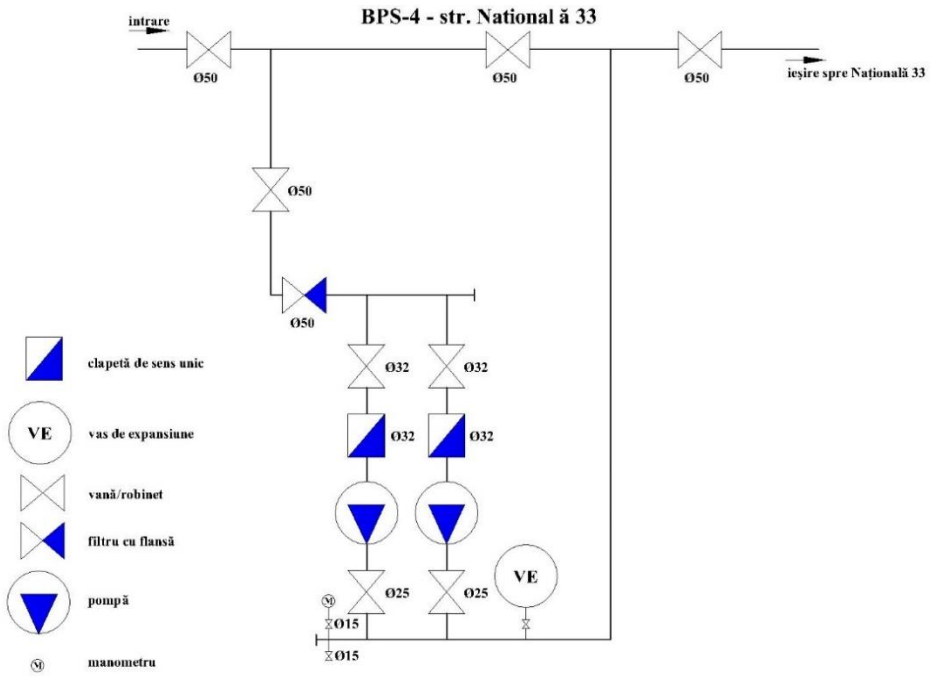

Figure 8 - Hydraulic Scheme with existing equipment of BPS-4 – Națională 33

The list of existing equipment on the station from which the signals to DACE must be received:

No.	Type / Model
1	Control System PEDROLLO CP 25/160B for 2 x Pumps 1.1kW

Local Data Acquisition and Control Equipment to be delivered by Contractor (new equipment):

- DACE Panel with the following specific requirements (general requirements are described in section 4.3.):
    - Inside mounting type.
    - Local and remote-control functionalities.
    - HMI at least 7 inch (or another web access solution).
- PLC with the following specific requirements (general requirements are described in section 4.12.):
    - Communication: Ethernet TCP/IP, RS-485 (Modbus RTU).
    - Digital Input – 9.
    - Digital Output – 7.
    - Analog Input – 4.
- Pressure transmitter: 2 pcs. Requirements are described in section 4.15.

- Power meters with all needed accessories: 1 pcs. For 1 existing power source 4kW.
- Water meter: 1 pcs. Pipe – DN63, on discharge pipe. Requirements are described in section 4.17.
- Door sensor. Requirements are described in section 4.18.
- All necessary cable, wiring and accessories for mounting: Yes.

Estimated total list of signals to be transmitted to the SCADA system (not limited to):

Type	DI	DO	AI	RS485
Energy data (voltage, current, power, consumption, power factor, etc.)				1
Pump status (Run / Ready, Ready / Trip)	4			
Pump control (Start / Stop)		2		
Door sensor	1			
Water pressure signal on suction			1	
Water pressure signal on discharge			1	
Water meter on discharge pipe	1			
Total	**6**	**2**	**2**	**1**
Total (with reserve)	**9**	**4**	**4**	**x**

The contractor must provide all necessary accessories for mounting, wiring, and connecting the equipment listed above to the DCAE panel.

5.3.5. BPS-5 – Romana 112

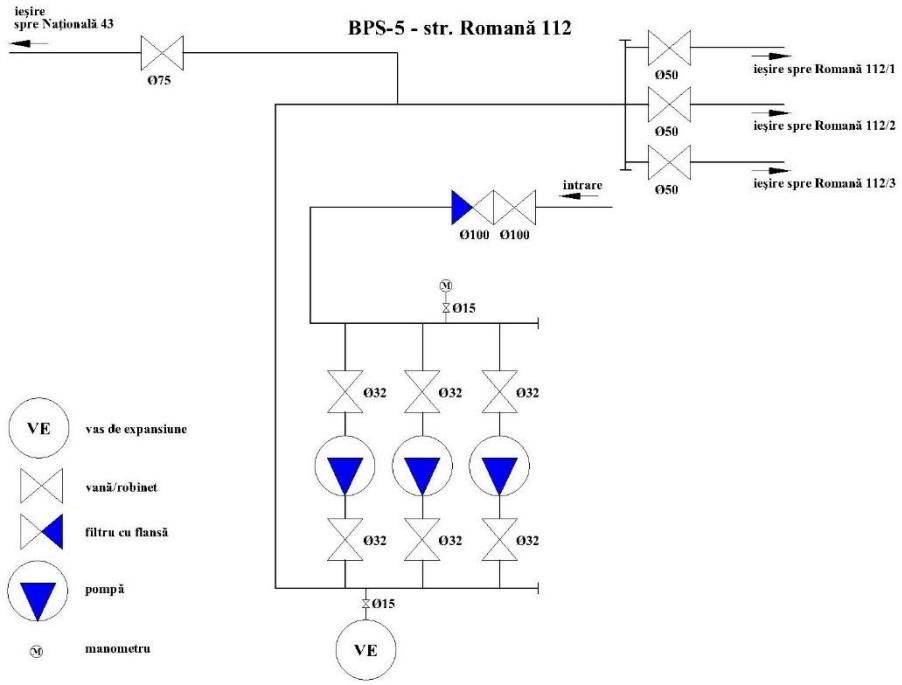

Figure 9 - Hydraulic Scheme with existing equipment of BPS-5 – Romana 112

The list of existing equipment on the station from which the signals to DACE must be received:

No.	Type / Model
1	Control System COR 3MVIE 1604 for 3 x Pumps 2.2kW

Local Data Acquisition and Control Equipment to be delivered by Contractor (new equipment):

- DACE Panel with the following specific requirements (general requirements are described in section 4.3.):

    - Inside mounting type.
    - Local and remote-control functionalities.
    - HMI at least 7 inch (or another web access solution).
- PLC with the following specific requirements (general requirements are described in section 4.12.):
    - Communication: Ethernet TCP/IP, RS-485 (Modbus RTU).
    - Digital Input – 9.
    - Digital Output – 7.
    - Analog Input – 4.
- Pressure transmitter: 2 pcs. Requirements are described in section 4.15.
- Power meters with all needed accessories: 1 pcs. For 1 existing power source 8kW.
- Water meter: 1 pcs. Pipe – DN110, on discharge pipe. Requirements are described in section 4.17.
- Door sensor. Requirements are described in section 4.18.
- All necessary cable, wiring and accessories for mounting: Yes.

Estimated total list of signals to be transmitted to the SCADA system (not limited to):

Type	DI	DO	AI	RS485
Energy data (voltage, current, power, consumption, power factor, etc.)				1
Pump status (Run / Ready, Ready / Trip)	6			
Pump control (Start / Stop)		3		
Door sensor	1			
Water pressure signal on suction			1	
Water pressure signal on discharge			1	
Water meter on discharge pipe	1			
Total	**8**	**3**	**2**	**1**
Total (with reserve)	**9**	**5**	**4**	**x**

The contractor must provide all necessary accessories for mounting, wiring, and connecting the equipment listed above to the DCAE panel.

5.3.6. BPS-6 – Ungureanu 9

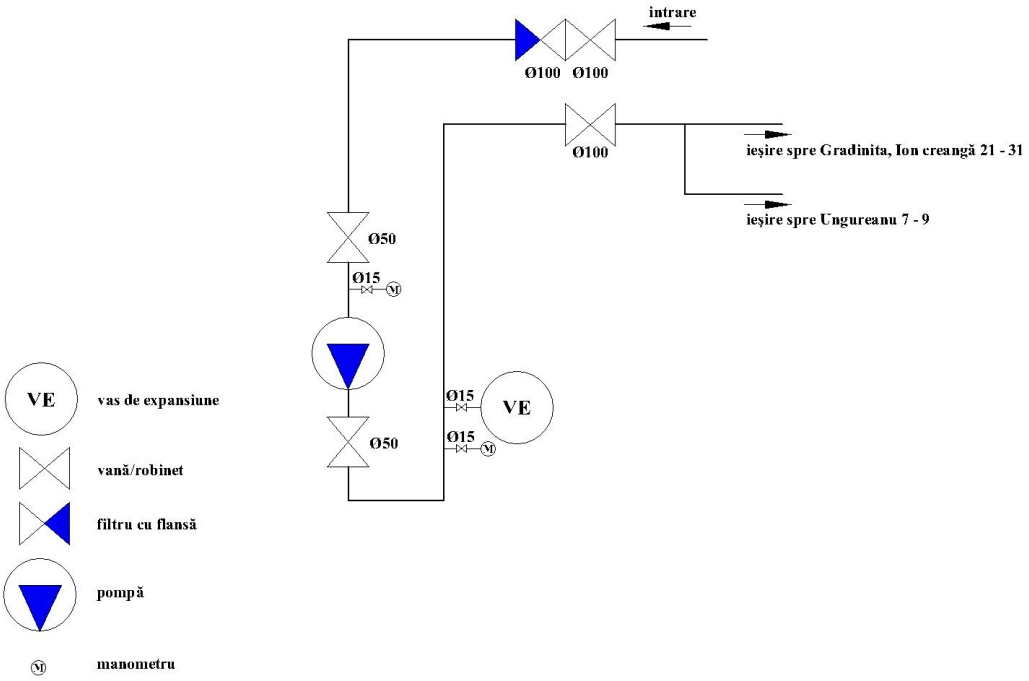

Figure 10 - Hydraulic Scheme with existing equipment of BPS-6 – Ungureanu 9

The list of existing equipment on the station from which the signals to DACE must be received:

No.	Type / Model
1	Control System COR-1MHIE1602-2G-GE for 1 x Pumps 2.2kW

Local Data Acquisition and Control Equipment to be delivered by Contractor (new equipment):

- DACE Panel with the following specific requirements (general requirements are described in section 4.3.):
    - Inside mounting type.
    - Local and remote-control functionalities.
    - HMI at least 7 inches.
- PLC with the following specific requirements (general requirements are described in section 4.12.):
    - Communication: Ethernet TCP/IP, RS-485 (Modbus RTU).
    - Digital Input – 9.
    - Digital Output – 7.
    - Analog Input – 4.
- Pressure transmitter: 2 pcs. Requirements are described in section 4.15.
- Power meters with all needed accessories: 1 pcs. For 1 existing power source 3kW.
- Water meter: 1 pcs. Pipe – DN110, on discharge pipe. Requirements are described in section 4.17.
- Door sensor. Requirements are described in section 4.18.
- All necessary cable, wiring and accessories for mounting: Yes.

Estimated total list of signals to be transmitted to the SCADA system (not limited to):

Type	DI	DO	AI	RS485
Energy data (voltage, current, power, consumption, power factor, etc.)				1
Pump status (Run / Ready, Ready / Trip)	2			

Pump control (Start / Stop)		1		
Door sensor	1			
Water pressure signal on suction			1	
Water pressure signal on discharge			1	
Water meter on discharge pipe	1			
Total	**4**	**1**	**2**	**1**
Total (with reserve)	**9**	**4**	**4**	**x**

The contractor must provide all necessary accessories for mounting, wiring, and connecting the equipment listed above to the DCAE panel.

5.3.7. BPS-7 – Cristiuc 11

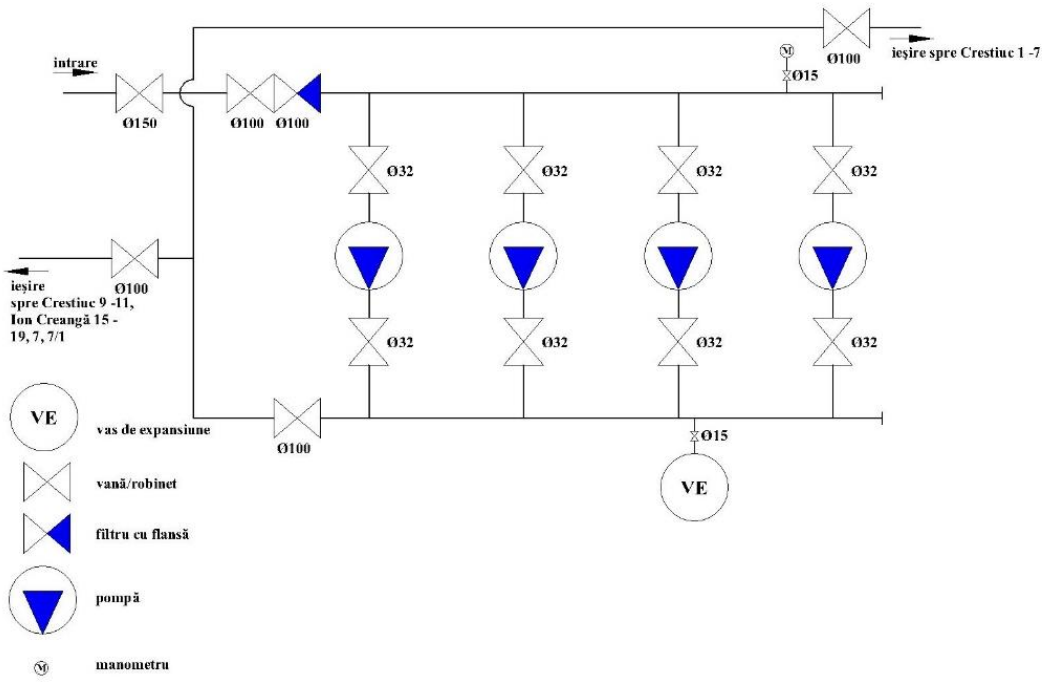

Figure 11 - Hydraulic Scheme with existing equipment of BPS-7 – Cristiuc 11

The list of existing equipment on the station from which the signals to DACE must be received:

No.	Type / Model
1	Control System COR-4MHIE803-2G VR for 4 x Pumps 2.2kW

Local Data Acquisition and Control Equipment to be delivered by Contractor (new equipment):

- DACE Panel with the following specific requirements (general requirements are described in section 4.3.):
    - Inside mounting type.
    - Local and remote-control functionalities.
    - HMI at least 7 inch (or another web access solution).
- PLC with the following specific requirements (general requirements are described in section 4.12.):
    - Communication: Ethernet TCP/IP, RS-485 (Modbus RTU).
    - Digital Input – 16.
    - Digital Output – 10.
    - Analog Input – 4.
- Pressure transmitter: 2 pcs. Requirements are described in section 4.15.
- Power meters with all needed accessories: 1 pcs. For 1 existing power source 10kW.

- Water meter: 1 pcs. Pipe – DN110, on discharge pipe. Requirements are described in section 4.17.
- Door sensor. Requirements are described in section 4.18.
- All necessary cable, wiring and accessories for mounting: Yes.

Estimated total list of signals to be transmitted to the SCADA system (not limited to):

Type	DI	DO	AI	RS485
Energy data (voltage, current, power, consumption, power factor, etc.)				1
Pump status (Run / Ready, Ready / Trip)	8			
Pump control (Start / Stop)		4		
Door sensor	1			
Water pressure signal on suction			1	
Water pressure signal on discharge			1	
Water meter on discharge pipe	1			
Total	**10**	**4**	**23**	**1**
Total (with reserve)	**16**	**8**	**4**	**x**

The contractor must provide all necessary accessories for mounting, wiring, and connecting the equipment listed above to the DCAE panel.

5.3.8. BPS-8 – Boico 5-7

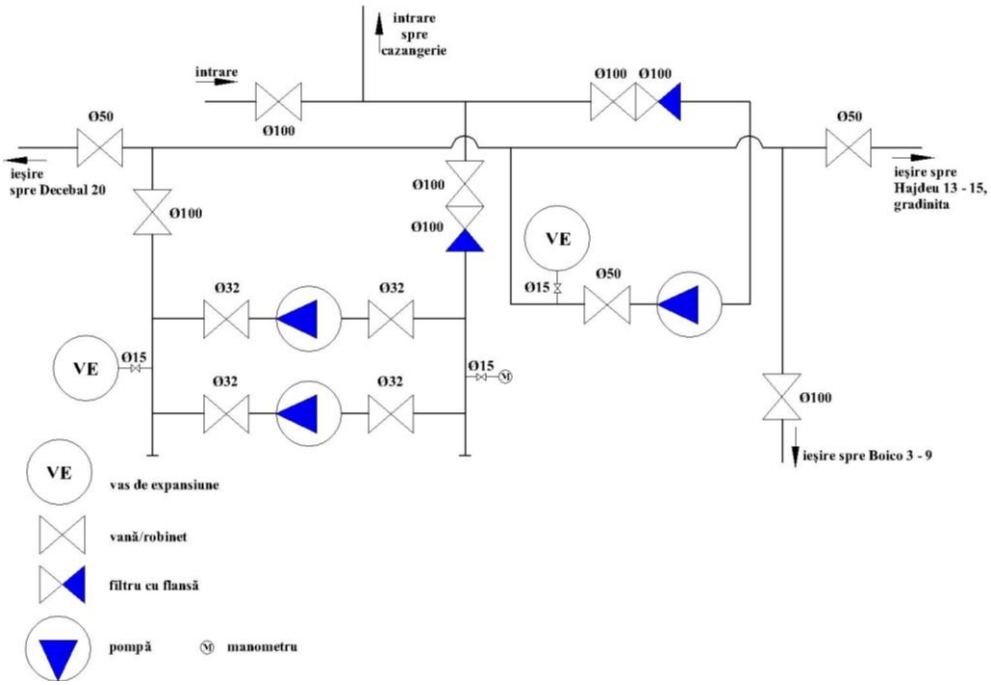

Figure 12 - Hydraulic Scheme with existing equipment of BPS-8 – Boico 5-7

The list of existing equipment on the station from which the signals to DACE must be received:

No.	Type / Model
1	Control System COR-1MVIE3202-GE for 1 x Pumps 5.5kW
2	Control System COR-2 MHIE 1602-2G/VR-RBI for 2 x Pumps 2.2kW

Local Data Acquisition and Control Equipment to be delivered by Contractor (new equipment):

- DACE Panel with the following specific requirements (general requirements are described in section 4.3.):
    - Inside mounting type.
    - Local and remote-control functionalities.
    - HMI at least 7 inches (or another web access solution).
- PLC with the following specific requirements (general requirements are described in section 4.12.):
    - Communication: Ethernet TCP/IP, RS-485 (Modbus RTU).
    - Digital Input – 16.
    - Digital Output – 10.
    - Analog Input – 4.
- Pressure transmitter: 2 pcs. Requirements are described in section 4.15.
- Power meters with all needed accessories: 1 pcs. For 1 existing power source 15kW.
- Water meter: 1 pcs. Pipe – DN110, on discharge pipe. Requirements are described in section 4.17.
- Door sensor. Requirements are described in section 4.18.
- All necessary cable, wiring and accessories for mounting: Yes.

Estimated total list of signals to be transmitted to the SCADA system (not limited to):

Type	DI	DO	AI	RS485
Energy data (voltage, current, power, consumption, power factor, etc.)				1
Pump status (Run / Ready, Ready / Trip)	6			
Pump control (Start / Stop)		3		
Door sensor	1			
Water pressure signal on suction			1	
Water pressure signal on discharge			1	
Water meter on discharge pipe	1			
Total	**8**	**3**	**2**	**1**
Total (with reserve)	**16**	**6**	**4**	**x**

The contractor must provide all necessary accessories for mounting, wiring, and connecting the equipment listed above to the DCAE panel.

5.3.9. BPS-9 – Porumbescu 3

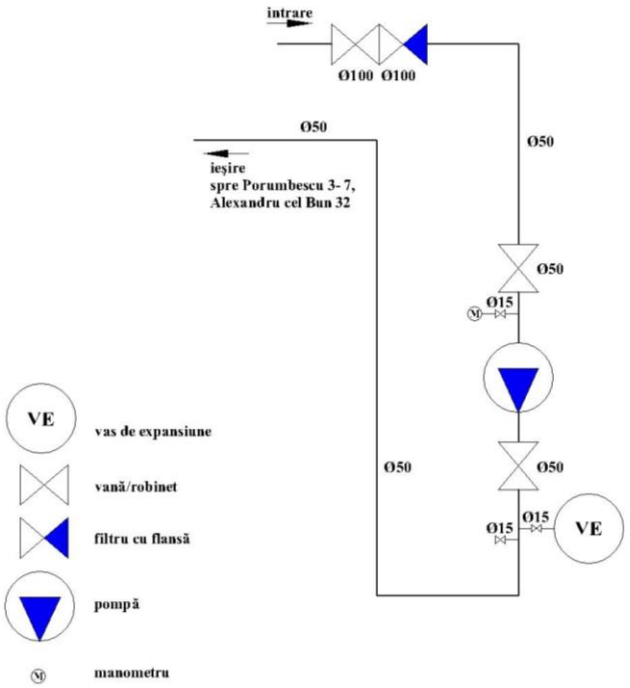

Figure 13 - Hydraulic Scheme with existing equipment of BPS-9 – Porumbescu 3

The list of existing equipment on the station from which the signals to DACE must be received:

No.	Type / Model
1	Control System COR-1MHIE1602-2G-GE for 1 x Pumps 2.2kW

Local Data Acquisition and Control Equipment to be delivered by Contractor (new equipment):

- DACE Panel with the following specific requirements (general requirements are described in section 4.3.):
    - Inside mounting type.
    - Local and remote-control functionalities.
    - HMI at least 7 inches (or another web access solution).
- PLC with the following specific requirements (general requirements are described in section 4.12.):
    - Communication: Ethernet TCP/IP, RS-485 (Modbus RTU).
    - Digital Input – 9.
    - Digital Output – 7.
    - Analog Input – 4.
- Pressure transmitter: 2 pcs. Requirements are described in section 4.15.
- Power meters with all needed accessories: 1 pcs. For 1 existing power source 3kW.
- Water meter: 1 pcs. Pipe – DN50, on discharge pipe. Requirements are described in section 4.17.
- Door sensor. Requirements are described in section 4.18.
- All necessary cable, wiring and accessories for mounting: Yes.

Estimated total list of signals to be transmitted to the SCADA system (not limited to):

Type	DI	DO	AI	RS485
Energy data (voltage, current, power, consumption, power factor, etc.)				1
Pump status (Run / Ready, Ready / Trip)	2			

Pump control (Start / Stop)		1		
Door sensor	1			
Water pressure signal on suction			1	
Water pressure signal on discharge			1	
Water meter on discharge pipe	1			
Total	**4**	**1**	**2**	**1**
Total (with reserve)	**9**	**4**	**4**	**x**

The contractor must provide all necessary accessories for mounting, wiring, and connecting the equipment listed above to the DCAE panel.

5.4. Wastewater Pumping Stations

A WWPS station is a pumping station whose main purpose is to lift wastewater from one level to a higher level, either to pass over some obstruction, or to accommodate changes in elevation in route to either another lift station, or to a wastewater treatment plant.

Existing wastewater pumping stations to be covered by the Contractor are listed in the bellow table:

Table 4 - List of Water Pumping Stations for installation of DACE equipment.

No	PS Name	Address
1	WWPS-1 (SPAU-1) – Tereza Sobolevschi	str. Tereza Sobolevschi
2	WWPS-2 (SPAU-2) – Cetireni	str. Cetireni
3	WWPS-3 (SPAU-3) – Ion Neculce	str. Ion Neculce
4	WWPS-4 – Ungureanu 15	str. Ungureanu 15
5	WWPS-5 – Decebal 71	str. Decebal 71

5.4.1. WWPS-1 (SPAU-1) – Tereza Sobolevschi

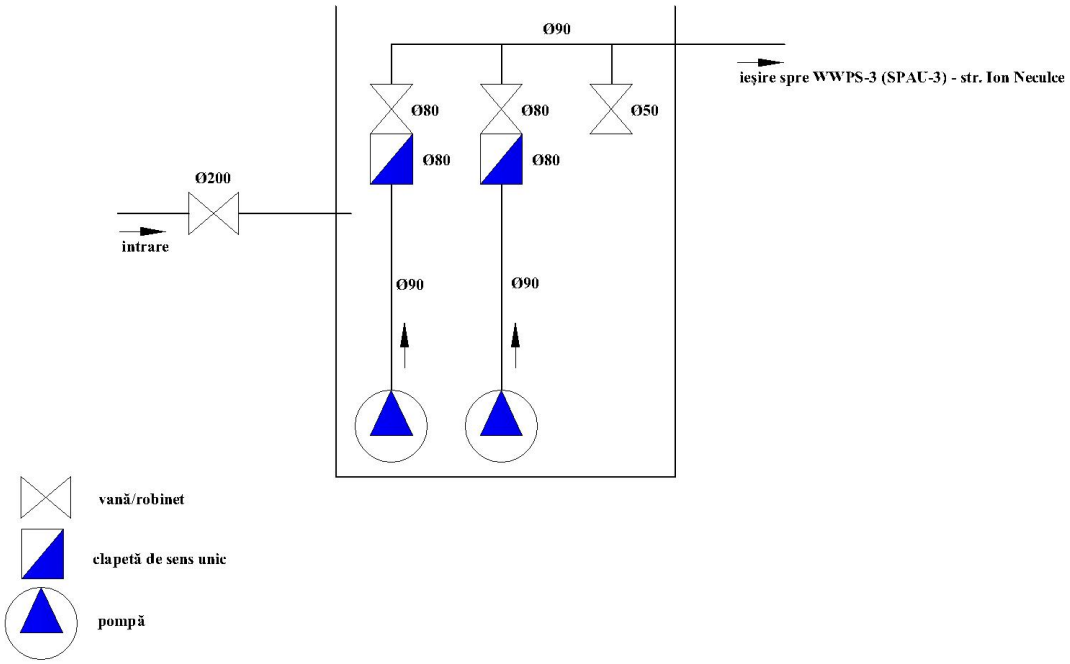

Figure 14 - Hydraulic Scheme with existing equipment of WWPS-1 – Tereza Sobolevschi

The list of existing equipment on the station from which the signals to DACE must be received:

No.	Type / Model
1	Control System Faggiolati G272T3V2 for 2 x Pumps 1.4kW

Local Data Acquisition and Control Equipment to be delivered by Contractor (new equipment):

- DACE Panel with the following specific requirements (general requirements are described in section 4.3.):
    - Outside mounting type.
    - Dual door constructions.
    - Heater options.
    - Local and remote-control functionalities.
    - HMI at least 7 inches (or another web access solution).
- PLC with the following specific requirements (general requirements are described in section 4.12.):
    - Communication: Ethernet TCP/IP, RS-485 (Modbus RTU).
    - Digital Input – 9.
    - Digital Output – 7.
    - Analog Input – 0.
- Power meters with all needed accessories: 1 pcs. For 1 existing power source 4kW.
- Level sensor: 3 pcs. For minimal, maximal, and maximal alarm level signalization.
- All necessary cable, wiring and accessories for mounting: Yes.

Estimated total list of signals to be transmitted to the SCADA system (not limited to):

Type	**DI**	**DO**	**AI**	**RS485**
Energy data (voltage, current, power, consumption, power factor, etc.)				1
Pump status (Run / Ready, Ready / Trip)	4			
Pump control (Start / Stop)		2		
Door sensor	1			
Minimum level signalling	1			
Maximum level signalling	1			
Alarm maximum level signalling	1			
Total	**8**	**2**	**0**	**1**
Total (with reserve)	**9**	**4**	**x**	**x**

The contractor must provide all necessary accessories for mounting, wiring, and connecting the equipment listed above to the DCAE panel.

5.4.2. WWPS-2 (SPAU-2) – Cetireni

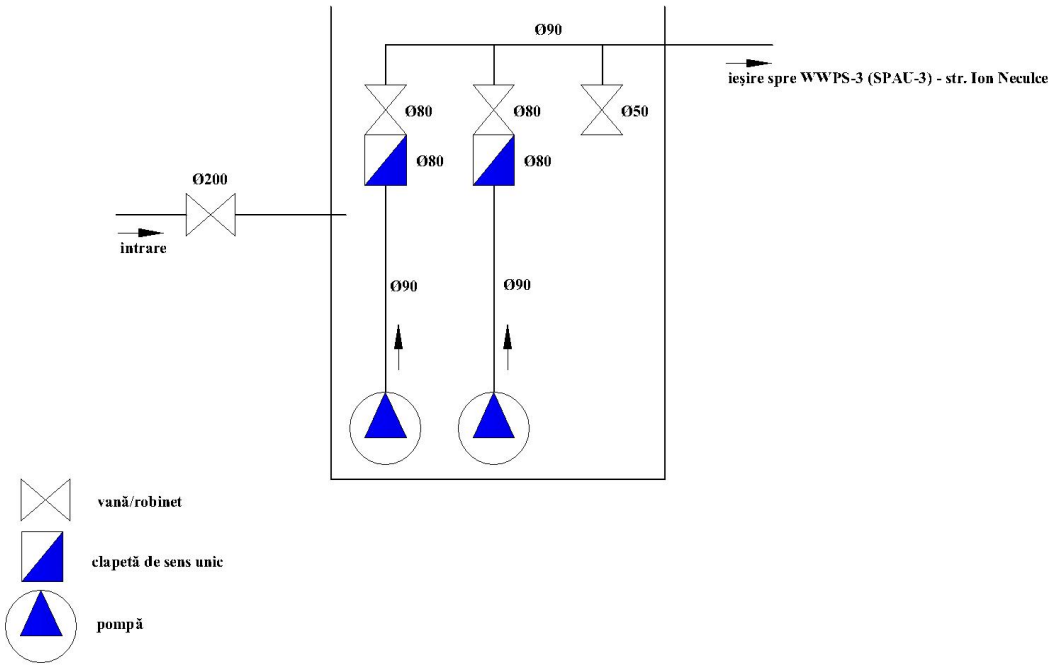

Figure 15 - Hydraulic Scheme with existing equipment of WWPS-2 – Cetireni

The list of existing equipment on the station from which the signals to DACE must be received:

No.	Type / Model
1	Control System Faggiolati G272T3V2 for 2 x Pumps 1.1kW

Local Data Acquisition and Control Equipment to be delivered by Contractor (new equipment):

- DACE Panel with the following specific requirements (general requirements are described in section 4.3.):
    - Outside mounting type.
    - Dual door constructions.
    - Heater options.
    - Local and remote-control functionalities.
    - HMI at least 7 inches (or another web access solution).
- PLC with the following specific requirements (general requirements are described in section 4.12.):
    - Communication: Ethernet TCP/IP, RS-485 (Modbus RTU).
    - Digital Input – 9.
    - Digital Output – 7.
    - Analog Input – 0.
- Power meters with all needed accessories: 1 pcs. For 1 existing power source 3kW.
- Level sensor: 3 pcs. For minimal, maximal, and maximal alarm level signalization.
- All necessary cable, wiring and accessories for mounting: Yes.

Estimated total list of signals to be transmitted to the SCADA system (not limited to):

Type	DI	DO	AI	RS485
Energy data (voltage, current, power, consumption, power factor, etc.)				1

Pump status (Run / Ready, Ready / Trip)	4			
Pump control (Start / Stop)		2		
Door sensor	1			
Minimum level signalling	1			
Maximum level signalling	1			
Alarm maximum level signalling	1			
Total	**8**	**2**	**0**	**1**
Total (with reserve)	**9**	**4**	**x**	**x**

The contractor must provide all necessary accessories for mounting, wiring, and connecting the equipment listed above to the DCAE panel.

5.4.3. WWPS-3 (SPAU-3) – Ion Neculce

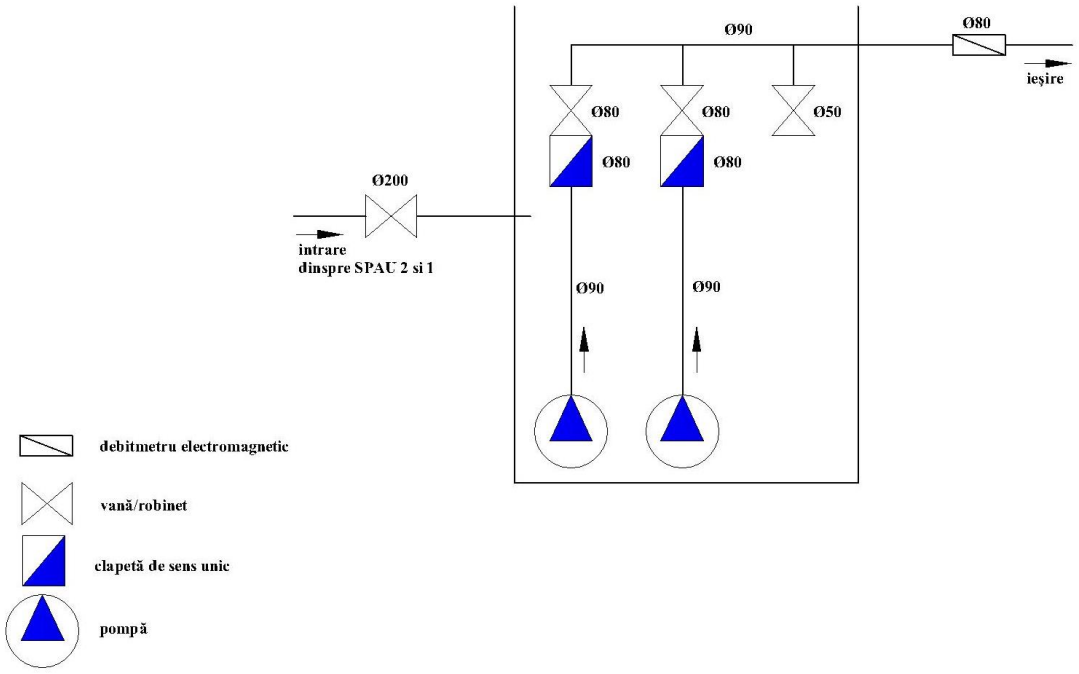

Figure 16 - Hydraulic Scheme with existing equipment of WWPS-3 – Ion Neculce

The list of existing equipment on the station from which the signals to DACE must be received:

No.	Type / Model
1	Control System Faggiolati G209T3V1 for 2 x Pumps 3.9kW
2	Flow meter Euromag MUT2200EL

Local Data Acquisition and Control Equipment to be delivered by Contractor (new equipment):

- DACE Panel with the following specific requirements (general requirements are described in section 4.3.):
    - Outside mounting type.
    - Dual door constructions.
    - Heater options.
    - Local and remote-control functionalities.
    - HMI at least 7 inches (or another web access solution).
- PLC with the following specific requirements (general requirements are described in section 4.12.):
    - Communication: Ethernet TCP/IP, RS-485 (Modbus RTU).

- Digital Input – 9.
- Digital Output – 7.
- Analog Input – 0.

- Power meters with all needed accessories: 1 pcs. For 1 existing power source 7kW.
- Level sensor: 3 pcs. For minimal, maximal, and maximal alarm level signalization.
- All necessary cable, wiring and accessories for mounting: Yes.

Estimated total list of signals to be transmitted to the SCADA system (not limited to):

Type	DI	DO	AI	RS485
Energy data (voltage, current, power, consumption, power factor, etc.)				1
Pump status (Run / Ready, Ready / Trip)	4			
Pump control (Start / Stop)		2		
Door sensor	1			
Minimum level signalling	1			
Maximum level signalling	1			
Alarm maximum level signalling	1			
Flow meter on discharge pipe				1
Total	**8**	**2**	**0**	**1**
Total (with reserve)	**9**	**4**	**x**	**x**

The contractor must provide all necessary accessories for mounting, wiring, and connecting the equipment listed above to the DCAE panel.

5.4.4. WWPS-4 – Ungureanu 15

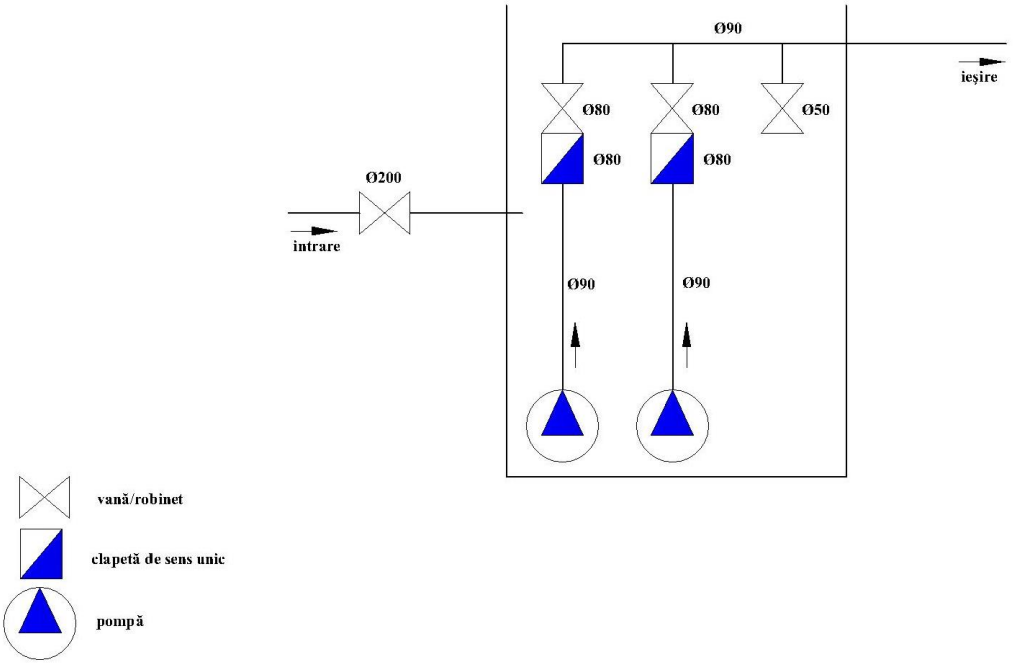

Figure 17 - Hydraulic Scheme with existing equipment of WWPS-4 – Ungureanu 15

The list of existing equipment on the station from which the signals to DACE must be received:

No.	Type / Model
1	Control System SEG.40.12.50B GRUNDFOS for 2 x Pumps 1.5kW

Local Data Acquisition and Control Equipment to be delivered by Contractor (new equipment):

- DACE Panel with the following specific requirements (general requirements are described in section 4.3.):
    - Outside mounting type.
    - Dual door constructions.
    - Heater options.
    - Local and remote-control functionalities.
    - HMI at least 7 inches (or another web access solution).
- PLC with the following specific requirements (general requirements are described in section 4.12.):
    - Communication: Ethernet TCP/IP, RS-485 (Modbus RTU).
    - Digital Input – 9.
    - Digital Output – 7.
    - Analog Input – 0.
- Power meters with all needed accessories: 1 pcs. For 1 existing power source 7kW.
- Level sensor: 3 pcs. For minimal, maximal, and maximal alarm level signalization.
- All necessary cable, wiring and accessories for mounting: Yes.

Estimated total list of signals to be transmitted to the SCADA system (not limited to):

Type	DI	DO	AI	RS485
Energy data (voltage, current, power, consumption, power factor, etc.)				1
Pump status (Run / Ready, Ready / Trip)	4			
Pump control (Start / Stop)		2		
Door sensor	1			
Minimum level signalling	1			
Maximum level signalling	1			
Alarm maximum level signalling	1			
Total	**8**	**2**	**0**	**1**
Total (with reserve)	**9**	**4**	**x**	**x**

The contractor must provide all necessary accessories for mounting, wiring, and connecting the equipment listed above to the DCAE panel.

6. INSTALLATION WORKS

6.1. General

The work under this contract involves the provision of all labour, superintendence, materials, tools, equipment, storage, permits, certificates, drawings, temporary work, inspection, testing, accessories, auxiliaries, and incidentals required for the installation, testing and commissioning of a complete and functioning system as specified herein and any other items of plant, equipment or materials required to form a complete turn-key installation.

The Contractor shall be responsible for the installation of the new equipment on site. The following main tasks shall be undertaken by the Contractor, but not limited to:

- Inspect and provide the required wiring, components, connections for equipment installation.
- Install and test server and workstation.
- Install and test SCADA software as detailed below.
- Install and test SCADA application as detailed below.
- Install and test Local Data Acquisition and Control Equipment as detailed below.

The Contractor shall develop a specific plan for the startup of the new SCADA system and for cutover of control to the new system. No startup or cutover activities shall be performed until the plan has been successfully approved by the Employer. The sections below give some guidelines and suggestions for cutover.

6.2. Work Permits

The Contractor shall obtain, and cover the costs for, obtaining all permits, approvals, and any other documents from Moldovan authorities, necessary for performing of the installation works and commissioning of the SCADA system, and shall arrange for applicable authority inspections.

In case certain permits/approvals are, according to the regulations, obtainable only by the Beneficiary, the Contractor shall prepare the necessary documents and shall obtain the respective permits/approvals on behalf of the Beneficiary. The Beneficiary shall duly sign the documents where necessary. The Contractor shall pay the costs for the permits / approvals. The Beneficiary shall support the Contractor by providing the necessary power of attorney for this purpose or shall delegate a representative for resolving the formalities together with the Contractor.

6.3. Transportation, Unloading, Storage and Handling

The Contractor shall be responsible for transportation, moving and temporary storage of all equipment included in the Contract. The Contractor shall handle and store equipment in the proper manner to ensure that all materials and coatings are not damaged.

The Employer can provide premises or space, whichever is applicable, for storage of delivered materials and equipment. In any case, the Contractor shall be responsible for the safety and integrity of the equipment and materials during storage. Precautions should be taken to ensure that the equipment remains in good condition during storage.

Deliver Operator Workstations and SCADA software, Local DACE in packaging designed to prevent damage from static electricity, and physical damage.

Store Operator Workstations and SCADA software, Local DACE according to manufacturers' requirements. As a minimum, store indoors in clean, dry space with uniform temperature to prevent condensation. Protect equipment and software from exposure to dirt, fumes, water, corrosive substances, and physical damage. Also, protect them from all forms of electrical and magnetic energy that could reasonably cause damage.

6.4. Working Environment

The Contractor shall provide safety and protective clothing for persons under his control on the Facility. The Contractor shall organize the Facility and his methods of working such that all are safe. Particular attention shall be paid to the risks pertaining to site conditions, e.g., high levels of noise, chemical pollution(chlorine), vibration, high electricity etc.

Adequate lighting of the workplaces and Facilities shall be provided by the Contractor.

Fire-fighting equipment shall be arranged by the Contractor.

6.5. Health and Safety

The Contractor shall be fully responsible for complying with the safety regulations and requirements for general order on site in accordance with the applicable laws, regulations, instructions of the local authorities and as provided in the Contract.

The Employer will notify the Contractor in full of the safety regulations which the Employer imposes on his own employees and the Contractor shall comply with such regulations.

The Contractor shall inform the Employer in writing in full of any special risks anticipated during the execution of the Works.

The Contractor shall designate a staff member responsible for safety and security in the working area.

The Employer's property, such as machines and instruments, shall be protected against damage.

Vibration and noise shall be reduced to a minimum. Adequate steps for reduction shall be taken.

The design of the plant and equipment shall include provisions to ensure the best possible working environment. Attention shall be paid to easy operation of and access to instruments and other components.

Warning signs in Romanian and English shall be placed on all machines that present a danger of injuries.

6.6. Marking of Equipment

Marking of materials, switchboards, plates, etc. shall be done in English and Romanian languages and according to Moldovan standards and requirements. Each item of equipment shall have its own position number related to the location. The numbers shall be marked on all equipment and used for identification on all drawings, manuals, and documentation.

6.7. Installation of SCADA Server Equipment to Central Dispatch and Control Office

6.7.1. Installation of SCADA Server Equipment

All equipment designed for Central Dispatch and Control Office, shall be supplied, and installed according to the TS. The following main tasks shall be undertaken by the Contractor, but not limited to:

- Installation of Rack IT Enclosure incl. passive elements (accessories).
- Installation of Server.
- Installation of Network hardware.
- Installation of Uninterruptible power supply UPS.
- Installation of Operator Workstation.

The exact locations for installation of all equipment shall be coordinated with the Employer during project execution.

6.7.2. Installation and Programming of SCADA Server

SCADA system configuration shall include the following based on the TS:

- HMI screens including overviews, symbols, pop-up screens, function buttons and any special features requested by the Employer during the initial demonstration.
- Alarm screens.
- Default trend screens.
- User accounts.
- Linking symbols to database points.
- Translation /scaling of raw data received from remote devices.
- Installation of software on final, Central Dispatch and Control Office, hardware.
- Configuration of network equipment.

6.7.3. Installation and Programming Software for Operator Workstation

Operator workstations shall be supplied and configured with all necessary software, in order to have a functional operating SCADA system, as required in the TS.

6.8. Installation of Data Acquisition and Control Equipment

Prior to installation works, the detailed design including all necessary drawings (e.g., cabling, lighting protection, switchboards, installations, P&I scheme etc.) as well as detailed implementation specifications (PLC and SCADA) shall be elaborated by the Contractor and submitted to the Employer for approval, as described in the TS.

The Contractor shall submit to the Employer certificates of origin certifying that the items purchased are in conformity with the required standards.

6.8.1. Installation of Wall Mounted Panel

All wall-mounted panels shall be securely fastened to walls (in place) in the local room of facility, use of tapped holding down bolts, drawl plugs or other accessories for mounting.

Wall mounted Panels are required in all locations, incl. water pumping stations, wastewater pumping stations, booster PSs and WTP, however the Contractor shall consult with Beneficiary to determine whether suitable space is available in existing racks.

Where panels are to be mounted to unfinished concrete or block walls, strut channels or similar rails shall be provided and installed to provide an air gap between the panels and the walls.

6.8.2. Low voltage cabling

Only outdoor low voltage cables for the main connections shall be laid in earth. All other cables shall be laid in suitable conduits, cable trays or ducting.

6.8.3. Installation of level transmitter

The reservoirs are located at PS-2 and MWWPS. Each reservoir shall be equipped with level sensor such as absolute pressure transmitter, which calculate level according to pressure or non-contact radar transmitter.

All wiring and associated works shall be included in the unit costs.

6.8.4. Installation of pressure transmitter

Pressure sensors shall be supplied and installed with socket, isolating valve and connected at local SCADA Panel. Valves shall be ball type.

Location of the pressure sensors shall be indicated in the detailed drawings.

All wiring and associated works shall be included in the unit costs.

6.8.5. Installation of flowmeters

The flowmeters must be installed in strict accordance with the manufacturer's recommendations mentioned in the installation manual of the delivered equipment. The flowmeters must be connected at local SCADA Panel. Location of the flowmeters shall be indicated in the detailed drawings.

All wiring and associated works shall be included in the unit costs.

6.8.6. Installation of PH, temperature, residual chlorine, and turbidity transmitter

The transmitters for PH, temperature, residual chlorine, and turbidity will be select by the contractor in accordance with the requirements of the technological process. The transmitters must be installed in strict accordance with the manufacturer's recommendations mentioned in the installation manual of the delivered equipment. The transmitters must be connected at local SCADA Panel. Location of the flowmeters shall be indicated in the detailed drawings.

All wiring, accessories and associated works shall be included in the unit costs.

6.8.7. Installation of open-door sensor at BPS and WWPS stations

Open door sensor shall be installed at each entrance door at booster stations and connected at Local Data Acquisition and Control Equipment.

Technical requirements of the open-door sensor are described above. All wiring and associated works shall be included in the unit costs.

6.8.8. Connection equipment and sensors to PLC

All existing equipment from each station (flow meter, pressure transmitter, level sensor, frequency converter, soft starter, power and electricity meter, security system, chlorine, etc.) shall be connected at local PLC, situated in SCADA panel. In case if the station does not have any sensors, the contractor shall simulate this to prove system functionality.

6.8.9. Programming PLC and HMI

After installation of SCADA panels and interconnection through sensors and PLC at each facility, all PLC and HMI devices, shall be programmed according to particular stations configuration.

7. TESTS AND COMMISSIONING

7.1. General Requirements for Testing, Inspection, Running-in and Commissioning

The Contractor shall offer all items of the works for inspection, examination and witness testing and shall agree with the Employer on time and place for the testing or inspection in good time before the testing or inspection is intended carried out.

If tests are beyond the resources of the Contractor, he shall make arrangements for such tests to be carried out elsewhere.

The Contractor shall carry out tests as stated in appropriate standards, performance tests and such other tests as are necessary in the opinion of the Employer, to determine that the station complies with Specifications, either under test conditions in the manufacturer's works, on site or elsewhere.

7.2. Factory Acceptance Test (FAT)

Thorough testing and verification for all deliverable equipment, software, and associated documentation shall be performed on all Contractor proposed system components.

The tests shall be performed to verify that the equipment is manufactured and assembled correctly, is operating as designed, and complies with the contractual requirements.

The tests shall be performed to verify that the software and hardware will meet the functional and performance requirements of this document. The equipment shall be interconnected and subjected to comprehensive system testing that simulates field conditions and operations.

The Factory Acceptance Test for the support software shall include the following, as a minimum:

- Demonstration of restoration of system using backup media.
- Demonstration of system editing capabilities including the addition and deletion or modification of points in an RTU, displays, report formats, control strategies, and the modification of the database and all database parameters.
- Demonstration of the editing of system parameters including timers, intervals, etc.
- Demonstration of utility software facilities, including assembling, compiling, appending, and executing new programs.
- On-line program debug facilities shall also be demonstrated, including downloading of a program from the central system to a remote PLC/RTU.

The Factory Acceptance Test (FAT) shall include the test and verification activities specified in this section.

The FAT shall be attended by the Employer’s and Beneficiary’s representatives. The FAT shall be conducted by the Contractor.

7.3. Site Acceptance Test (SAT)

After installation is completed and the equipment is running satisfactorily after primarily setting to work, the Contractor shall notify the Employer that he is ready to demonstrate the performance of the equipment.

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.

A Site Demonstration Test of the functions, software, and performance shall be conducted after all system elements have been installed and the I/O Point Checkout has been completed. The system site demonstration tests shall be performed to verify complete operation of the system, requiring a repeat of much of the comprehensive system tests but with the equipment installed at the permanent sites, and shall

include additional tests required to verify field installed equipment, which was not available during the FAT. The Contractor shall:

- Verify all the facility installations.
- Demonstrate each functional requirement identified by the specification. This demonstration shall repeat the tests used during FAT but using real rather than simulated conditions.
- Demonstrate all equipment control functions, including the operation of automatic control strategies. Actuation of field devices shall be closely coordinated with facility operations.
- Verify system performance parameters and system responses under field operational conditions.
- Verify accuracy of documentation, especially operator's manuals, software documentation, and general system operating instructions.

The Contractor shall provide the appropriate technical staff for the execution of the Site Demonstration Test. The Contractor's test support personnel shall be qualified to resolve and correct problems encountered with the system during the tests. In addition to test support personnel, the Contractor shall provide all test instruments and equipment necessary to troubleshoot any of the Contractor's proposed system problems encountered. The Employer reserves the right to increase the requirements for test support personnel if support by the Contractor is inadequate.

7.4. Testing facilities

7.4.1. Equipment Test and Verification

7.4.1.1. Hardware Tests

All hardware enclosures shall be inspected. As a minimum, the following shall be inspected and verified:

- Cabinet enclosures.
- Frame structure.
- Paint work and finish.
- Dimensions.

7.4.1.2. Inspections

As a minimum the following inspections shall be performed:

- CFE and Console Panels physical layout.
- Power supply mounting.
- Power cable routing.
- Data cable routing.
- Wiring runs across hinges properly installed.
- Fans and blowers are unobstructed.
- Power conditioning correctly installed.

7.4.1.3. System Functional Test

The functional test shall exercise and demonstrate the successful operation of every specified system function and shall include (but not be limited to) the following:

- Rigorous exercising of all devices both individually and collectively.
- Verification of proper scanning and data acquisition of all status and data points.
- Verification of proper Control Strategy up/downloading to the PLCs/RTUs.
- Demonstration of analogue input, pulse input, and analogue output accuracy.
- Testing of all user interface functions.

- Verification of all control operations to ensure that they result in the correct sequence of operation at all the PLCs/RTUs using the test PLC/RTU.
- Simulation of communication error conditions and demonstration of error detection and handling.
- All specified display types, reports, and operator/user procedures must be shown to be implemented and verified for accuracy.
- Create and process device failure conditions including PLC failure, Operator Workstation failure, peripheral failures, etc. Special attention shall be given to creating failures in the middle of operator sequences and control actions such as:
  - Communication failure after a command is issued but before the result is recorded in the database.
  - Computer failure after a command is issued but before the result is recorded in the database.
  - Failure of a major communications component.
  - Incorrect operator entry in the middle of a multi-step action.
  - Operator Workstation failure in the middle of a control action.
- Demonstration of all redundant functions and components.
- Demonstration of all required alarm processing functionality, including audible annunciation.
- Demonstration of all required historical capture, storage, and retrieval functions.
- Demonstration of all required data logging functions.
- Demonstration of all required IT interface functions.
- Demonstration of all required device control functions.
- Demonstration of all required database management functionality.
- Demonstration of all required software support utilities.
- Demonstration of all system diagnostics, both on-line and off-line.
- Demonstration of correct operation of calculated quantities including totalized values
- Demonstrate the proper operation of all changes to the system negotiated and approved during the implementation period.

7.4.2. System Testing

The Contractor shall stage the entire system in an integrated Factory Acceptance Test. The following system components shall be used for FAT. All components shall be interconnected using the LAN equipment:

- All Workstations provided by this Contract.
- All Printers provided by this Contract.
- All communication equipment and PLC/RTUs provided by this Contract, with final configuration loaded. These PLC/RTU programs shall include all Communication Strategies for the individual communication channels.
- Complete SCADA Server provided by this Contract.
- Web Server provided by this Contract.
- Historian Server provided by this Contract.
- PLC/RTU test set provided by the Integrator.

7.4.3. Simulation Software

The Contractor shall utilize software that simulates system loading conditions equivalent to the Steady State and Heavy load conditions defined in this specification.

7.4.4. 72-Hour Continuous Test

After the successful completion of the functional testing specified above, a 72-hour continuous test of the system shall be initiated.

The test shall be deemed successful if no system function is lost, no hardware or software failure occurs, and no module automatic failover occurs (unless instigated by testing efforts).

Hardware failure is defined for this test as the loss of a major piece of hardware, such as a peripheral, monitor, processor, I/O board, etc. Software failures will include, but not be limited to, server or workstation “lockups” or failure to respond to operator input. During this test, the system shall be exercised with simulated inputs, events, and conditions in a manner similar to an operational environment.

No software "patches" or changes will be allowed to bypass failed modules during this test. Any software and/or hardware correction made to the system shall result in the mandatory rerun of the entire 72-hour test. During the 72-hour period, at least 24 hours of unstructured testing shall be included, in which the Engineer or the end user’s representatives shall be allowed to operate the system without the Contractor's supervision (Contractor may observe).

7.4.5. I/O Point Checkout

The Contractor shall perform a checkout of selected I/O points as the SCADA system is installed and shall provide testing support at the Central DCO.

As each PLC/RTU is switched to the new SCADA system, the integrator will test a representative sample of the I/O present on the PLC/RTU. Up to 25% of the I/O on each PLC/RTU shall be tested to confirm the database setup and HMI graphic connection. The Contractor shall verify the tested points at the HMI database level and on the configured SCADA system screens. The testing shall be witnessed by the Employer’s or Beneficiary’s Representatives. The quantity of points selected for testing shall be controlled by the engineer and shall be sufficient to confirm proper database configuration. Should improper database configuration be found during the testing process, additional testing shall be conducted at no additional costs to the project.

Test signals shall be injected to verify the operation of the selected Analog Input (AI), and Discrete Input (DI) point. The signal injection point shall be at the field instrument for each Analog Input or Discrete Input. Each Analog Output (AO) and Discrete Output (DO) shall be also tested for proper operation, to the Final Control Element.

End-to-end testing shall use the process graphic displays to verify proper operation of the I/O points all the way to the Operator Workstation control console. I/O point checks will also verify the proper configuration of the Historical Data Storage and Alarm/Event Subsystems on the SCADA HMI Software.

I/O point checks shall utilize final communications system and SCADA network. The SCADA software must be fully operational in order to conduct this test.

The Contractor shall develop a complete I/O Point Checkout Test Procedure. The test procedure shall identify the method to be used by the Contractor for verifying the I/O signals in each database location. The Contractor shall develop a point checkout form for each I/O point. The point checkout form shall include the point ID, description, all checks performed for the point, date and time of the check, and a signoff block for both the Contractor’s representative and the Employer’ representative. For each item checked, the form shall include both the expected value/result and the actual value/result witnessed.

For each analogue input point tested, the following values shall be checked:

- Value at 0% of full scale (ramped in both directions).
- Value at 100% of full scale (ramped in both directions).

For each analogue input tested and its associated alarms, verify that the testing signals are stored in the Historical Database, if the signal is designed for historical data collection, that each alarm is displayed on the alarm displays on the SCADA Software and that each alarm is shown on the hard-copy alarm log.

For each analogue output point tested, the following values shall be checked:

- Milliamp reading at 0% of full scale (ramped in both directions).
- Milliamp reading at 100% of full scale (ramped in both directions).

For each analogue output tested, verify that the change in each output is stored in the Replicated Database, Event Historian and that each event is shown on the hard-copy event log.

For each discrete input point tested, the following items shall be checked:

- For status points, proper indication.
- For alarm points, proper alarm notification.

For each discrete input tested, verify that the testing signals are stored in the alarm/event historian, that each alarm is displayed on the alarm displays and each event on the event displays, and that each alarm/event is shown on the hard-copy alarm or event log.

For each discrete output point tested, the following items shall be checked:

- Proper operation.
- Actuation time-out alarm (if value is entered in database).

For each discrete output, verify that the change in each output is stored in the Event Historian and that each event is shown on the hard-copy event log. The completed I/O Checkout forms for all points shall be included as part of the I/O Checkout Test Report to be prepared and submitted at the conclusion of all I/O checkout activities.

7.5. Commissioning of Works

The Contractor shall be responsible for organization of taking-over committee and successful start-up of the system, including drafting necessary certificates on taking-over and commencement of works, and other associated documents.

7.6. Delivery of Spare Parts

The Contractor shall provide spare parts as set out in the schedule of prices and the tools required for the normal maintenance and repair of the installation by the Employer's staff.

The Contractor shall include in his price mandatory spare parts. Mandatory spare parts shall be the spare parts, which are recommended by the makers to have in stock for a period of operation. Each spare part item shall be separately numbered and priced. The delivery of spare parts shall be specified 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 station to maintain and repair every item of the installation. List of tools shall be provided with Tender, as required.

7.7. Operation and Maintenance Manuals

The Contractor shall deliver complete operation and maintenance manuals of the installation to the Employer. Two copies of fully detailed manuals in Romanian language for the operation and maintenance of the equipment are to be provided in a durable form to be approved by the Employer.

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.
- Control description.

- Automation and functional scheme.
- Schedule for intervals between maintenance of all items. 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 components of the system.
- Calibration of instruments.

The manuals shall be accompanied by the following documents:

- Schedule of equipment supplied giving manufacturers name and appropriate Model No and Type.
- Other necessary information for unambiguous identification of the component.
- Schedule of routine maintenance for all equipment supplied.
- Schedule of spares supplied.
- General arrangement and schematic diagrams of the "As Installed" control panels and Switchboards.
- "As Wired" diagrams of all electrical connections, between the control panels, Switchboards, and installed loads.
- Full and comprehensive instructions for all items of equipment supplied. Including Performance guaranties and warranties, characteristics (curves, diagrams, test certificates etc.).

The manuals thus shall contain all relevant information to properly maintain and repair of the equipment, and to obtain correct spare parts where necessary.

7.8. Training

7.8.1. Training Overview

A comprehensive training program shall be provided by the Contractor covering the operation and maintenance of all elements of the Contractor's proposed system. Several specific requirements for the training program are listed below:

- Training classes shall be tailored to the specific needs of the class participants.
- All training classes shall be completed prior to the start of the Site Acceptance Test.
- All instructors shall be highly qualified for technical training with demonstrated expertise in not only SCADA system functionality but also professional training techniques. During training, instructors should have no other duties that would interrupt training. Training shall not be combined with other activities such as system configuration or startup.
- Complete, professional, training materials shall be provided for all training classes including course outline and schedule, training manuals (in addition to system documentation), and review/testing materials.
- Training courses shall be a combination of classroom and hands-on training. To the extent possible, hands-on training shall utilize components from the Contractor's proposed system.

7.8.2. Training Plan

The training plan shall include complete descriptions of all training classes, a preliminary training schedule, a list of all proposed instructors along with resumes, examples of proposed training manuals, and a description of any special training tools available (simulators, self-paced modules, personal computer-based training, etc.).

The Employer will review the training plan for assurance that the training planned by the Contractor will meet the training needs.

7.8.3. Training Manuals

Comprehensive training manuals shall be professionally written to present the course material in a format that is easy to comprehend. The manuals shall serve as teaching aids during presentation of the training classes and shall additionally serve as reference material after the training has been completed. Portions of system documentation may be incorporated into training manuals provided that the overall manual achieves an instructional format. If the Contractor proposes to use standard training manuals, these manuals shall be appended to reflect system characteristics specific to the projects of SCADA System.

The manuals shall be prepared in Romanian language.

7.8.3.1. Operator Training

Training courses shall be presented that instruct the system operators in the efficient operation of all aspects of the SCADA. The course material shall include the general operation of the SCADA system, and the operation of the specific system features incorporated in the SCADA system. In particular, the operator training shall include instruction on the use of all operational functionality.

7.9. System Performance

7.9.1. System Diagnostics

The Contractor shall clearly state the tools and methods available for system health monitoring, system performance statistics and proactive failure analysis for all SCADA components.

The SCADA shall have extensive self-diagnostic capabilities running on-line as a background function.

The SCADA shall generate alarms and log internal errors/faults to the system log files for archiving.

The SCADA shall provide graphic displays dedicated to providing diagnostic and system performance overviews to enable clear identification of system component failures including both primary and backup in the case of redundant nodes.

7.9.2. Controller Failure

The SCADA controllers provided must incorporate fault diagnostics generation & alarming on CPU failure.

7.9.3. SCADA Memory Retention

All SCADA devices or components containing volatile memory shall employ a means of battery back-up in order to preserve memory contents for not less than 60 days subsequent to interruption of power to the system, and so avoiding the need to re-load software.

The Contractor shall fully describe where all software resides in the system and identify where volatile memory cannot be preserved for the specified time.

7.9.4. Processing and Scan Rates

7.9.4.1. Controller Analogue Performance

Controller analogue performance based on system execution speed, under the stated loading conditions, shall facilitate loop execution speed as described below. Where execution speed refers to the computation period for the cycle of reading all inputs, executing analogue algorithms and writing the results should be referred to the analogue output registers.

Based on I/O loading of 100% actual I/O + spare.

- 20% for 1.0 second updates.
- 60% at 0.50 second updates.

7.9.4.2. Controller Digital Performance

Controller digital performance based on system execution speed, under the stated loading conditions, shall facilitate loop execution speed as described below. Where execution speed refers to the computation period for the cycle of reading all inputs, executing digital algorithms, and writing the results should be referred to the output registers.

Based on I/O loading of 100% actual I/O + spare. 100% for 200ms updates.

7.9.4.3. Operator Interface Station System Response Times

The SCADA operator interface station system response times detailed below shall be based on manipulating the most complex graphic application available.

- Graphic Displays - 1 second.
- Alarm Annunciation - 1 second.
- Graphic Display Dynamic Data Update - 1 second.
- Alarm and event resolution - 1 second.
- Sequence Of Events Resolution - 1 millisecond.
- Response to Keyboard/Trackball – Immediate.

7.9.5. Loading

Loading of operator interface stations, controllers, data communications devices and networks shall not exceed 60% of total capacity under maximum loading conditions including all spares capacity defined in this document, maximum loading conditions is to be based on the heaviest alarm load possible.

7.9.6. Alarm Flooding

The SCADA system shall provide inherent alarm handling capabilities to prevent/minimise alarm floods on the SCADA. The alarm handling package shall be capable of automatically disabling alarm annunciation both audible, and visual on the alarm summary displays under prescribed operating conditions. The alarm handling package shall also support manual selection of alarm disabling by the process operator. The disabled alarm states shall still be visible to the operator on the applicable process graphic and be logged in the alarm/event log.

The alarm handling package should automatically identify the operating conditions to initiate alarm disabling from a set of criteria based on measured operating parameters defined by the Employer in the detailed design documentation.

7.9.7. SCADA System Re-Boot Time

The Contractor shall state and guarantee the time that the entire SCADA system, including all controllers, servers, gateways, switches, hubs, interface stations, software applications, historizing & archiving functions take to conclude their re-start routines and return to normal status.

This value is to be based on the actual system hardware and software proposed in the Contractor proposal, not on a typical installation.

The figure guaranteed will be subject to verification during the FAT procedures.

7.9.8. SCADA Communications

7.9.8.1. Data Communications

The control system network shall provide real time performance. The control system shall be based on "open" system architecture and protocols. That is, the system shall have inherent capability to integrate and exchange information with other brand system devices and platforms via industry standard communications, platforms, and protocols.

7.9.8.2. SCADA Network Loading

Loading of data communications devices and networks shall not exceed 60% of total capacity under maximum loading conditions including all spares capacity defined in this document, maximum loading conditions is to be based on the heaviest alarm load possible.

7.9.8.3. Network Diagnostics

The Contractor shall clearly state the tools and methods available for system health monitoring, system performance statistics and proactive failure analysis.

The SCADA shall have extensive self-diagnostic capabilities running on-line as a background function.

The SCADA shall generate alarms and log internal errors/faults to the system log files for archiving.

The SCADA shall provide graphic displays dedicated to providing diagnostic and system performance overviews to enable clear identification of system component failures including both primary and backup in the case of redundant nodes.

The SCADA shall display the number of re-tried transmissions resulting in non-fatal communications errors to enable advance warning of network issues.

7.9.8.4. Network Error Handling

The Contractor shall clearly state the tools and methods utilised to manage transmission error detection and elimination. These shall include but not be limited to:

- Error checking on all transmissions.
- Automatic re-transmission on error detection.
- Automatic switching to standby data path in the event of primary link critical fault or failure.

7.9.9. Availability/Reliability Requirements

7.9.9.1. General

The SCADA System is required to have an overall availability of 99.99% or better with a Mean Time to Repair (MTTR) of no more than one hour. The Contractor shall submit the availability calculation for the system proposed along with the system reliability figures for all SCADA subcomponents. Equipment reliability figures used in the calculations shall be based on proven field performance or similar installations. The overall design of the system shall be such that the failure of any component of the system shall have minimal effect on the process operation.

7.9.9.2. System Reliability Figures

The reliability figures to be achieved by the system are summarized below:

- MTBF Mean Time Between Failure: - *
- Minor Failure: - *.
- Significant Failure: - *.
- Major Failure: - * > 10 Years.
- Total Failure: - * > 30 Years.

* Indicates value to be calculated by Contractor.

Data used in the calculations shall be supplied and the source of the data shall be identified. All assumptions shall be clearly explained with justifications.

7.10. Warranty terms

The warranty period for manufacturing/installation defects must be at least 24 months.

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 Employer and the Beneficiary have been duly notified in writing.

The Contractor commits himself to carry out any remedial works within time limits agreed with the Beneficiary as soon as a malfunctioning or defective component has been discovered.

The Contractor shall give all details in his Tender about location of the nearest SCADA devices manufacturer/supplier representative.