BRNĚNSKÉ VODÁRNY A KANALIZACE, a.s.
BRNO, CZECH REPUBLIC

SLUDGE MANAGEMENT WWTP BRNO - MODŘICE

EMPLOYER´S REQUIREMENTS

MAY 2018

Content:

List of abbreviations:

ASTM	American Society for Testing and Materials
BEP	Best efficiency point
BOZP	Bezpečnost a ochrana zdraví při práci
BS	British Standard
BSK5	Biochemická spotřeba kyslíku za 5 dní při 20 °C
BVK	Brněnské vodárny a kanalizace, a.s.
CCTV	Closed Circuit Television
ČOV	Čistírna odpadních vod
ČS	Čerpací stanice
DIN	Deutsche Industrie-Norm
DN	Dosazovací nádrž
DS	sušina
EEC	Evropské hospodářské společenství
EKV	Elektrická kontrola vstupu
EO	Ekvivalentní obyvatelé
EPS	Elektrická požární signalizace
EZS	Elektronický zabezpečovací systém
FAT	Factory Acceptance Test
GIS	Geodetický informační systém
HAZOP	Hazard and Operability Study
HCL	HashiCorp Configuration Language
HMI	Human–Machine Interface
HW	Hardware
CHSK	Chemická spotřeba kyslíku
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
JTSK	Jednotná trigonometrická síť - Křovák
KGJ	Kogenerační jednotka
Ncelk	celkový dusík
NL	Nerozpuštěné látky
NLZŽ	Nerozpuštěné látky ztráty žíháním
NN	Nízké napětí
NT	Total nitrogen
OS	Operační systém
OV	Odpadní vody
PID	Process & Instrumentation diagrams
PLC	Programmable Logic Controller
PN	Pressure nominal
PO	Požární ochrana
PZTS	Poplachové zabezpečovací a tísňové systémy
QM Systém	Quality Management System
RL	Rozpuštěné látky
SCADA	Supervisory Control And Data Acquisition
SM	Směrnice

SS	nerozpuštěné látky
SW	Software
THP	Termická hydrolýza
TN	celkový dusík
TS	Trafostanice
VL	veškeré látky
VLZZ	veškeré látky ztráty žíháním
VN	Vyhnívací nádrž
VO	Veřejné osvětlení
ZO	Základní organizační normy

1 Introduction and current situation

1.1 Introduction

1.1.1 Basic project information

At present, the sludge line at the Brno - Modřice WWTP includes a pair of primary sludge thickening tanks, flotation thickening unit and biological sludge thickening centrifuge, homogenization tank, digesters and sludge storage tanks, mechanical sludge dewatering unit and sludge drier.
Primary sludge from primary sedimentation tanks is thickened in a pair of gravity thickening tanks. Excess biological sludge is thickened in the flotation unit or using the biological sludge thickening centrifuge.
Mixed sludge is pumped into four digesters with mechanical stirring at 35 °C. The sludge retention time in the digesters is ca. 19 days. The digesters are covered by a gas-tight laminated ceiling and the stirrers are attached to a massive reinforced concrete footbridge.
Stabilised sludge is pumped from the digesters into sludge storage tanks and then dewatered and dried.
The sludge dewatering and drying facility is located between the digesters and primary tanks. The main part of the facility includes a hall housing equipment for sludge dewatering and drying. The sludge dewatered using centrifuges with a dry solids content of about 24% is transported to the sludge drier by a screw conveyor. In case of the drier downtime, the dewatered sludge is transported off site for composting after all the necessary analyses have been carried out.
The NARA NPD14W sludge dries is based on the principle of indirect sludge heating system. A natural gas boiler is used as the main source of heat for the sludge drier. Hot oil isused to transfer heat within the drier. The dried sludge with ca. 92% dry solids is transported from the drier using cooled conveyors into containers located outside the drier and, after analyses confirming the required parameters, it is transported to be processed in the cement works.
The gas management system ensures biogas storage and processing for the WWTP. Biogas produced during sludge digestion is extracted from the digesters and stored in two double-membrane gas holders. The biogas is used for the production of electricity and heat in CHP units, 2 x 500 kW, or burnt in the boiler room to heat the digesters and other buildings. The cooling water from the engines is used to ensure additional heating of the digesters and heating of the WWTP site. Exhaust gas heat is used as a source of additional heating for the drier heating oil loop.

The current status was subject to evaluation as part of the preparatory work both in terms of the current and future capacity and in terms of the optimal use of energy flows. To assess the capacity with respect to the future sludge management system load, the year 2035 was set as the target year.
With respect to the assessment of the current process, the following was established:

- return liquors from the sludge management system are higher than considered normal;
- the activation tank loads caused by return liquors results in a higher sludge concentration in the tanks since during the period of increased volumes of primary sludge, the necessary amount of surplus sludge is not extracted and the sludge is stored in the activation reactor system;
- the average annual digester load is so high that 87% of its design capacity is used.

Furthermore, an analysis of the el. energy and thermal energy management was carried out. The analysis shows that, in particular in the area of waste heat management, it is necessary to make substantial changes compared to the existing solution. The most problematic areas of the current system of heat generation and distribution are the following:

- Prioritised use of heat recovered from the sludge drier loop at the expense of heat from the CHP units.
- Impossibility of simultaneous "parallel" connection of the CHP unit and the hot-water boiler room to the low-capacity heat distribution system.

The analysis concludes that a majority of the sludge management facilities is inadequate both in terms of capacity and energy flows but in terms of its technical status. In particular, the structural condition of

the digesters is at the end of the service life and the sludge dryer technology is inadequate in terms of its capacity and energy-intensive.
Therefore, on the basis of an evaluation of the current status, a decision was made to carry out changes in the sludge management of the Brno - Modřice WWTP, which will address the inadequate capacity and operating conditions that have a negative impact on the WWTP operation. The required measures address the interaction between individual technological units, energy optimizing with the use of the preferred thermal sludge hydrolysis, operational reliability of the process while optimizing the cost of operation and at the same time they address compliance with legislative requirements in the field of sludge management (sludge disposal after 2019). The sludge management technology at the WWTP is designed to meet the demands on the quality of sludge in relation to its final disposal at the Mokrá cement works. Act No. 185/2001 Sb., on Waste and amendments to other acts, as amended (hereinafter referred to as the "Waste Act") lays down the conditions for the disposal of sludge from WWTPs.
The proposed measures in the sludge management system also correspond to the existing capacity of the plants that, based on predictions, covers the outlook until 2035.

1.1.2 Purpose and objectives of the project

The purpose of the Works is to construct a sludge line at the Brno - Modřice WWTP with a capacity reserve for the future increase in the amount of sludge by 2035, to replace the inadequate existing structures and use a suitable combination of technological processes in order to achieve optimal use of internal energy resources (sludge, waste heat). At the same time, it should be ensured that the proposed solution is in line with legislative requirements, notably in the area off waste management and air protection requirements.

The purpose of the Works is expressed by the objectives of the project as follows:

- Provide insufficient capacity of the sludge management process
- Ensure sufficient capacity reserve of the sludge management system with an outlook to 2035
- optimize energy management with maximum utilisation of biogas
- Ensure compliance with legislation in the field of waste management, air protection and further applicable legislation;
- Meet the requirements for sludge energy utilization of sludge in the cement works at Mokrá,
- Ensure that all sludge production within the sludge management system, with a future quantity up to 50 t/day, will be dried to a minimum solids content of 90%
- Minimise operating and maintenance costs
- Ensure reliable operation of the sludge management during overloading and under extraordinary operating conditions according to chapter 8.6.

Technical parameters of the Works are expressed as follows:
Table 1: Designed sludge load

Designed sludge load	values and units	
Average thickened primary sludge weight	24,740	kg dry solids/d
Maximum thickened primary sludge weight	30,000	kg dry solids/d
The average mass of drained excess sludge at the outlet from THP	25,885	kg dry solids/d
Maximum thickened sludge load at the THP output	30,000	kg dry solids/d
Average mixed sludge weight at the digester input	50,625	kg dry solids/d
Minimal production of biogas	500	litres/ kg MLVSS
Minimum dry solids content in dried sludge	90	%

1.1.3 Scope and subject of the Works

The subject of the Work is the design, engineering, construction and testing operation of the sludge management system at the Brno - Modřice WWTP. In terms of the operation and function, the Works are defined In the basic (conceptual) design - texts and drawings provided in the land-use permit documentation (AQUATIS, a.s. 11/2017) – see Annex No.1.
The Works consists of the following process units:

- Surplus sludge thickening
- Thermal hydrolysis of surplus sludge
- Mixed sludge pumping station including mixed sludge tank
- Digesters with gas holders
- Desulphurisation and residual gas burner
- Digested sludge storage tanks
- Digested sludge mechanical dewatering
- Sludge drier
- Dried sludge container stand
- Sludge drier boiler room
- Boiler room and heat plant
- Gas engines
- Service water pumping station
- Biofilters
- Related civil structures and process units ensuring the function of the Works
- Demolition of existing buildings and dismantling of facilities that will not be used for the Works

More detailed requirements for the conceptual design of the sludge management system are specified in Chapter 2 of these Employer's Requirements. More detailed requirements for the plant are specified in chap. 3.4 of these Employer's Requirements.

1.2 Construction site

1.2.1 Restrictions in terms of spatial planning and master plans

The area in question (site intended for construction) is not an urban conservation zone, conservation area or a specially protected area.

1.2.2 Weather conditions

Basic weather characteristics:
The area in question is located according to E. Quitt in the warm climatic zone T2. In terms of rainfall, this locality is steadily rather dry, the total rainfall is relatively very low, only in recent years an increased variability of rainfall as been recorded. This is mainly demonstrated during warmer months, when the total rainfall reaches multiples or, on the contrary, only fractions of usual average values.
The average annual rainfall is 500-510 mm.
The annual sunshine ranges from about 1,700 to 2,000 hours, the average number of hours per year is 1,771, the sun exposure minimum with the number of hours is up to 50 in December, the sun exposure is the highest in May, June and August with the number of 250-350 hours.
Average relative humidity in the long-term is about 75-78%, the most humid months are November, December and January, and the driest months are April-June.
The predominant wind direction is northwest, wind area II - the baseline wind speed v = 25 m / s.
According to the snow map of the Czech Republic (ČSN EN 1991-1-3: 2005), the construction site is located in area I, the snow load on the ground is 0.7 kN/m^2.

1.2.3 Localization, land

The Works are fully located within an enclosed fenced-off area of the Brno - Modřice wastewater treatment plant.

The construction site is located in accordance with the Basic Design, for which the land-use permit was issued, and on the following lots of land or parts thereof owned by the Employer as registered in the Land Registry of the Czech Republic in Title Deeds LV 1502 and LV 1389:

in the cadastral area of Chrlice:
land plots: 2084/9, 2078/1, 2074/3, 2074/1, 2070/1, 2074/7, 2063/1, 2062/1, 2062/15, 2069/1
in the cadastral area of Modřice:
land plots: 1977/48, 1977/49, 1977/36, 1977/8, 1977/119, 1977/59, 1977/9, 1977/120, 1977/121, 1977/78, 1977/137, 1977/171, 1977/172, 1977/173, 1977/174, 1977/175, 1977/14, 1977/53, 1977/20, 1977/21, 1977/163, 1977/67, 1977/65, 1977/47, 1977/151, 1977/42, 1977/186, 1977/110, 1977/111, 1977/73, 1977/57, 1977/104, 1977/10, 1977/182, 1977/54, 1977/176.
The boundary of the area to in question, i.e. the delimitation of the areas on which the Contractor can operate during the execution of the Works - including temporary occupation and site accommodation s marked in the land-use permit documentation. This concerns land or parts thereof, which are defined by the line as the boundaries of the area in question in the land-use permit documentation see Annex No. 1, (Coordination lay-out - drawing No. C3).
The Employer will provide the Contractor with the right to access all parts of the Site, will hand over the Site and enable its use within the period specified in the Annex to the Tender. The construction site will be provided by the Engineer to the Contractor for use via a site handover protocol.

1.2.4 Construction site for new facilities

New structures and technological units will be located in a vacant undeveloped area in the central part of the WWTP site.
The Employer, considering the needs of the WWTP operations and the future development of the site, limits the scope of the areas that the Contractor can use for the location of the new facilities. New facilities within the Works may only be located on plots of land and their parts, which are specified in the relevant land-use permit as areas for development. Construction on other plots is not permitted by the Employer.

The location of the new facilities, their construction and their future use shall not prevent or limit the operation of the existing WWTP. The Contractor shall allow the Employer's personnel access to the provided Site, including machinery, to the extent necessary for the operationof the existing WWTP.

1.2.5 Construction site for the reconstruction and demolition of the existing buildings

The Employer shall provide the Contractor with access and the right to use those parts of the Site that are, as part of the Works, undergoing reconstruction or are designed to be demolished within the scope necessary for the preparation and implementation of the Works. The timing and movement of the Contractor's employees are subject to the approval of the Engineer. Entry to the existing facilities requires the issue of access cards which will be, in the required and justified number, issued by the Sewerage Control Room to the Contractor at its request. The Contractor shall announce the commencement and completion of its work on a daily basis to the Sewerage Control Room.

1.2.6 Site accommodation

For the purpose of establishing the temporary site accommodation, the area between the road leading from the main gate to the back entrance gate and the fence along the cycle track on land No. 2069/1 is allocated in the extent corresponding to the boundary of the area in question according to the Coordination Layout provided in the land-use permit documentation (see Annex No.1).

Provision of the building permit for the temporary facilities in the site accommodation, its construction, operation and dismantling are the sole responsibility of the Contractor and at his own expense.
Connections of the site accommodation facilities to the on-site electricity, drinking water and sewerage networks will be organised by the Contractor.

1.2.7 Access roads

The access road to the construction site is along public roads. The Contractor's access from the public roads to the construction site is ensured along the access road to the main entrance gate (the road is owned by the Employer and it is located on the land in the cadastre of Chrlice, land no. 2089, 1977/39 a 2092).
The Contractor is obliged to provide the Employer with a drawing and description of all access roads to the Site that will be used for connection to the publicly accessible roads including a document proving discussions related to such access roads (if such discussion is necessary) with the relevant public authorities, owners and administrators of the roads prior to their use for the Contractor's and subcontractor’s needs.
The Contractor is obliged to provide the Employer with a drawing and description of all publicly accessible roads that the Contractor will use in relation to the implementation of the Works including a document proving discussions related to such public road use (if such discussion is necessary) with the relevant public authorities, owners and administrators of the roads prior to theiruse for the Contractor's and subcontractor’s needs. The Contractor shall remove any contamination of the roads causes in connection with the execution of the Works without undue delay.
The Contractor is required to proceed in such a way as to minimize damage to publicly accessible land by the site transport. The Contractor shall not use publicly accessible roads whose structural and technical condition does not correspond to the site traffic demands. If use is made of publicly accessible roads by the Contractor contrary to their technical parameters and their structural and technical condition, the responsibility for the road repairs and damage incurred will be borne by the Contractor. The Contractor is obliged at his own expense to ensure data collection related to all publicly accessible roads before and after theiruse in order to identify possible damage due to excessive traffic during the implementation of the Works.
For the entry and exit of the Contractor into/out of the WWTP site, the Contractor will use the main entrance gate, which is continuously attended by the Employer's guarding service. Potential use of the back gate will be enabled by the Employer at the request of the Contractor only in duly justified cases (e.g. the use of weighbridge for removal of excess material, etc.).
The Contractor shall be responsible for repairing any damage to existing public, access and site roads that will be caused by transportation to and from the Site by the Contractor, its sub-contractors or suppliers. The Contractor shall take all necessary steps to prevent damage to roads, dirt, mud spilling or spreading or pollution caused by other materials through the transport associated with the Works on all roads used by the Contractor.
If, in the opinion of the Engineer, the Contractor does not maintain cleanliness of the roads, the Engineer may arrange for such cleaning work to be carried out by the Employer or the public road administrator.

1.2.8 Connection points

The existing wastewater treatment plant has ensured supplies of natural gas, electricity and drinking water.
The capacity of the supply piping/line from the point of connection to the relevant facility shall be determined by the Contractor in accordance with the needs of the proposed cleaning process. Any necessary extension of the supply installations shall be made by the Contractor as part of the Works .
The list of connection points for temporary and permanent structures, their location and permissible maxima:

- Drinking water - connection point (exact location as needed): JTSK: Y 597249, X 1168106; WGS-85: N: 49,13025° E: 16,63126°, DN 80, polyethylene, maximum permitted consumption 6l/s
- Natural gas - connection point (exact location as needed): JTSK: Y 597288, X 1168045; WGS-85: N 49.13076^{o}, E 16.63065^{o}; DN 160, polyethylene, maximum permitted consumption 850 Nm3/ hour)
- El. power - connection point (exact location as needed): JTSK: Y: 597375, X 1168373; WGS-85: N: 49,12775° E: 16,62995 °, HV cable 22 kV, cable type 22AXEKVCEY 1x240, number of cables 3, maximum power input 1600 kVA

1.2.9 Data on the effluent parameters

The existing wastewater treatment plant in Modřice is located in a prevailingly flat or slightly sloping locality.
In the area allocated for the construction of the sludge management facilities here is a number of grasslands enabling rainwater seepage. A detailed geological survey was carried out as part of the preparatory work (Geotest, a.s. 06/2017 - see Annex No. 3).
Three point infiltration tests indicate that the area of interest, which is formed by clay and backfills, can be classified as easily permeable to water. The coefficient of hydraulic conductivity of the rock environment (backfill) in the infiltration point is estimated on average at $tk_f = n \times 10\text{-}4$ m/s.

1.2.10 Flood protection

The Brno - Modřice WWTP has its own Flood Protection Pan from 2009, which was approved in 2010. The Flood Protection Plan is drawn up in accordance with higher degree flood protection plans - flood protection plans for the town of Modřice and city district of Brno - Chrlice. The WWTP site is protected by a protective dike system up to Q 20 (248.5 m3.s-1).
The Contractor is required to deal with the protection of the Works in the course of implementation up to Q100 not affected by the Svratka (395 m3.s-1) and Q 100 not affected by the Svitava (1181,5 m3.s-1).

1.2.11 Surveys

Surveys were carried out at the construction site as part of the preparation, the results of which are annexed to the Employer's Requirements.

a) Topographical survey

The geodetic survey has been completed and updated for the entire WWTP covering utility lines and surface points in the Balt elevation system. Latest update from spring 2017, see Annex No. 4: Brno - Modřice WWTP, land survey data, AQUATIS, a.s., 04/2017.
In the area of the WWTP there is the Basic Land Surveying Network - see Annex No. 5.

b) Geotechnical survey

The groundwater level at the construction site was probed to be detected in the layer of fluvial sandy and gravel sediments, at a depth of 3.4 - 5.4 m below the ground level i.e. in a range 185.7 - 188.0 m a.s.l.
The steady groundwater level as detected using hydrogeological boreholes at the level of 3.54 -4.1 m below the ground level, i.e. 187.28 - 187.51 m above sea level
If the Contractor lowers the groundwater level by pumping the groundwater when laying foundations, he will be responsible for obtaining all the necessary permits and for all operations and controls.

c) Data on buried facilities

On Site there are remnants of buried structures demolished during previous construction projects. Available information on the scope of these buried structures is provided in the attached documentation - Data Collection - of the abandoned structures, see Annex No. 6. As part of the Works the Contractor will take account of these aggravated foundation conditions.

1.3 Existing situation

The Modřice wastewater treatment plant treats wastewater conveyed by sewerage not only from the city of Brno and from the surrounding municipalities.
The original WWTP was put into operation in 1961, as a conventional two-stage treatment plant with anaerobic sludge stabilisation. In the following decades, it was been gradually extended and modernized in several stages.

In 2001-2005 a total reconstruction and extension of the WWTPs took place in order to increase its capacity, which was followed by the optimization of activation reactors in 2010 and a new primary sludge thickening line was built in 2015.
Currently, it is a mechanical and biological wastewater treatment plant with nitrification and denitrification, phosphorus removal by simultaneous precipitation with an existing capacity of 640,000 PE. The WWTP capacity is expressed as the population equivalent (PE) related to BOD. This parameter is expressed in the EEC Directive by the 60 g/d BOD parameter per population equivalent.

1.3.1 Current water line facilities at the WWTP

Mechanical stage:

- Inlet structure;
- Pumping station sewer A
- Pumping station sewer F;
- stormwater tank, volume of 10,700 m3;
- gravel trap;
- screens building: 6 mechanically scraped screen lines;
- sand traps: 6 aerated lines, separation of sand;
- influent metering profile with sampling;
- main screw pumping station: 4 screw pumps
- flow split upstream primary clarifiers;
- primary clarifiers: 4 circular tanks with bypass in case of high flow rates;

Biological stage:

- intermediate pumping station: 4 submersible pumps
- activation reactors: 4 separate operation lines, total volume of 110,300 m3, fine-bubble aeration system
- blower house: 4 turboblowers, type HV turbo
- secondary clarifiers: 6 tank with a diameter of 50 m,
- outlet structure with a service water pumping station, flow metering with sampling of discharged wastewater;
- discharge to the Svratka River;

Other civil structures and process units at the existing WWTP:

- sewerage control room in service 24/7;
- chlorination plant, service water tanks.
- main transformer station TS 1 and substations TS 1.1.,TS 1.2., TS 1.3
- SCADA control system
- electronic security signalling system, access control, CCTV
- power supply 22 kV (owner E.ON)
- el. Power distribution system
- on-site sewerage system incl. PS
- drinking water mains
- service water mains
- natural gas distribution system
- biogas distribution system;
- utility tunnels
- roads and paved areas
- maintenance workshops;
- storage 1,2,3,4,6,6,7,8,9;
- biofilters (screens building, PS in sewer F)

All parts of the wastewater treatment plant are equipped with adequate automation and control with sub-metering.

1.3.2 Current sludge line facilities at the WWTP

- primary sludge thickening tanks 2 pcs - not subject of the Works
- sludge retention tank - not subject of the Works
- flotation tank
- Flotation overflow pumping station with mechanical thickening of surplus sludge;
- Mixing tank (homogenisation of primary and surplus sludge)
- digestors - 4 tanks, mesophilic digestion
- -ludge storage tanks - 2 units
- mechanical sludge dewatering
- NARA GF sludge dryer;
- sludge hygienisation tank;
- dried sludge storage,
- membrane gas holders- 2 units,
- desulphurization unit, residual gas burners;
- gas motor generators, total power 1004 kW,
- biofilters - sludge dryer, primary sludge thickening

1.4 Permits

Before the commencement of the tendering procedure, the Employer obtained the following permits:

1.4.1 Permit to operate the existing WWTP

The Employer received the permit to operate the Brno-Modřice wastewater treatment plant via a decision of JMK9415 / 2005-OŽP-Mi of 5th April 2005 (Annex No. 7).

1.4.2 Water permit

The Brno - Modřice WWTP has a valid permit to handle water issued by a decision dated 3th March 2010 granted by the Regional Authority of the South Moravian Region, ref.no. JMK 171826/2009 with a period of validity until 31st December 2020 (See Annex No. 8).

1.4.3 Land-use permit

The land-use permit no. 35/2018 for the construction of the sludge line in the basic option according to the developed land-use permit design documentation was issued by the Construction Authority of the City Council of Šlapanice, ref. no. OV-ČJ/181564-17/RSG on April 20, 2018 (further and above also only „land use permit). Land use permit is in Annex 2.
The Contractor is authoriszed to implement a solution that requires a change in the land-use permit. However, the Contractor is not entitled to implement such a solution, which would require environmental impact assessment proceedings under Act No. 100/2001 Sb., on Environmental Impact Assessment and amendments to certain related acts. The time required to obtain a change in the land-use permit is not a reason for extending the Time for Completion or the time to meet a binding milestone under the Contract.
Any solution proposed by the Contractor shall not impair any of the conditions set out in the applicable land-use permit.

1.5 Cooperation

The Contractor shall allow other contractors providing the Equipment with repairs and maintenance of the equipment at the existing WWTP to carry out the necessary work, and the Contractor shall comply with the Internal directives of the Employer ZO009 Traffic regulations, SM 015 Risk assessment and management in the field of occupational health and safety, SM 105 Occupational Health and Safety Management, SM 106 Occupational Injuries, SM 107 Fire Protection - Annex No. 9.

1.5.1 Employer’s equipment

Not applicable.

2 Sludge management solution conception

2.1 Sludge load

2.1.1 Current sludge load

According to the current WWTP design, the primary sludge is fed to the digesters from primary sedimentation tanks, this sludge thickened in the gravity thickening tanks, and biological surplus sludge from activation reactors thickened in the existing flotation unit.

The average primary and secondary sludge load in 2016 is shown in the table below.

Table 2: Current sludge load in the anaerobic digesters - primary sludge and biological sludge.

Current sludge load (year 2016)	Parameter	
Thickened primary sludge output	21,764	kg dry solids/d
Dewatered surplus biological sludge output	11,466	kg dry solids/d
Dewatered mixed sludge to digesters	36,128	kg dry solids/d

The biological sludge contains a relatively high proportion of sand. According to the results of the analyses, the sand content ranges from 8 to 12% dry solids.

2.1.2 Designed sludge load

Anaerobic digesters will be designed to receive primary sludge from primary tanks and surplus biological sludge (secondary sludge) from activation reactors in a ratio of about 1: 1
Expected load trends in the SS indicator – inlet to the digestors is described in the following table.

Table 3: Expected load trends in the SS indicator – inlet to the digestors:

year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
SS t/day	37,60	38,20	38,81	39,41	40,01	41,39	42,77	43,37	43,98	44,58

year	2027	2028	2029	2030	2031	2032	2033	2034	2035
SS t/day	45,18	45,78	46,39	46,99	47,59	48,19	48,80	49,40	50,00

The primary sludge is extracted from the bottom of the primary sedimentation tanks and is thickened in gravity thickening tanks. Surplus biological sludge is extracted from the bottom of secondary sedimentation tanks , dewatered in mechanical thickening tanks, and the thickened sludge is then fed to the thermal hydrolysis (THP) system. Primary sludge is mixed with hot surplus sludge from the THP and both sludge lines are then connected to the digesters where temperature suited for mesophilic digestion should be achieved.

The proposed sludge load with respect to these three components is as follows:

Table 4: Sludge design load in the anaerobic digester with primary sludge and biological surplus sludge.

Designed sludge load	**values and units**	
Average thickened primary sludge weight	24,740	kg dry solids/d
Maximum thickened primary sludge weight	30,000	kg dry solids/d
Average thickened surplus sludge weight at the outlet from THP	25,885	kg dry solids/d

- Maximum thickened sludge load at the THP output	30,000	kg dry solids/d
Average mixed sludge weight at the digester input	50,625	kg dry solids/d

2.2 Sludge quality

Current sludge quality is characterized by:

- Sludge analyses for the period 2016-2017 are provided in Annex No. 17.
- Granulometry is provided in Annex No. 18

Table 5: Expected quality of primary sludge, biological surplus sludge and mixed sludge.

Sludge quality	Parameter	
Primary thickened sludge		
- SS concentration	45	kg/m³
- MLVSS concentration	74.4	%
- Total solids concentration	4.6	%
- TN concentration	1.93	kg/m³
Dewatered surplus sludge at THP output:		
- SS concentration	138	kg/m³
- MLVSS concentration	68.0	%
- Total solids concentration	14.2	%
- Nt concentration	8.26	kg/m³
Mixed sludge to digesters:		
- SS concentration	68.7	kg/m³
- MLVSS concentration	71.1	%
- Total solids concentration	7.1	%
- Nt concentration	3.55	kg/m³

2.3 Mass and energy balance

Diagrams showing mass and energy balance are provided in Annexes 10 and 11.

2.3.1 Mass balance

The total mass balance is such that the daily production reaches about 52 tons of dry solids (a mixture of primary sludge and biological surplus sludge) and, after thickening, about 50.5 tons dry solids is fed to into the digesters. Once processed in the new sludge line, the daily production will be 30 tonnes of dry solids/ day for final disposal.
The new sludge line includes the following units:

- Mechanical thickening tanks
- Thermal hydrolysis (THP)
- Anaerobic digesters
- Sludge storage tanks
- Mechanical dewatering
- Buffer tanks (silos)
- Low-temperature sludge driers

Mechanical thickeners

Mechanical thickeners treat the surplus biological sludge from the return sludge pipes in aeration tanks. The thickeners will achieve 98% solids separation efficiency and the sludge will be thickened to 16.5% dry solids.

Table 6: Load and efficiency of solids separation in mechanical thickeners

Mechanical thickeners (surplus sludge)	**Parameter**	
Input sludge		
- Sludge flow	4,063	m³/d
- Sludge concentration, SS	6.5	kg/m³
- Sludge weight	26,407	kg dry solids/d
Output sludge		
- Sludge flow	157	m³/d
- Sludge concentration, SS	165	kg/m³
- Sludge weight	25,885	kg dry solids/d
Effectiveness of solids separation - thickening	98	%

Thermal hydrolysis process

From mechanical thickening tanks, the concentrated biological sludge is fed to THP. Steam is added to the process to sludge hydrolysis to increase biogas production.

Table 7: THP load

Thermal hydrolysis (THP)	**Parameter**	
Input sludge		
- Sludge flow	157	m³/d
- Sludge concentration, SS	165	kg/m³
- Sludge weight	25,885	kg dry solids/d
Output sludge		
- Sludge flow	188	m³/d
- Sludge concentration, SS	138	kg/m³
- Sludge weight	25,885	kg dry solids/d

Digesters

Thickened primary sludge and thickened secondary sludge from THP are fed to the digesters. The digesters should be designed for a retention time of 16-18 days, which requires a total volume of 13,500 m³. Sludge is conveyed from the digesters to sludge storage tanks with a volume of 9,000 m³ with a storage capacity of 10-11 days.

Table 8: Anaerobic digester load

Anaerobic digesters	Parameter	
Input sludge		
- Sludge flow	737	m³/d
- Sludge concentration, SS	68.7	kg/m³
- Sludge weight	50,625	kg dry solids/d
Output sludge		
- Sludge flow	737	m³/d
- Sludge concentration, SS	42.3	kg/m³

-	Sludge weight	31,175	kg dry solids/d
Biogas output			
-	MLVSS reduction	19,450	kg dry solids/d
-	Biogas production	17,116	Nm³/d

The MLVSS reduction in in the anaerobic digesters is 54 % as organic matter is degraded and used for biogas production.

Mechanical dewatering
Digested sludge is fed to the mechanical dewatering unit from the sludge storage tank and polymer is added. The dewatering unit will have a solids reduction rate of 95% and the sludge will be dewatered to approx. 28% dry solids content. Dewatered sludge is pumped into buffer tanks.
Table 9: Load and efficiency of solids reduction in mechanical thickeners

Mechanical dewatering		Parameter	
Polymer dosing		104	m³/d
Input sludge			
-	Sludge flow	841	m³/d
-	Sludge concentration, SS	37.1	kg/m³
-	Sludge weight	31,175	kg dry solids/d
Output sludge			
-	Sludge flow	106	m³/d
-	Sludge concentration, SS	280	kg/m³
-	Sludge weight	29,616	kg dry solids/d
Effectiveness of solids separation - thickening		97	%

Low-temperature sludge drier
Dewatered sludge is pumped from buffer tanks to low-temperature sludge driers in a two-line arrangement. The dryer will have 100% solids separation efficiency and the sludge will be dried to a minimum dry solids content of 90%

Table 10: Load and efficiency of solids separation of low-temperature sludge dryers

Low-temperature sludge dryer		Parameter	
Input sludge			
-	Sludge flow	106	m³/d
-	Sludge concentration, SS	280	kg/m³
-	Sludge weight	29,616	kg dry solids/d
Output sludge			
-	Sludge flow	33	m³/d
-	Sludge concentration, SS	900	kg/m³
-	Sludge weight	29,616	kg dry solids/d
Effectiveness of solids separation - drying		100	%

Demand for operational scenarios
The design load mass balances are defined in different scenarios where various process units are out of service, for example in the event of maintenance or downtime:

- **The THP is out of service**

With the THP unit out of operation, biological sludge will not be hydrolysed, the biodegradability of volatile solids organic in the sludge will be lower, and the sludge viscosity will be higher. The sludge can not be thickened to the same concentration, and the digesters cannot be operated as the same load with respect to the dry solids content as this would result in overload in relation to the organic matter. Therefore, it will be necessary to reduce the amount of biological surplus sludge which will be stored in the aeration tanks. The hydraulic loading of the digesters will be maintained in order to achieve the same retention time.
In order to store sludge, it is necessary for the activated sludge system to be prepared for increased load before any THP downtime by extending the sludge extraction time. Sustainability of this process is limited in time because too much sludge would accumulate in the aeration tanks after a few weeks.
The volatile solids degradation in the digestors is reduced from 54% to 48% without THP in operation. Due to the lower organic load in the secondary sludge and the reduced degradation of organic matter, the production of biogas will be significantly reduced. In addition, less sludge will be supplied to the low temperature driers.

- **One digester is out of service**

With one digester out of service, the digester volume decreases from 13,500 m³ to 10,125 m³. To avoid overloading of the three remaining digesters, the surplus biological sludge load will be reduced and the sludge will be stored in the aeration tanks while the primary sludge feed will remain unchanged. The hydraulic load in each digester increases with this solution but the organic load corresponds to the normal scenario.
As mentioned above, the activated sludge system can be prepared in advance for the downtime by extending the sludge retention time. Again, there is a limitation on how long this will work as sludge will gradually accumulate in the aeration tanks.

- **One drier out of service**

When one dryer is off line, only about 60% of the sludge is fed to the drier and the remaining sludge is stored in the input bunker.

2.3.2 Energy balance

The total energy balance shows that the internal energy production (biogas) is 117 MWh/day and the need for external energy (natural gas) is 68 MWh/day. Most energy is therefore produced internally from the sludge.
Digesters
According to the material balance, following the thermal hydrolysis of biological sludge, the production of biogas in the new digesters is expected to amount to approx. 18,000 Nm³/d. It is expected that biogas contains 65% of methane. The energy contained in biogas can be estimated at approx. 117 MWh/day. This is the internal energy production that is available for the sludge management system.
Biological surplus sludge is heated in the THP unit and, after mixing with the primary sludge, the mixed sludge is fed to the digesters at a temperature of about 40 °C.
The output from the THP unit has a temperature of approx. 90 C. Heat from THP sludge is recovered by mixing with primary sludge. The mixed sludge temperature is expected to be ca. 40 °C, which is the operating temperature in the digesters.
An overview of the energy balance is given in the following diagram.

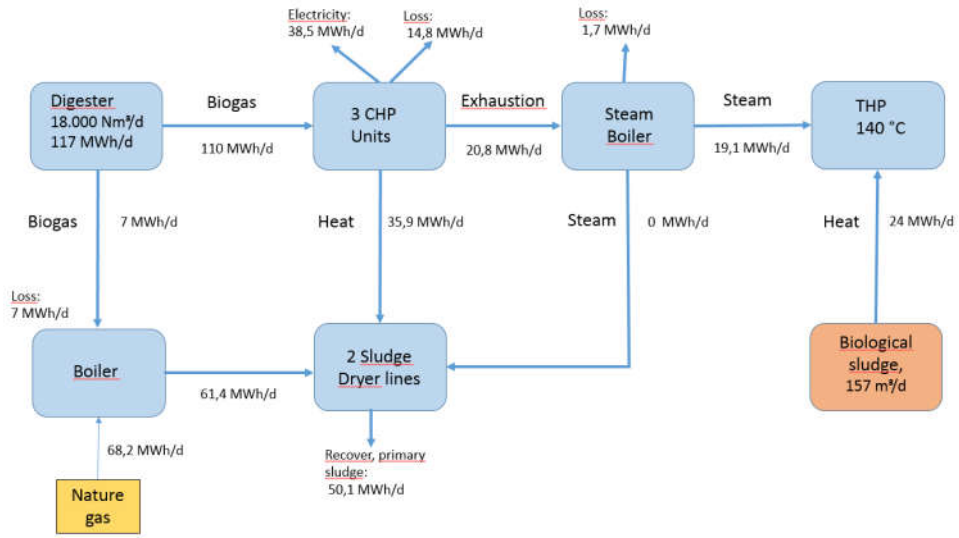

Fig. 1 : Energy balance of the new sludge line

CHP

The solids reduction rate in the CHP units is 30.6% for electricity generation, 50.4% for heat production and 19% is the expected loss.

The required electrical efficiency of the new CHP must be higher than 35% and the heat efficiency with the use of waste gas for regeneration i s a min. of 45%

Sludge drier

The sludge drier consumes 97.4 MWh/day and gets heat from 35.9 MWh of heat/day produced by the CHP and 61.4 MWh of heat/day from the boiler room using mainly natural gas as a source of energy. Therefore, it is assumed that the consumption of natural gas in the sludge drier will be approx. 68.2 MW/day.

Heat from the sludge drier will be used to heat primary sludge. The sludge drier produces ca. 53.4 MWh/day. This heat is in the form of 40 °C hot water obtained through steam condensation. A cooling unit is connected to this heat and, according to the energy balance, the cooling results in a loss of about 48 MWh/d.

THP unit

The energy for the THP unit is supplied from a steam generator that uses recovered heat from the exhaust gas from the CHP unit as the primary source of energy. The steam generators must be able to process both biogas and natural gas as a fuel.

The THP is supplied with 24 MWh/day from the steam generator so at to reach a temperature of about 140 °C.

3 Employer’s general requirements

3.1 Design requirements

3.1.1 Generally

It is required that the technological equipment be based on well-proven, operationally-tested technological units that are not prototypes. The delivered equipment shall be brand new, not used yet.
The required backup of individual equipment shall ensure the required availability of the equipment as per chapter 3.4.
The Contractor shall ensure the compatibility of the new equipment with the existing technological equipment of the Brno - Modřice WWTP, in particular with the water line, auxiliary facilities, to the extent in which the equipment is part of the Contractor's technical solution.
PID drawings - the marking of technological and process equipment (machines, instrumentation, etc.) according to the process schemes of the individual process units (Tag Numbers) must follow up and be in line with the existing system of marking of machines and equipment within the existing WWTP. Existing labelling system - see Annex 12.

3.1.2 Contractor's documents:

The Contractor shall prepare and submit for rewiev in accordance with the Sub-clause 5.2 of Particular conditions to the Engineer the following documentation:

- **Basic design:**

The documentation shall provide the Engiener with the basic information on the proposed design, in particular:

- basic design of civil structures, layout
- basic design of process units with technological schemes, list of basic machinery and equipment listing the manufacturer, type and parametres;
- basic calculations demonstrating the fulfilment of Employer requirements

- **Design documentation for the building permit:**

The documentation shall comply with all the requirements of Decree No. 499/2006 on Construction Documentation (as amended), and shall be in such a level of detail as to enable the competent public authorities or other state agencies to to issue their statements and binding opinions required for the issuance of the building permit and the building authority for the issue of the building permit. A copy of the correspondence with these authorities will be provided to the Engineer as part of the documentation submitted for review. The documentation shall be prepared in a structure specified in the Contract for Works.

- **Documentation to issue a change in the building permit:**

Documentation for the issue of a change in the land-use permit including the relevant documents for discussing the change in the permit with the relevant authorities and participants in the land-use proceedings (if required) is a subject of the Works if the design according to the Contractor's proposal will require a change of the issued land-use permit according to Clause 1.4.3 of the Employer's Requirements.
The documentation shall comply with all the requirements of Decree No. 499/2006 on Construction Documentation (as amended), and shall be in such a level of detail as to enable the competent public authorities or other state agencies to to issue their statements and binding opinions required for the issue of a change in the land-use permit and to enable the construction authority to issue the change in the land-use permit

- **Design documentation for construction changes before completion:**

If during the implementation of the Works there are changes that will require the issue of a permit to change the construction before completion, the Contractor shall prepare the design documentation in such a level of detail as to enable the governmental agencies and other relevant authorities to issue

their statements and binding opinions as a basis for the application to the construction authority to change the construction before completion

- **Detailed design documentation:**

The documentation shall meet all requirements in accordance with Decree No. 499/2006 on Construction Documentation (as amended). Other attachments to the documentation:

- PIDs indicating tag numbers (Tag No) and following the current system used at the existing WWTP - see Annex No.12.
- The breakdown of civil structures and operating units into items which will enable, upon completion of the Work, in accordance with Act No. 563/1991 Sb. on Accounting, as amended, and Act No. 586/1992 Sb. on Corporate Income Taxes, as amended, to include all parts of the Work in the Employer's Assets Register. The accuracy of the data contained in this annex must be confirmed and approved by a person authorized to verify the correctness of the classification of production in the relevant items of the Standard Classification of Production and Classification of Construction Works.
- The Contractor's documentation in the extent and level of details (including shop drawings) required for the implementation of the Works and for assessing the compliance of the proposed solution and procedures with the Contract.
- An overview of sampling points and consumption and media/energy production metering for inspection and tests carried out in accordance with Part 8 of the Employer's Requirements.
- Proposed points for the installation of necessary meters and sample taking for the purposes of control, monitoring and evaluation of technological processes.

- **HAZOP study**

The Contractor shall prepare and submit a hazard analysis and risk assessment, "HAZOP", together with a statement concerning the methods employed for the design, safe construction, operation and maintenance of the plant. The deadline for preparing and submitting the HAZOP study shall be included by the Contractor in the time schedule. The study will be developed according to IEC 61882 Hazard and Operability Studies (HAZOP). These documents will form part of the building documentation package. This will cover the analysis and assessment of hazards and risks associated with various soil conditions. The Employer reserves the right to participate in meetings concerning such analyses and evaluations.

- **As-built design documentation:**

The Contractor shall prepare and update a complete set of "as-built designs" of the Works showing the exact actual location, size and details of the works as they have been carried out. These records must be kept on the Site. Two copies shall be delivered to the Engineer prior to the start of the Tests on Completion.

The documentation shall meet all requirements in accordance with Decree No. 499/2006 on Construction Documentation (as amended).Other attachments to the documentation:

- PIDs indicating the tag numbers and following the current system used for the existing WWTPs.
- The breakdown of civil structures and process units into items, including the purchase prices and life time. which will enable, upon completion of the Works, in accordance with Act 563/1991 Sb. on Accounting, as amended, and Act 586/1992 Sb. on Corporate Income Taxes, as amended, to include all parts of the completed Works in the Employer's Assets Register. The accuracy of the data contained in this annex must be confirmed and approved by a person authorized to verify the correctness of the classification of production in the relevant items of the Standard Classification of Production and Classification of Construction Works.
- The Contractor's documentation in the extent and structure in which it has been agreed by the Engineer, which proves the details of the as-built documentation of the Works, e.g. reinforcement drawings, workshop documentation.
- Geometric Plan of the Works
- The geodetic part will be developed in the scope and details specified in the internal directive of the Employer SM 704 BVK - Development and Use of the GIS - Annex No. 13.

The as-built documentation issued after approval by the Engineer shall be handed over by the Contractor to the Engineer in a number of 6 complete copies. Works will not be considered completed until the Engineer receives these documents.

- **Supporting documents for the commencement of the testing operation:**

The Contractor shall prepare supporting documents for the commencement of the testing operation in accordance with the terms and conditions stated in the applicable building permit.

- **Other documentation not provided elsewhere:**

The Contractor shall prepare all other documentation that may be required, for example, by governmental agencies or utilities during the implementation of the Works as a result of the construction progress.

- **Documents for the application for the final acceptance certificate:**

The Contractor shall prepare all documentation (testing operation report, inspection reports, results of the required measurements, records of the final inspections etc.) required in the decisions, statements and opinions issued, which will form the basis for the Employer's application for the final acceptance certificate. Based on the approval by the Engineer, the Contractor will issue the complete documentation for the FAC in 6 copies.

- **Update of the operating regulations:**

The Contractor shall draw up an update of the operating regulations - see Chapter 3.10.7

3.2 Layout

The layout of the Works is provided in the land-use permit documentation on the basis of which the relevant land use permit was issued.
The land-use permit design documentation addresses the designed construction or reconstruction of facilities of the sludge management system at the Brno - Modřice WWTP.
The land-use permit documentation addresses the Works as follows:
Surplus sludge is designed to be thickened by thickening centrifuges followed by thermal hydrolysis of sludge, which will boost sludge stabilisation of the sludge while increasing biogas production of the WWTP sludge management system. The sludge stabilisation is designed to take place in four new above-ground circular tanks with integrated gas holders and common engine room. The sludge will be stored in two new circular above-ground tanks with a common engine room. Sludge dewatering should take place in thickening centrifuges. Dewatered sludge will be dried in low-temperature sludge driers in a two-line arrangement. Dried sludge will be stored in containers for the necessary period of time. The energy demand will be covered by a new sub-station. The heat demand for sludge drying will be covered primarily by the sludge drying boiler room. The heat needed to heat civil structures and thickened sludge before stabilisation will be supplied by the existing boiler room and heat plant. The steam demand for thermal hydrolysis will be covered by flue gases from the cogeneration units in combination with a steam generator. Sludge will be stored in an integrated gas holder in the digesters and in a free-standing membrane gas holder. Biogas will be desuplhurised in a desulphurisation unit before burning. Surplus biogas will be burnt in residual gas burners, if need be. The design includes connecting pipes and utility tunnels, service roads and pavements.
The existing sludge dewatering structure will be technologically decommissioned and the equipment will be removed. The structure will then serve as a storage.
Unused existing structures will be demolished. The existing digesters and sludge storage tanks will be demolished, including the engine room and existing warehouse No. IX located near the digesters, the existing mixed thickened sludge tank, flotation tank, flotation overflow pumping station, two existing membrane gas holders, membrane gas holder engine room, the existing desulphurisation unit, residual gas burners, shelters for the existing sludge drying and dewatering, biofilter for the existing primary sludge thickening building and biofilter for the existing sludge drying and thickening building. The sludge drying and thickening building itself will not be demolished.
For the avoidance of doubt, the layout proposed in the land-use permit documentation is not a mandatory requirement of the Employer for the land-use permit. The Employer does not exclude any other layout if all other requirements are met.
The Contractor shall keep land lot no.1977/48 in the cadastre of Modrice vacant as a reserve for the possible construction of two additional digesters of the same size in case of increased sludge load.
All technological processes must be equipped with sampling points for checks, inspections and analyses at least at the inlet and outlet of the facilities. These sampling points must be located in such a manner that they can be easily accessible to the operator, i.e. they must be equipped with platforms, ladders, stairs, etc., if necessary.

As regards newly constructed energy media (especially electricity, natural gas, biogas, heating water, steam), metering points will be installed in all places important for the purposes of operation, balancing, evaluation of guaranteed parameters and specific indicators, which will be introduced into the existing system of secondary energy metering.

The media and values of non-energy nature (e.g. sums of wastewater, service water, drinking water, sludge, chemicals, running hours, average temperatures, levels, concentrations, etc.) necessary for the purposes of balancing and evaluating the guaranteed parameters and metering indicators will be measured, monitored, balanced and saved in the SCADA system.
During the implementation of the Works, the WWTPs, including sludge management line, shall be kept in fully continuous operation.

3.3 Process requirements

To implement a new sludge line at the WWTP in Brno-Modřice ensuring the required sludge quality, the Contractor will include the following processes and equipment for sludge disposal in its Works:

- Surplus sludge mechanical thickening
- Thermal hydrolysis (THP)
- Mixed sludge pumping station
- Digesters with integrated gas holders
- Residual gas burner
- Desulphurization
- Gas holder
- Digested sludge storage tanks
- Digested sludge mechanical dewatering
- Sludge drier
- Sludge drying boiler room
- Dried sludge container stand
- Gas engines
- Boiler room and heat plant
- Biofilters for exhaust air treatment
- Connecting pipelines to existing water, natural gas and electricity distribution networks
- Connecting pipes, utility tunnels, landscaping, lighting, access roads and paved areas.

Furthermore, the Contractor is obliged to carry out the reconstruction of some of the existing buildings. These are the engine room, boiler rooms and heating plant, service water pumping stations, disinfection dosing and service water pumping, mechanical sludge dewatering and sludge drying.
Demolition of the existing sludge treatment facilities that will not be included in the future WWTP operation is also covered by the project.
The Contractor shall be fully responsible for the design, delivery and installation of the equipment, the testing operation and inclusion of all facilities, buildings, mechanical and electrical equipment, HVAC, control and monitoring systems, etc., in order to ensure full operation of the sludge line.
The technological equipment must be designed to enable easy use, operation and user-friendliness for the Employer.

3.4 Requirements for the plant

The Contractor shall include, inter alia, the following specific requirements of the Employer.
The final design of the plant is the sole responsibility of the Contractor.

3.4.1 Employer’s general requirements

- After the implementation of the Works, the Employer determines the permissible biological line load generated by return liquors from the technological processes of the Works as a max. of 1,114 kg Nt/d.
- The biological treatment process can be loaded up to the max. of 100 l/s of discharged supernatant.

- The maximum of 10.7 l/s of rainwater at a design rain of 15 min. and periodicity of 0.2 can be discharged into the on-site sewerage.
- Max. permitted drinking water consumption for the Works is 6 l/s.
- Wastewater (safety overflows) is discharged to the existing on-site sewerage in the following points:
- mechanical sludge thickening,digesters and storage tanks: DN 600, route along the road leading from the Storage 1 towards the activation reactors;
- The sludge drier including mechanical dewatering and boiler room (wastewater only): sewer DN 700/1050 is in a poor structural condition (see Annex No. 20). The Contractor will construct a new sewer in the section between points determined by the coordinates (JTSK Y 597254.18, X 1168292.55 and Y 597243.13, X 1168192.06 (in parallel with the utility tunnel) at the existing thickeners.
- Reject water from the new processes of mechanical thickening of digested sludge including cooling water from the sludge driers and mechanical thickening of surplus sludge will be connected to the activation feed pipe DN 2000, HOBAS , from the primary sedimentation tanks to the inlet to the intermediate pumping station, land lot no. 2069/1, cadastre of Chrlice, suitable connection points shall be determined by the Contractor.
- The on-site sewerage may only receive water from paved areas that could be contaminated as result of the operation– along the sludge drying and sludge dewatering facilities and along surplus sludge thickening, THP and mixed sludge pumping station: into the on-site sewerage with constructed retention infiltration structures.
- The roofs of newly-built sludge facilities must be drained using rainwater downpipes into surrounding areas and all water must be infiltrated.
- Facilities that are not within a reach of distribution from the newly constructed TS 1.4. (including temporary connections during construction),may use available reserve capacity in the existing substations TS 1.2 or TS 1.3. The Employer prefers the use of free reserves in substation TS 1.3 (except for the site accommodation connection). The available reserves may be used by the Contractor only with the consent of the Engineer.
- Available capacities in existing substations:
    - TS 1.2. - 3 x 250 site switchboard for the site accommodation is connected to this substation, it is also possible to connect another 1x 3 x 500 A outlet and 2x 3x 160 A outlets;
    - TS 1.3. - 2 x 3 x 250 A outlets can be connected.
- The CCTV, alarm and emergency system, electronic access control system, electronic fire alarm signalling, SCADA will be connected to the existing facilities in the sewerage control room;
- The new telephone lines will be connected to the existing system at the exchange in the office building.
- All equipment and other installations installed or affected by the Work will be labelled locally in accordance with the piping and instrumentation diagrams (PIDs).
- The site accommodation will be connected in the following points:
    - Water mains: water meter box, land No 2069/1; cadastre of Modřice;
    - Sewerage: manhole in the road, land No 2070/1, cadastre of Modřice, JTSK coordinates: Y 597162.5, X 1168414.0;
    - El. power: site switchboard, land No. 2069/1, cadastre of Modřice, permitted power input 3x250A.

  El. energy and water supply for the needs of the site accommodation will be paid by the Contractor to the Employer on the basis of installed submeters.

3.4.2 Surplus sludge mechanical thickening

Description
Secondary (surplus) sludge is extracted from the return sludge pipe in the activation tanks. The existing secondary sludge discharge pipeline must be connected to the secondary sludge thickening facility to be installed.
Surplus sludge will shall be stored in a secondary sludge tank with a volume of about 50 m³. This tank must be equipped with a stirrer and a safety overflow. The safety overflow will be connected to the newly constructed sewer which will be connected to the existing on-site sewerage.

Secondary sludge will be pumped from this tank by means of screw pumps into the mechanical thickening facility. Screw pumps will be installed in a 2 + 1 arrangement so that any of the pumps can feed the sludge to any of the mechanical thickening units.
Each mechanical thickening tank must be equipped with a flocculation station for the preparation and dosing of flocculants into the dosing pump connected to the thickener. The flocculant is dosed to the pipes by dosing pumps.
Reject water from the dewatering unit is drained into a sump. The reject water will be drained from this sump by means of submersible centrifugal pumps and will be fed into the existing inlet pipe of the intermediate pumping station. The submersible pumps will be installed in a 1 + 1 layout. The reject water sump will also receive water from the flotation station safety overflows.
Dewatered sludge is conveyed from the mechanical thickening tanks using screw pumps to the dewatered sludge buffer tank from which the dewatered secondary sludge is pumped by 1 + 1 screw pumps to the THP inlet.

Minimum requirements

Preferred technology:	Centrifuges
Number units:	2+ 1
Min. unit capacity:	2,350 m³/day
Min. total capacity:	30 t dry solids/day
Dry solids content (THP in operation):	16-18% dry solids
Dry solids content (THP out of service):	6% dry solids
Max. consumption of active polymer:	12 kg/ton of dry solids

3.4.3 Thermal hydrolysis

Description
Surplus sludge will be fed to the thermal hydrolysis (THP) process after being thickened. The thermal hydrolysis process result in sludge cell disintegration and the content will be released into a sludge solution. The sludge cell disintegration boosts biogas formation, improves dewaterability of anaerobically stabilised sludge and reduces its volume.
The THP process for surplus sludge treatment is based on steam expansion and increased pressure. Steam is formed using high heat (HH) from waste gases produced by the CHP units.

Minimum requirements

Preferred technology:	Thermal hydrolysis without additional chemicals
Number of units:	1
Min. unit capacity:	182 m³/day
Min. unit capacity:	30 t dry solids/day

3.4.4 Mixed sludge pumping station

Description
Thickened preheated primary sludge will be pumped into a new mixed sludge tank that will be located at the THP unit.
Hydrolysed secondary sludge will also be fed into a new mixed sludge tank. This tank will have a capacity of approx. 50 m³ and will be located near the THP unit.
The mixed sludge pumping stations will feed mixed sludge in a 2 + 2 arrangement (100% backup required): to stabilisation in four digesters.
Minimum requirements

Pump type:	Screw pump or eccentric screw pump

3.4.5 Digesters with gas holders

Description
Mixed thickened sludge is stabilised in four digesters. In order to achieve the lowest possible heat loss and effective stirring of the digester content, above-ground flat digesters are preferred.
The digesters must be efficiently stirred to ensure that SS concentration does not differ by more than 10% at any point inside the digesters. The digester content stirring will be ensured by a stirrer located

outside the digesters. In addition, measures must be taken to minimise sludge foaming in the digesters.
At the bottom of the digesters there must be manholes, DN 800, which must be provided with a flange.
The digesters will be equipped with a suitable sand and floating scum removal system.
The Contractor shall consider the use of integrated gasholders while ensuring minimum total biogas storage volume of 5,000 m3 in a situation when one digester is out of service.
An engine room will be constructed between the four digesters.
The primary heat source for heating the sludge in digesters will be surplus sludge, which will be heated by thermal hydrolysis and preheated primary sludge. In the case of THP downtime, the sludge fed to the digesters will be heated by an integrated hot-water pipeline inside the digesters. If THP is out of operation, surplus sludge will not be heated up to the high THP temperature. The heat demand for sludge heating will be covered by the boiler room through increased combustion of natural gas, whose consumption will be reduced by the use of high heat from the CHP which is primarily designed for THP and which is connected to the boiler room heating plant.
The digesters will be operated in two operating lines. One feed pump for filling the digesters with mixed sludge will be used for two digesters. The feed pumps will be located in a dry pit at the mixed sludge tank in the 1 + 1 layout. The digesters will be emptied using the buffer tanks. One buffer tank will be designed for each pair of digesters. From here, the sludge will be pumped by means of 1 + 1 screw pumps into two sludge storage tanks.

Minimum requirements:

Required technology:	Mesophilic digestion
Method of construction:	Cast-in-site concrete
Number units:	4
Min. unit volume:	3,375 m³
Min. retention time (at 40 °C) 16 days	
Min. unit capacity:	12.5 t dry solids/day
Inlet dry solids content:	6-8 % dry solids

3.4.6 Residual gas burner

Description
Surplus waste gas will be combusted using a new residual gas burner.
A pair of residual gas burners will be fitted to a foundation slab and connected to the biogas pipeline.
The residual gas burner is used to burn surplus biogas, if necessary.
Minimum requirements

Min. gas flow capacity:	24,000 m3/d

The equipment will be equipped with a 5-staged control system in a range of 20 to 100%.

3.4.7 Desulphurization

Description
All biogas produced in the digesters must be fed to the desulphurization plant for desulphurisation. The sulphur content of biogas can cause incrustation in gas installations, especially in the biogas combustion systems (boilers, cogeneration units). Therefore, the biogas must be stripped of sulphur up to the level of a harmless limit.
Accumulated biogas will be desuplhurised in the new desulphurisation station once pressure has been increased. Desuplhurised biogas will be fed by a new biogas pipeline to the points of consumption such as the existing boiler room, existing gas engines, and new sludge drier boiler room.

Minimum requirements

Min. gas flow capacity:	24,000 m3/d

3.4.8 Gas holder

Description
Biogas will be fed to the gas holders installed on top of the digesters or to a stand-alone gas holder. Biogas will be discharged from the gas holders by a pipeline to the point of consumption. At the biogas outlet from the gas holder there will be an auxiliary pumping station where pressure in the biogas pipeline will increase.

The gas holder will have reinforced concrete foundations. The gas holder includes a gas holder engine room. Biogas will be fed to the engine room by the biogas pipeline and the biogas discharge pipeline will also be installed here. Valves and fittings, including condensate drainage pipes, will be installed on the pipes. The biogas feeding and discharge pipeline will be equipped with a direct connection allowing for the gasholder bypass.

Minimum requirements

Preferred technology:	Spherical triple-membrane gas holder
Minimum total volume of gas with one digester out of operation:	5,000 m³.

3.4.9 Digested sludge storage tanks

Description

Stabilised mixed sludge will be temporarily stored in covered sludge storage tanks of sludge of the same shape as a VODOJEM and then pumped to the sludge dewatering plant.

The volume of sludge storage tanks will not be fully utilised during normal operation and will provide a reserve for the storage of stabilised sludge during maintenance and downtime of the sludge dewatering and drying facilities.

The sludge storage tanks will be equipped with a top-mounted agitator. Stabilized mixed sludge will be pumped from the sludge storage tanks by pumps in the 2 + 1 arrangement to the dewatering system.

H_2S and methane sensors will be installed to control the ventilators (start and stop).

At the bottom of the storage tanks there will be manholes, DN 800 profile, protected by flanges.

Minimum requirements

Method of construction:	Cast-in-site concrete
Number units:	2
Min. unit volume:	4,500 m³
Min. retention time in the unit:	5 days
Type of pump:	screw

3.4.10 Digested sludge mechanical dewatering

Description

Stabilised mixed sludge is pumped from sludge storage tanks to the mechanical sludge dewatering system.

Mechanical sludge dewatering is carried out by means of dewatering centrifuges which dewater the sludge to a min. 28% dry solids content. Clarified reject water will be pumped upstream the storage pit back to the treatment process. The reject water will be drained from this sump by means of submersible centrifugal pumps and will be fed into the existing inlet pipe of the intermediate pumping station. The reject water pit will also collect water from the flotation station safety overflows.

In order to ensure good mechanical dewatering of sludge, a flocculant must be dosed to the mixed stabilised sludge feeding pipe. The flocculant will be added to the pipe in order to improve sludge dewatering properties. The flocculant will be supplied in the form of a powder that will be mixed with drinking water in the automatic flocculation station. Dewatered sludge will be pumped into two sludge drier lines or into an outside storage tank storing dewatered sludge. The storing "big bags" will be located at the flocculation station.

The transport equipment must be installed under the sludge storage tank so that dewatered sludge can be extracted. A sludge tank will be used in the event of a breakdown or long-term downtime of the sludge driers.

Dewatered sludge is pumped to the dewatering centrifuges using 2 + 1 screw pumps to two sludge drying lines or the outdoor sludge dewatering tank. The sludge tank will serve as an emergency solution for the storage and removal of dewatered sludge at the WWTP.

Minimum requirements

Preferred technology:	Centrifuges
Number units:	2+ 1
Min. unit capacity:	440 m³/day
Min. unit capacity:	19.5t of dry solids/day
Solids content:	28% dry solids
Max. consumption of active polymer:	4 - 12 kg/ton of dry solids
SS in reject water:	1,500 mg SS/l
Sludge storage tank:	100 m³

3.4.11 Sludge drying

Description
A low-temperature sludge drier in a two-line layout will be installed to dry dewatered stabilised sludge.
After sludge dewatering, each sludge drying line wil be fitted with one input bunker (sludge drier tank) for dewatered sludge. This special bunker will be equipped with a self-emptying hydraulic system that will deliver the sludge to a pumping system that will convey the sludge directly to the drier.
The dewatered sludge will be transported to the bunker from the sludge dewatering system and the bunker will also be filled directly using a mobile system (trucks, containers mounted on trucks, etc.). Sludge temporarily stored in the dewatered sludge tank will also be dried after dewatering using mobile equipment and transported from the sludge tanks to the containers.
The sludge drying line consists of the drier, air scrubber and a condensing unit that can be connected to the sludge drier.
Exhaust air from sludge drying will be vented out to the atmosphere through biofilters after being treated in the scrubber. The air scrubber chemicals will be stored in barrels located at each drying line.
Condensed and heated cooling water from the sludge dryer will be used to preheat primary sludge and then discharged through the reject water tank from the sludge dewatering system to the existing inlet pipe of the intermediate pumping station.
Dried sludge will be pneumatically conveyed on conveyors and stored in two special dried sludge silo, each with a volume of 100 m3. The silo for the dried sludge will be inertised with inert gas (nitrogen). The source of nitrogen will be a nitrogen generator located outside the building.
The dried sludge will be filled to the silos protected by inert gas using a special filling system in order to avoid undesired air escape into the silo. The dried sludge will be conveyed from here to containers which shall be stored for a necessary period of time needed for dried sludge sampling at the dried sludge container stand. After this, the containers with dried sludge will be transported outside the WWTP site for disposal.
A separate building shall be constructed for each of the sludge drying lines. The buildings shall be located near the sludge dewatering facilities.

Minimum requirements

Preferred technology:	Belt drier Low temperature system (less than 100 °C)
Number of units:	2
Min. capacity (per unit, i.e. 60% of the total):	87 m³/day
Average yearly capacity (total):	38,690 t of dry solids/year
Min. dry solids content, output:	90 % dry solids
Min. number of running hours of each line:	7,500 h/year

The quality of output sludge must be in line with the requirements for its mass and energy recovery at the CEMO cement plant:

granulometry	0-15 mm
dry matter content in dried sludge	min. 90 %
temperature	max. 40 °C.

3.4.12 Dried sludge container stand

Description
The dried sludge container stand are two separate structures with a covered area. Each container stand will be fitted with 14 closed containers with a capacity of 20 m3/container. The containers will be used for intermediate storage and for removal of dried sludge for disposal outside the WWTP site.
Minimum requirements:

Container volume:	20 m³
Total number of containers:	28 pcs

3.4.13 Sludge drier boiler room

Description
The source of heat for sludge drying shall be new boilers for both biogas and natural gas located in a new boiler room, which shall be integrated with the sludge dewatering facility.
Other heat sources to be used for sludge drying in order to utilise thermal energy at the WWTP and in order to reduce the volume of purchased natural gas are low temperature heat from the cogeneration units located in the existing gas engine building and excess high heat from the cogeneration units. Both these heat sources shall be fed to the sludge boiler room heating plant.
A separate set of dual-fuel boilers in the 2 + 1 configuration will be installed for each sludge drying line.
Minimum requirements

Type of boiler burners:	Dual fuel
Fuel:	Natural gas, biogas
Total boiler capacity for each sludge drying lines:	2.75 MW
Total boiler capacity for both sludge drying lines::	5.5 MW

3.4.14 Gas engines

Description
A new cogeneration unit will be located in the existing gas engine building.
The new cogeneration unit shall serve to generate electricity, low temperature heat to cover part of the heat demand of the sludge drying process and steam generation from flue gases produced by the cogeneration unit for thermal sludge hydrolysis.
There are two existing cogeneration units in the gas engine building, which are currently equipped with a heat exchanger for heating diathermal oil from the cogeneration unit waste gases. This heated oil is currently used to cover the heat demand of the sludge drying process. During construction, the existing diathermal oil heating recuperator using flue gases produced by the cogeneration units will be dismantled and replaced by flue gas steam generators. These generators will be located in the adjacent building housing the existing boiler room and heating plant and the waste gas will be conveyed to these generators by a pipeline.
The building will be connected to a new biogas system. The connection of the facility to natural gas will be maintained.
Minimum requirements:

Fuel for the co-generation units:	Natural gas, biogas
Number of units:	1
Capacity, electrical power:	0.5 MW
Electrical efficiency	> 35 %
Total efficiency	> 80 %
Operational time between oil change	> 1000 hours

3.4.15 Boiler room and heat plant

Description
The boiler room and heating plant are an existing building.
There are eight positions for boiler installation in the existing building. In the boiler room building there are five hot water boilers type Roucka Slatina VKP 400 S with a total nominal heat input of 3,190 kW. The four existing boilers are equipped with dual-fuel burners and can burn both natural gas and biogas. The four existing boilers shall be replaced by four new boilers installed on the original foundations. The fifth existing boiler shall not be replaced.
The boilers shall be used to heat buildings with the average (operating) building heating demand being 0.58 MWh/d. The maximum heat demand for heating the buildings is approx.1.27 MWh/d. The new installed boilers will be used as an alternative source of heat for the digesters in the event of the THP downtime (maintenance, breakdown). The average (operating) heat demand for the digesters is approx.1.4 MWh/d.
These boilers must be complemented with three steam generators, which will generate steam from waste gases using two existing and one new cogeneration unit. The heating plant will also be reconstructed.
A water treatment plant for steam generation will be constructed.

The existing building heating loops shall be kept for the non-demolished buildings. New building heating system and technological heating circuits shall be installed. There shall be a heating system for the new digesters and a separate steam distribution circuit for the for thermal sludge hydrolysis. In addition, the heating loop of the sludge dryer from the cogeneration units shall be added. The building shall then be connected to a new biogas loop. The connection of the civil structure to natural gas shall be maintained. The heating water treatment plant shall be reconstructed.

Minimum requirements for boilers:

Type of boiler burners:	Dual fuel
Fuel:	Natural gas, biogas
Number of boilers:	4
Total capacity per boiler:	0.7 kW
Minimum requirements for steam generators:	
Fuel:	Waste gas, natural gas
Min. total output of steam generators:	1,300 kg steam/hour

3.4.16 Service water pumping station

Description
At the WWTP outlet there is an existing pumping station, which pumps water from the WWTP effluent to the disinfection dosing and pumping facility. The existing service water distribution starts at this facility. Water pumped water from the outlet, once disinfected, is used as service water for the entire WWTP area. Given the increasing demand for water for the produced dried sludge volume it is necessary to increase the capacity of the service water pumping station. The pump and pressure piping will be replaced and the necessary construction work will be performed.

Minimum requirements:

Pump lay-out:	2 + 1

3.4.17 Disinfection dosing and pumping station facility

Description
Water taken from the WWTP effluent is pumped from the WWTP outlet pumping station to the disinfection dosing and pumping facility. Together with the increased capacity of the pumping station at the outlet it is necessary to boost the capacity of water disinfection from the WWTP outlet. Also, the distribution pumps supplying disinfected service water to the on-site water supply network will be replaced with higher capacity pumps. As regards the service water delivery pipe from the service water PS, the existing micro sieve will be replaced with a new one with a higher capacity, corresponding to the hydraulic capacity of the service water PS. From the point of view of construction works, the existing concrete foundation blocks of the service water distribution pumps will be refurbished and new openings will be made in the wall for new water delivery pipeline from the WWTP outlet.

Minimum requirements

Pump lay-out:	2 + 1

3.4.18 Biofilters

Description
New biofilters treating waste air from the new sludge line facilities will be established.
The biofilters will be buried in the ground. They will be located a concrete foundation slab. Air, sprinkle system and signal cable will be brought to the biofilters. The biofilter will be equipped with a sprinkle system and active medium. To monitor proper functioning, the biofilters will be fitted with necessary metering, at least pH metering at the outlet and fed air temperature metering.

Minimum requirements
The following new biofilters will be established:

- Two new biofilters to treat waste air from the sludge drying facilities. Each biofilter will be designed for one sludge drying line. Waste air from sludge drying will be discharged through the biofilters into the atmosphere after treatment in the air scrubber located in the sludge drying facility. The dewatering system shall be in the form of a pipeline that will discharge into a supernatant pit from the surplus sludge dewatering init.
- One new biofilter will treat waste air from the sludge dewatering facility and sludge storage tanks. The waste air from the facilities will be discharged through the biofilter into the air. The dewatering system shall be in the form of a pipeline that will discharge into a supernatant pit from the surplus sludge dewatering init.
    - One new biofilter will treat waste air from the primary sludge dewatering facility, mixed sludge pumping station and digester machine room building. Exhaust air from the facilities will be discharged through the biofilter into the air. The drainage will be ensured by a pipeline discharging into the on-site sewerage system..

3.4.19 Buried connecting tunnels

Description
Underground connecting tunnels will connect the existing structures with the new sludge treatment facilities.
Connecting pipes will be installed in the connecting tunnels and will therefore form a joint connecting route.
The connecting tunnel will form two branches connected to the existing connecting tunnel. The existing installation tunnel leads between the existing digesters and the existing blower house. One branch will connect the existing tunnel with new sludge drying and dewatering facilities. The second branch will form an extension of the existing tunnel and will connect the new facilities processing surplus, mixed and stabilised sludge with the existing tunnel.
The tunnel will house sludge pipes, hot water heating, steam pipes for THP and drinking and service water pipes.

3.4.20 Connecting pipelines

Description
New sludge treatment facilities will be connected to the existing pipeline network through new routes:

- The thickened primary sludge pipeline will be connected to a new line in the existing installation tunnel at the primary sludge thickening facility.
- The surplus sludge pipeline will be connected to the existing site pipeline buried in the ground behind the activation tanks.
- The drinking and service water pipeline will be connected to the existing site distribution system in the installation tunnel.
- The new hot water pipeline needed to heat new structures, to heat sludge for stabilisation and to boost sludge drying heating will be connected to the existing boiler room.
- The new steam pipeline will be connected to the existing boiler room.
- The natural gas pipeline will be connected to the existing natural gas pipeline at the existing boiler room.
- The new biogas pipeline will also be connected at the existing boiler room.

As regards pipes or other lines installed on pipe trays, the minimum headroom of 4.5 m must be respected. As regards over-ground lines, the installations must be insulated (freeze / overheating protection or other operating reasons) if required by the conveyed medium.

3.4.21 Transformer station TS 1.4

HV distribution system: 3 ~ 50Hz, 22kV, IT (r)
LV distribution system: 3PEN ~ 50Hz, 400/230V, TN-C
Protection against dangerous contact according to ČSN 33 2000-4-41:
LV part: Automatic disconnection from the power source

HV part: Automatic disconnection from the power supply - earthing in the IT network
Increased protection: Equipotential bonding (to the same potential)
Power balance: Pi = 2100 kW
Pp = 1200 kW

Power supply of TS1.4 by a 22 kV cable line from the existing cable distribution system at the WWTP. A 22 kV cable branch between the TS1 main transformer station and the TS1.2 substation installed along the new substation TS1.4. is interrupted at the point of connection and ”looped” into TS1.4.

3.4.22 SCADA

The SCADA system concept for the Works shall respect the following conditions:

For HMI, the Wonderware InTouch process visualization is currently deployed, installed in 2012 - Wonderware historian software and a set of support applications. (AS viewer, DB Client, etc.). The new sludge management system design will be integrated into the existing SCADA system so that the operator can use a uniform environment controlled from a single workstation. The existing system is developed in the form of a redundant solution to operator workstations, where two dispatcher workstations located at the WWTP control room are equipped with 2 large LCD panels that can display most of the technology simultaneously and other workstations (8 pcs) are located at the plant with LCD touch sensitive panels used for local control by the staff in charge of the relevant technological part of the operation. This system will be kept after the Works completion. Likewise, all SCADA functionalities will be maintained or expanded so as not to reduce the existing user comfort.
SCADA HMI processing will maintain the existing solutions that optimise system interventions by not requiring multiple application modifications (dispatcher workstations vs. local workstations) at the same time but only the master application modifications.
The Works will include SCADA HMI updates to the latest available version, including migration of existing technology. The OS of the stations will be migrated from the existing MS Windows 7 to MS Windows 10 (current OS version at the time of the Works handover).
All HW workstation equipment will be migrated to match the OS manufacturer's HCL.
The user interface will be provided via faceplates for individual technology components, assuming the use of the existing SCADA HMI user concept. This also implies the use of the existing KDM standard library.
A major change compared to the current condition of the original sludge management will be made at the level of process signal collection and connection of sensors or actuators in the form of distributed peripheries of the control system.

3.4.23 Low-voltage power distribution system:

Intrusion and hold-up alarm systems (in Czech PZTS), Electronic access control system (in Czech EKV):
The existing combined PZTS and EKV system will be used, and the PZTS and EKV installation for new facilities must be fully compatible with the existing system.
In case of explosive atmosphere, the wiring and all system components will bypass these areas.

Closed Circuit Television (CCTV)
The camera points housing cameras will be interconnected by an optical network and connected to the existing CCTV network. The newly added points must be designed to be fully compatible with the existing CCTV system.

Electric fire alarms (EPS)
The existing EPS system has been reconstructed and expanded according to the requirements of PBR approved in the land-use permit documentation. System lines with fire alarms will be connected to the individual facilities. Exits from the facilities will be fitted with alarm push buttons. According to the fire safety requirements, dedicated fire equipment and sirens will be connected to the electric fire alarm system in the facilities.

3.4.24 Telephones

As part of constructing the new sludge management at the WWTP, new telephone cabling will be installed in the existing facilities. The cables will be laid in the WWTP premises in joint underground cable routes, which are part of the construction works to be delivered.
There is an existing telephone exchange in the office building, which will also be used for new telephone facilities.

Required location of telephones

- Digesters and storage tanks
- Surplus sludge thickening
- Digested sludge dewatering
- Digested sludge drying 1
- Digested sludge drying 2
- Transformer station TS1.4

3.4.25 Demolition of the existing facilities and equipment

Description
The existing sludge management facilities shall be functionally replaced by new facilities. During construction, the existing sludge management system shall, however, be in operation. Only short-term interruptions can be made when connecting new pipeline routes to the existing ones. These downtimes must be planned with the WWTP operators so that their impact on the wastewater treatment process is minimal.
Upon completion of the construction and full commissioning of the new sludge management facilities, the existing structures will be decommissioned.
Unused existing structures and installations shall be demolished. Decommissioning of the existing technological equipment will be carried out in accordance with the operator's instructions.
The existing digesters and sludge storage tanks shall be demolished, including the machine room, the existing mixed thickened sludge tank, flotation tank, flotation overflow pumping station, two existing membrane gas holders, membrane gas holder engine room, the existing desulphurisation unit, residual gas burners, shelters for the existing sludge drying and dewatering, biofilter for the existing primary sludge thickening building and biofilter for the existing sludge drying and dewatering building. The sludge drying and dewatering building itself will not be demolished.
The existing sludge dewatering structure shall be technologically shut off and the technological equipment shall be removed. The existing Babcock sludge drying boiler shall also be dismantled. This structure shall be used as a storage room in the future. For available information on the existing structures to be demolished - see Annex No. 14.
Any material produced by the demolition and removal of the buildings, structures and other facilities listed above must either be reused or transported off the Site, provided that all relevant standards are followed.

3.4.26 Roads and hardstanding surfaces

The new facilities will be connected to the existing site roads through new roads and paved areas. New roads will be constructed for the new sludge management facilities so as to enable easy access to them and to provide sufficient handling space for the container transport equipment (sludge drying, sludge dewatering and dried sludge storage facilities-containers). The road load capacity will be 26 tons per vehicle. The road structure will be designed for class V of traffic load with the design level of road damage D2.

3.4.27 Pipelines including bridges

For overground pipes and other networks it is necessary to observe the under-crossing height of the load bearing structures in a min. of 4.5 m.

3.4.28 Landscaping

Landscaping will consist of existing tree and shrub clearing and felling and planting of new trees and shrubs in vacant grassy areas. Landscaping will consist of earthworks required after demolition and construction of buildings. The existing terrain at the WWTP area is flat and the elevation will be kept.

3.4.29 Street lighting

Description
The facilities shall include outdoor lighting in the area of the new sludge management.
Minimum requirements
The outdoor lighting shall be divided into two branches, each branch shall individually switchable and allows operational (all lights on) and economical operation (every third light on). In the economical mode the individual branches shall be connected to different phases so as to achieve a uniform loading of the network.
Outdoor lighting control and switching shall be done in automatic mode from the control system or manually from the switchboard.

3.4.30 Requirements for temporary relaying

Temporary relocation of pipelines and cable lines shall not restrict the operation of the existing WWTP. Each such relocation shall be discussed and approved by the Engineer prior to its implementation. The Contractor may not start any work related to temporary relocations without the consent of the Engineer.

3.5 Requirements for the completion of the Works

The Works will be completed and ready for handover once:

- the Works have been completed in structural terms and will manifest no defects and oustanding work save for minor defects and outstanding work not preventing from proper use;
- one-year testing operation of the Works has been successfully completed;
- the performance guarantee tests have been completed;
- verification tests have been successfuly completed;
- documents for the final acceptance certificate have been submitted
- the updated Operating regulations have been submitted

3.6 Environmental protection requirements

3.6.1 Noise

Noise emissions produced by the wastewater treatment plant must be checked. Noise coming from buildings must comply with all health and safety regulations with respect to noise levels, tone effect and exposure to noise nuisance.
Noise emissions produced as a result of the implementation of the Works shall not result in exceeded limits for the whole WWTP including new technologies in accordance with the valid regulations, in particular Government Regulation 272/2011 Sb. as amended. Compliance with the noise limits shall be demonstrated by the Contractor during the Tests on Completion.

3.6.2 Odour

The Contractor shall ensure consistent elimination of potential odour emitted to the ambient environment by the operations of the Contractor during the execution of the Works. At the same time, the Contractor shall eliminate the risk of odour nuisance after the completion of the Works (roofing, forced ventilation and installation of efficient biofilters).

3.6.3 Emissions

The new stationary sources within the meaning of the Act on Air Protection put into operation from 20th December 2018 and later must meet stricter specific emission limits set by the Employer as follows:

Table 11:

Type of source	SO_2 mg/m^3	CO mg/m^3	NO_x mg/m^3
Stationary source of combustion with an output over 1MW (natural gas)		45	90
Stationary source of combustion with an output over 1MW (biogas)	100	45	90
Piston type internal combustion motors over 1 MW (gas fuel)	107	600	450

Specific emission limits are recalculated to the dry gas in normal conditions for reference content of oxygen in carrying gas 3% for boilers and 5% for combustion engines.

The Contractor is also obliged to fulfill other requirements for specified sources of air pollution pursuant to the Act on Air Protection No. 201/2012 Sb. and implementing decrees, as amended.

3.7 Design service life

- Individual parts of the Works will be designed to achieve a minimum lifetime as follows given continuous (24 hour) as well as intermittent operation and local weather conditions:
- Concrete structures: 50 years
- Steel structures: 30 years
- Pipelines: 50 years
- Machines, equipment, fittings, couplings, ironwork 20 years
- Cables: 25 years
- Electrical installations: 15 years
- Process control equipment, PLC 10 years
- Process control equipment, PLC 5 years
- Instrumentation: 10 years

3.8 Regulations, norms and standards

Design documentation, Contractor's documents, the execution of the Works and completed Works must be in accordance with Czech legislation and technical standards and, if not available, in accordance with EN standards. The overview of relevant legal regulations and standards - see Annex 15 - serves as an aid, it is not an exhaustive list. If a legal regulation or a standard is not listed in this overview, this does not mean that the Contractor may not need to comply with such a regulation.

3.9 CE marking

The Contractor shall ensure that the total plant and all parts of the sludge management plant shall be CE-marked in accordance with the directives and relevant regulations, norms and standards concerning mechanical equipment.
CE marking shall include all required activities as described in the directive, including:

- Technical Documentation
- Risk assessment
- Declaration of Conformity
- Operation and maintenance manuals

The Declaration of Conformity must contain an overview of all directives relevant to the sludge treatment facilities and other standards related to the Works.
It is the responsibility of the Contractor to obtain all relevant documentation from its subcontractors and other entities in relation to the implementation of the Works.

3.10 ATEX (Explosive Atmospheres)

The Works shall be in line with Government Decree No. 409/2004 Sb. on further requirements for occupational health and safety in in an environment with an explosive atmosphere, as amended
The Contractor shall, as part of the documentation, update the document titled External Impact Category submitted as a supporting document by the Employer and shall include facilities constructed as part of the Works. The currently valid External Impact Category document will be handed over to the Contractor upon handover of the Site.

3.11 Requirements for the implementation and completion of the Works

3.11.1 Execution of work during operation

The Contractor will carry out the work during full operation of the WWTP and the Contractor's operations shall not restrict or endanger the operation of the existing WWTP or cause any damage to the Employer or any third party.

3.11.2 Safety precautions

All technological equipment including the supply points must be readily accessible for service and maintenance and must be designed in accordance with applicable safety regulations.
In order to ensure safe operation, all equipment and installations must be marked in accordance with the PIDs.

3.11.3 Quality assurance system

In order to meet the requirements of the Contract, the Contractor shall elaborate and establish (in accordance with the provisions of Article 4.9.of the Particular Conditions) a Quality Management System (hereinafter "QM System").

In general, the QM System must include the duties and obligations of the Contractor, the Employer and the Engineer with regard to meeting the requirements of the Contract.
The Contractor shall ensure that the QM System complies with applicable Czech standards and is in compliance with international ISO standards.

The Contractor will be actively engaged in the preparation of the quality management procedures of the individual sub-contractors in order to harmonise their procedures with the Contractor's QM system during the designing and implementation of the Works. Discussions related to the preparation of quality management procedures will be attended by the following parties based on the nature of the discussions: Contractor, Subcontractors, Employer, Employer, Engineer,

The first meeting will take place no later than 15 working days after the Engineer receives the QM system from the Contractor in accordance with sub-clause 4.8 of the Particular Conditions.
The Contractor will be responsible for maintaining the current QM System in accordance with the quality management procedures and contractual requirements.

Minimum requirements for the QM System:

a) Scope of the QM system use

b) Organization and human resources The QM System defines the organisation of the Contract execution including organisational charts, in particular:

- Discussions concerning the quality management process preparation;
- Discussions concerning the progress of the Works;
- Organisation of internal and external checks;
- Description of the function and responsibilities of persons involved in the Contract execution;
- It specifies the maximum percentage of temporary staff engagement.

c) Checks of designing work

- The QM system includes in particular:
- Allocation of tasks amongst subcontractors;
- Types and list of documents to be submitted to the Engineer
- Procedures for identifying critical points;
- Procedures for checking drawings and documentation

d) Checks of documentation, workflow

The QM system includes in particular:
- Rules for document identification;
- Rules for distributing various documents
- Documentation management methods (distribution, classification, archiving).

e) Procurement

The QM system includes in particular:
- List of suppliers and subcontractors.
- Procedures for addressing the Engineer's requirements
- Subcontractor evaluation process

f) Implementation and testing

The QM system includes in particular:
- List of documents and procedures defining the implementation, resources and sequence of operations;
- Procedures for compiling a list of critical points of implementation, inspections and tests
- Internal control procedures for concerning subcontracted tasks;
- Control procedures for delivered products;
- Inspection and testing procedures during performance;
- Procedures for final inspections and tests prior to their acceptance by the Engineer;
- Procedures for document management (distribution, classification, archiving).

g) Non-conformities

The QM system includes procedures for identifying, evaluating, and resolving identified non-conformities.

h) Protection of equipment on site

The QM System provides procedures for drawing up list of equipment to be protected and description of appropriate measures.

i) Annexes

- Design work planning;
- Work planning work
- Subcontractors address books

Quality audits:
The Engineer may at any time perform an audit of the Contractor's Quality Management procedures during the design preparation and implementation of the Works. This audit will be carried out in accordance with the Contractor's QM System and on the basis of the quality management procedures.
The auditor will draw up an audit report listing the identified non-conformities no later than three weeks after the audit
Within 10 days starting from the date of the receipt of the auditor's report, the Contractor shall propose in writing the corrective actions intended to be implemented, their planning and the names of persons responsible for the implementation and control of these remedial measures.

3.11.4 Safety on site

To ensure site safety, the Contractor shall follow these guidelines:

- ensure that the Works are implemented in accordance with generally binding legislation on occupational health and safety, fire and environmental protection;
- ensure occupational health and safety for the staff performing work as per the Contract for Works and provide them with protective equipment and H&S precautions trainings;
- ensure compliance with internal regulations issued by the Employer: ZO 009 Traffic regulations, SM 015 Occupational Health and Safety Assessment and Risk Management, SM 105 Occupational Safety and Health Management and Traumatology Plan, SM 106 Occupational Injuries, SM 107 Fire Protection - see Annex No. 9.

3.11.5 Contractor’s operations at the site

Permitted el. energy consumption during the implementation of the Works - the Employer has an agreed reserved capacity under the electricity supply contract, the exceedance of which is subject to a charge. The Contractor will install connection points to the existing el. distribution system fitted with electric meters and protection as per the required el. input. The Employer will increase the reserve capacity by such a required power input with the distributor and the associated costs shall be borne by the Contractor.

Site traffic: The Contractor is allowed to use only those site roads that are defined in Annex No. 16. For the safe movement of vehicles at the Site, including the access routes within the site, the Contractor shall provide temporary traffic signs, which will be agreed upon prior to their installation by the Engineer. Temporary traffic signs will respect the individual construction stages and the operational needs of the Employer.

Working hours at the site:
It is expected that the normal working hours during the construction period will be:
7 a.m.- 6 p.m. from Monday to Friday
7 a.m. - 12 a.m. on Saturday
Working outside these working hours will be subject to the consent of the Engineer who will not reject such request without serious reason.

3.11.6 Characteristics of the environment

In general
In order to address the environmental impacts associated with the Works, the Contractor shall submit an Environmental Management Plan (EMP) together with the construction detail design.
This EMP will include, inter alia, the following:

- Solid waste disposal in the form of all building materials and surplus and waste materials in an environmentally safe manner; this material should be recycled to the greatest extent possible and, if this is not possible, it should be transported off site to a suitable landfill site.

- Liquid waste management in relation to possible leakages of flammables and chemicals used during the construction should be performed in an environmentally safe manner outside the site in accordance with applicable legislation;
- Minimising the impact of the equipment in relation to the use of heavy machinery with a view to protecting human health and the environment. This includes minimising emissions of noise, dust and accidental leakage of harmful substances that can lead to contamination of drinking water;
- Sanitary waste disposal in the form of waste produced by the staff on site will be performed in an environmentally safe manner;

The Contractor must comply with the requirements of the relevant environmental protection authorities and obtain the necessary permits in this respect.
In addition to the measures described above, the environment must be protected against noise, vibration and dust as described below.
Control of the noise level during construction
In general, the Contractor will ensure that the impact of noise caused by the construction activities is minimised through good maintenance of the site and plant. For this reason, the Contractor will use the best practical means to minimise noise caused by its activities, including plant maintenance.
All vehicles and machinery used on site shall be equipped with effective exhaust silencers and shall be maintained in good and efficient operation over the duration of the Works. Machines in intermittent operation must be shut down or their performance limited to a minimum at the time in between the operation. The Contractor will remove all equipment from the site that is inefficiently silenced according to the opinion of the Engineer. All compressors must be "low noise" with acoustic covers, which must be permanently closed when using the machines. All auxiliary pneumatic impact tools shall be equipped with shock absorbers or systems of a type recommended by the manufacturer. Pumps and mechanical static equipment must be placed in acoustically silenced cabinets or shielded according to the instructions of the Engineer.
Any equipment such as generators and pumps that will operate outside normal working hours must be located in acoustically silenced areas.
Piling, including temporary piling, will be performed using recognized noise reducing systems. Without a written consent of the Engineer, the piling must not be installed before 08:00 a.m. or after 18:00 p.m.
Vibrations during construction
The Contractor shall take all necessary measures to minimise vibrations caused by the equipment and machinery used on site. It is not allowed to use any equipment that uses heavy load-lifting system, either on the basis of mechanical force or gravity, to break pavement or foundations. Vibrations will be monitored by vibrometers on the basis of instructions given by the Engineer. Vibrations associated with mechanical equipment must not exceed 2.5 mm/s in the form of maximum particle velocity in any perpendicular direction at the boundary of the relevant land
Dust emissions during construction
Due to the nature and extent of the Works to be carried out on site, dust may be blown in the prevailing wind direction over adjacent land plots located near the area where the construction work will be carried out. The Contractor will keep dust emissions as low as possible in accordance with procedures for proper site management. If the dust emissions on site turn out to be an issue, the Contractor shall take the following measures on site:
- windbreaks at soil heaps;
- conveyors, trucks and other means of transport will be of a covered type;
- materials will be covered with plastic covers;
- Compaction using binding materials and
- the top soil layer will be sprinkled.

3.11.7 Employer's staff training

Until the issue of the Taking-over certificate, the Employer's staff will only operate the new Works under the supervision of the Contractor, who will be fully responsible for the operation of the Works and the training of the Employer's staff at that time. The Contractor will check the number and qualifications of the Employer’s staff and will train the personnel allocated by the Employer so that they can provide the Contractor with the necessary assistance during the trial operation.
The Contractor is responsible for ensuring that the operation and maintenance personnel acquire the skills necessary to operate, maintain, service and repair all equipment at the new sludge management plant. The Contractor is also responsible for ensuring that the operation and maintenance personnel acquire full knowledge of the use of the Operation and Maintenance Manuals.

The Contractor will prepare a Training Plan for the approval of the Engineer at least one month before the intended start of the first training. The plan shall contain an outline of the courses, duration, subjects to be taught, documentation to be issued, names and qualifications of instructors, etc.
The overall purpose of the training is to enable the staff to:

- understand the sludge treatment processes
- operate the equipment in an optimal way,
- carry out the necessary adjustments and corrections,
- undertake correct preventive and normal maintenance,
- undertake trouble-shooting and repair of all equipment and auxiliaries installed,
- adjust all equipment to optimise the plant,
- operate and understand the SCADA system,
- select the necessary spare parts,
- intervene in case of disturbance, and
- understand environmental aspects in relation to odour, safety etc.

All equipment and manuals needed for the training shall be provided by the Contractor and handed over to the Engineer before commencement of the training.
Personnel having an expert knowledge of the subjects and a proven record of experience in teaching adults shall undertake the training. Instruction and demonstration shall be given at appropriate levels for skilled and semi-skilled personnel and for plant operators. Separate courses for different categories of staff may be necessary depending on number of staff to be trained.
The training shall be given in the Czech language, if necessary by use of interpreters provided by the Contractor. Documentation of the training carried out shall be submitted to the Engineer prior to the trial operation.
The training will include both a theoretical and the practical part. Emphasis will be put on practical exercises that will last at least fifty (50)% of the training time.
The practical exercises shall include normal maintenance activities, adjustments, use of tools, measuring equipment and workshop facilities included in the plant.
The following areas will be included in the training:

- Basic process design of the plant
- Principles of basic unit processes
- Principles of process optimisation
- Process troubleshooting

The following areas will be included in the training concerning the operation of mechanical equipment:

- Basic principles of mechanical components (pumps, mixers, gas engine, boilers, mechanical sludge thickeners, sludge dewatering, sludge dryer, conveyors etc.)
- Capacities
- Maintenance works
- Tuning in the plant for the optimum performance,
- Basic fault finding and remedy of simple/typical faults
- Reading and understanding the Operation and Maintenance Manuals
- Spare parts
- Safety

Training concerning el. installations will include:

- Switchboards including control equipment (frequency converters, controllers, instruments etc.)
- Basic principles of electrical components (relays, motor starters, ELCBs, etc.),
- Basic fault finding and remedy of simple/typical faults (reset of MCBs etc.),
- Maintenance routines,
- Detection and remedy of typical faults,
- Reading and understanding diagrams,
- Spare parts
- Safety

Theoretical courses are assumed to be carried out separately for each staff category, i.e. electricians and operators. Practical courses may be for both categories.

For each course a compendium including programme, details on the subjects, manuals, exercises (practical and theoretical) shall be prepared. The compendiums shall be submitted to the Engineer for his approval at least fourteen (14) days prior to the start of the particular training course.
Furthermore, the Contractor shall have completed the draft version of the Operating and Maintenance Instructions before the first course.
Place of training
The training shall take place at the Modřice Wastewater Treatment Plant.

3.11.8 Operation and maintenance manuals

The Contractor will provide six copies of the Operating Regulations drawn up as an update to the valid Operating Regulations for the Brno - Modřice WWTP (the current Operating Regulations will be submitted to the Contractor with the handover of the construction site). The Operating Regulations update will be developed in the scope and structure according to Regulation No. 216/2011 Sb. on the Handling Regulations and Operation Regulations for Water-related Structures and other Instructions for Operation and Maintenance.
The prepared draft update of the Operating Regulations will be a necessary document, without which the consent of the Engineer to start the trial operation cannot be given. Changes to the Operating Regulations registered during the trial operation (if any) will be incorporated by the Contractor into the final version of the Operating Regulations.
Immediately upon completion of the Tests on Completion, the final version of the Operating Regulations will be prepared and submitted to the Engineer for review.
The Contractor shall submit to the Engineer the draft operations and maintenance manuals in two (2) copies and in one (1) electronic version in the Czech language no later than fourteen (14) days prior to the start of the Tests on Completion. These manuals will be used during operation and maintenance training.
These operations and maintenance manuals will include the following for all equipment:

- A general part describing the content and description of the equipment,
- Drawing documentation
- Functional description;
- Component list showing the manufacturer, type, component number, order number and other data and position;
- Maintenance instructions indicating procedures and maintenance intervals;
- Errors detection instructions;
- Analogue signal circuits calibration reports;
- Datasheets;
- List of spare parts;
- Tool list and
- List of consumables.

As regards mechanical equipment, the manuals will include at least the following:

- Machine type and serial number (all in one list);
- Operating instructions;
- Lubrication tables and maintenance instructions (all equipment in one overview);
- Details of fault detection to fix basic faults;
- List of parts with parts numbers in relation to drawings, preferably in an enlarged scale. This list must enable correct ordering of whole parts and spare parts;
- Brochures containing all components with vendor names and addresses;
- Power curves, diagrams, test certificates, etc.
- Corrosion protection specifications; and
- Specifications for repairing all coated /surface-treated surfaces.

As regards el. installations, the manual will be divided into separate parts for the following equipment:

- Control panels;
- Tools;
- Control and measuring elements (signalling system); and
- Other components

This manual will also include the following ion relation to electrical equipment:

- CE marking and declaration of conformity;
- Lay-out drawings;
- Diagrams and wiring diagrams;
- Detailed description;
- Special operating instructions;
- Special maintenance instructions;
- List of components for all equipment;
- Error detection charts; and
- Emergency procedures.

All information contained in the manuals only applies to the supplied equipment and will not contain any unnecessary facts contained in the manufacturer's manuals.
This final version of the operation and maintenance manuals will be submitted in two (2) copies and one (1) electronic version in the Czech language. The operations and maintenance manuals must be submitted both in printed form and in electronic form as approved by the Engineer.

3.11.9 Offices for the personnel and workers

The Contractor shall provide and maintain (from the commencement of the Works and until 3 months after the issue of the Taking-over Certificate) offices for the Engineer. The offices will form a part of the Contractor's site facilities but the will be separated from the Contractor's offices and clearly marked as the Engineer’s facilities. Installation of the offices, all equipment and facilities will be paid by the Contractor, they will be connected water supply, electricity, sewerage and heating. The offices will be equipped with high-speed internet access and a sufficient number of power points.

- Required scope of the Engineer’s offices:
- 1 office for the Engineer’s team leader 16 m2
- 1 office for deputy team Leader 16 m2
- 3 offices each for two team members 3 x 20 m2
- Meeting room for 12 people 24 m2
- Archive 20 m2
- 2xWC
- Wash room with shower
- Kitchenette with dining area
- Changing room 10 m2

All offices will be equipped with work desks with chairs, cabinets with sufficient storage space, table lamps, garbage bins, boards, etc.
The meeting room will have a capacity for a meeting of a minimum of 12 people with the possibility of presentations - PC connection with a large LCD display unit, multifunction laser colour copier with a scanner and a printer for A3 format.
The kitchenette will be equipped with a refrigerator, microwave oven, electric kettle, coffee maker.
The dining area must be sufficient for 8 people staying there at the same time and the meeting room does not replace the dining area.

4 Civil Works

4.1 General Requirements

All construction products (every product determined for permanent building into constructions) have to fulfil the conditions stated by the laws of the CR and the government decree. During document preparation, production, transport, storage, assembly, testing and all other activities and deliveries, the Czech legislation and standards shall be followed. This means that all CSNs and harmonized standards will be considered binding when performing the Works. An overview of the legal regulations and standards is given in Annex 12.
The products need to have such qualities that the constructions fulfil the following requirements for constructions provided they have been duly designed, built and maintained:
1. Mechanical stability
2. Fire safety
3. Hygiene, protection of health and environment
4. Safety of use
5. Protection against noise
6. Energy savings and protection of heat

These requirements have to be fulfilled with normal maintenance in economically reasonable period of time, on condition of normally foreseeable influences affecting constructions. The product has to maintain its technical qualities during the period of its economically reasonable life, i.e. for the period when the indices of the utility properties of the construction are maintained on a level compatible with the fulfilment of the given requirements for constructions.

4.2 Earthworks

Geological ratios in the given locality must be taken into account during earth works. Prior to initiation of earth works, it is necessary to carry out an inspection survey of the construction site with analyses of ground water samples. The method of excavating the construction pit will be selected based on the geological survey and the surrounding built-up area. Geological conditions, including groundwater information, can be found in the geological survey - see Annex 3. Further information on geological conditions - see Engineering and Geological Survey, December 1999 – Annex 19
Prior to initiation of civil works, it is necessary to detect and survey all underground networks in the area of the construction site and its immediate vicinity.

4.2.1 Foundation

The construction must be founded using a method that corresponds to the foundation conditions at the Site and the requirements of the upper structure and the installed technological equipment. The foundation works must take into account possible changes in the ground conditions affecting the adjacent structures or service networks. The foundation structure must be protected against aggressive water and substances that could damage it. Floor structures or potential buried civil structures must be insulated from the surrounding soil or foundations to ensure protection from ground moisture.

The foundation works must be carried out in accordance with the relevant provisions of the ČSN standards and the applicable regulations.

The civil structures will be built based on local conditions and the level of the footing bottom in open or sheeted pits or trenches always in a non-freezing depth under the existing ground level. Possible non-load bearing or otherwise unsuitable layers will be removed and replaced by compacted suitable fills. Contaminated soil and materials will be stored separately and taken to an appropriate landfill site.

For soils classified as 1-5, the excavation shall be carried out mechanical, provided that the soil is suitable for laying of pipes, up to a maximum depth of 10 cm above the bottom edge of the structure or the base of the pipe.

The bottom of the excavation site must be opened manually and exactly according to the required profile, and the lower part of the construction pit must be compacted using a suitable tool.
All pits will be sheet piled using a suitable piling.

4.2.2 Top soil

Shall be removed or scraped in the width of the trench + at least 50 cm. The top soil shall be stored laterally so that mixing with other types of soil is excluded.
Topsoil which becomes unsuitable due to the fault of the Contractor must be replaced with suitable soil at his own costs.

4.2.3 Unsuitable soil

Unsuitable types of soil have to be replaced by a suitable filling material.

4.2.4 Support of excavation

The Contractor shall secure all excavation with suitable supports, if required so by the conditions on the Site, in particular safety on Site using suitable sheet piling. If in the Engineer opinion the support is insufficient the Contractor shall alter or strengthen the support to the Engineer's satisfaction. No such support shall be removed until in the opinion of the Engineer the permanent work is sufficiently advanced to allow such removal.

4.2.5 Surveying cuts

It is expected that in all of the area of the waste water treatment plant there will be many intersections with existing lines and cables. This must be considered by the Contractor. Furthermore, special attention should be paid to the avoidance of damage to the functional lines when carrying out civil works.
In places where the construction of new sludge management structures will be carried out, the underground is affected by the remains of previously demolished buildings, as shown in the attached documentation – Data Collection of abandoned civil structures - Annex 6. Prior to commencement of designing and excavation work, a detailed subsoil survey is required to enable the Contractor to examine the appropriate method for foundation works.

4.2.6 Refilling and compacting

Refilling and compacting shall be carried out in line with the applicable provisions of CSN standards and Czech guidelines.
If parameters of compacting are determined, such required values must be met.
Compacting is carried out by means of suitable machinery in layers of max. 40 cm.
Upon detecting insufficient compactness the Employer reserves the right to have the filling material completely or partially removed and re-filled and re-compacted.

4.3 Pipe works

4.3.1 Water pipes and internal water distribution system

Potable water pipes connected to the water distribution system must not be interconnected with other sources.
Water pipes, or as the case may be, part of the internal distribution system led in the earth must be laid in a non-freezing depth or must be protected against freezing using e.g. heat insulation.
The main water closure must be accessible and its location must be visible and permanently designated.
If hot water mains are to be installed, they must always be insulated.

Corrodible pipes must be protected against corrosion.
The internal water system must be protected against possible back suction of polluted water.
The internal water system ensuring supply of water used for fire-fighting purposes in compliance with the standardised values must be equipped with hydrant systems with stable pressure and immediately available water supplies.
Outflows other than potable water must be designated in a visible place with a sign for non-drinking water.
Newly laid pipes must be subject to the pressure test conducted as per applicable standards and norms. The purpose of the test is to demonstrate the tightness of the pipes, pipe joints, separate pipe sections and to prove safe positioning of the pipes.
The results of the pressure test must be put down in a protocol including the lay-out and list of pipes.

4.3.2 Wastewater pipes and internal sewer system

The sewer pipes must be laid in a non-freezing depth or protected against freezing by e.g. heat insulation.
Crossing of wastewater service pipes with other underground networks must be designed in a way preventing from mutual endangering of discrete systems or their functions and must enable possible repairs to be carried out.
The internal sewerage system must be designed so as not to damage the stability of the structure of the building even during repair work. The system must be watertight, gas-tight and ventilated.
Ventilation line of the internal sewerage must no lead to chimneys, air chimneys and must be led 500 mm above the level of the roof cladding, at minimum.
Floor drains must be installed in rooms with wet cleaning of floors. If required by the type of operation, the drain must be equipped with a mud flap.

The Contractor must consider the underground conditions before the pipes are laid.
Laying of pipes and refilling must meet the standard requirements of the producer.

Before takeover all pipes have to be cleaned by the Contractor.

For all sewers and a determined number of relevant shafts it is necessary to carry out a leakage test after finishing of construction. The tests can be performed in the whole system or in individual sections and conducted as per applicable standards and norms.

The tests shall be carried out in sections that have not yet been refilled. The pipes must be secured against movement, if necessary pipes can be partly or completely covered –however the pipe joints should remain free.

4.4 Concrete Works

When implementing, it is necessary to follow pertinent Czech standards.

4.4.1 Preparation of concrete

Cement must comply and admixtures must comply with Czech standards.
Regulations concerning resistance to aggressiveness must be adhered to.
Composition of concrete must be announced to the Engineer upon request.

4.4.2 Confirmation of the concrete quality

The Contractor shall conduct the quality test in corresponding range and in the Engineer’s presence and shall also prepare necessary test pieces. The test pieces will be handed over by the Contractor to an Czech state accredited concrete test laboratory.
Tests of suitability and quality are related to all required characteristics of fresh as well as hardened concrete.

4.4.3 Leakage test of the tanks

All tanks are to be tested if they are water tight. Zkoušky vodotěsnosti nádrží budou prováděny v souladu s příslušnými normami a předpisy. Filling may 28 days after completion of concrete works. Initiation of tests depends on the agreement.

4.5 Buildings

Buildings must be designed and constructed in a manner fully complying with applicable laws and regulations.
The shape and form of the buildings must correspond to other buildings at the existing WWTP and with buildings constructed as part of the Works. The height and dimensions of the buildings and civil structures will correspopnd to the landscape, the existing buildings at the Brno-Modřice WWTP (mainly in terms of external appearance and roofingy) or alternatively they will be considered a landmark depending on the overall design. All external cladding, tiling, texture and colors must conform to the building shapes used at the Site and the existing WWTP. The construction of the cladding and windows and doors must withstand the effects of weathering. The Contractor will use the colors as much as possible to define and / or reduce the visual impact.
The buildings will be made of masonry or concrete filled with masonry or other material. As regards the buildings, the conditions for the required fire safety and energy performance must be met. From the fire safety point of view, the structural systems of all buildings must be non-flammable - DP1 in accordance with ČSN 730804 and ČSN 730810.

4.5.1 Plumbing Installation and Sanitary Fittings

The internal water system must be protected against possible back suction of polluted water.
The internal water system ensuring supply of water used for fire-fighting purposes in compliance with the standardised values must be equipped with hydrant systems with stable pressure and immediately available water supplies.
If hot water mains are to be installed, they must always be insulated.
The internal sewerage system must be designed so as not to damage the stability of the structure of the building even during repair work. The system must be watertight, gas-tight and ventilated.
Ventilation line of the internal sewerage must no lead to chimneys, air chimneys and must be led 500 mm above the level of the roof cladding, at minimum.
Floor drains must be installed in rooms with wet cleaning of floors. If required by the type of operation, the drain must be equipped with a mud flap.

4.5.2 Heating Systems

Calculation of heat losses in buildings is specified by standardised values.
Heating systems must be equipped with instruments enabling measurements and setting of heat system parameters. Operation of the heat systems must be provided with a heat input control in dependence on the heat demand.
Heat supply coming from an external resource must be equipped with a main closure of heat-transfer fluid at the inlet and outlet to/from the internal heating system of the building.

4.5.3 Roofing

The roofs shall catch and drain rain water, snow and ice to eliminate potential danger for persons and must be designed to meet these safety functions.
The roof structure shall meet the requirements for thermal-technical properties in heat transfer, steam transfer and air transfer through the structures based on standard values of heat resistance of the structure, the internal surface temperature distribution throughout the structure, the thermal momentum of the structure in connection with the room or the building, steam diffusion and humidity balance, air permeability of the structure, its joints and connections.
Walk on roofs shall secured for safe access, when expected.

4.5.4 Windows, doors and gates

The structure of windows, doors, panels etc. must be of a corresponding rigidity preventing from destruction, drooping or any other deformation during normal operation and must resist loading, including its own weight, and wind loading even when the casements are in open position, without causing their damage, shifting, deformation or deterioration of their function.
The requirements concerning thermal-technical properties in a stable temperature state have to be met. The heat-transfer coefficient including the casings and jambs is determined by a standardised value according to the nature of the building and the type of the panel.
The panels must have such acoustic properties that correspond to the possible requirements for soundproofing.
The smallest dimensions of manholes in ceilings and manholes leading to shafts and canals are determined by a valid regulation.
All openings in the walls must be provided with a protection against fall of personnel if a fall to a depth greater than 1.5 m might occur.
Openings in fire dividing structures (doors, gates, trap-doors) must be equipped with fire stoppings complying with the standardised values with respect to their type and fire resistance. Doors located on the escape ways must enable easy and fast passage.

4.5.5 Walls

Walls and partition walls of the building must meet the requirements for loading capacity as regards bearing walls and self-supporting partition walls.
Peripheral or, as the case may be, internal walls, must be fire resistant or the combustibility grade of used building materials and the limiting state must comply with standardised values in dependence on the fire safety of the building.
External walls, internal walls, separating spaces with different heating regimes and wall structures adjacent to the terrain must comply with the specifications concerning heat-technical properties for heat transmission, water vapour penetration and air infiltration as specified by the standardised values of heat resistance of the structure, distribution of internal surface temperatures on the structure, thermal persistence of the structure in relation to the room or the building, diffusion of water vapours and moisture balance, air permeability of the structure, its joints and contacts. Walls or partition walls must also be compliant with respect to sound insulation, i.e. meet the requirements of building acoustics for soundproofing, so that the noise and, possibly, vibration generated in the structure with these walls and partition walls affecting people (animals) is at a level harmless to health and the working environment.

4.5.6 Floors

The basic required properties of floors must be assessed as a whole along with a roof structure, including possible soffit. Therefore, the floor structure must meet the requirements for thermal-technical properties in stable as well as unstable temperature conditions. Furthermore, it must comply with the specifications of building acoustics for soundproofing determined by standardised values for all the strata of the floor structure.
The floor structure must be provided with anti-slip surface protection.
Surface of the walls and floors must be easy to clean and maintain, i.e. it must be smooth and washable.

4.5.7 Ceilings

The basic specification concerning the ceilings is the bearing capacity.
Fire-proof ceilings and ceiling inside fire-safety sections must ensure fire resistance corresponding to standardised values. They must be rendered from building materials corresponding with the standardised values.
Ceilings must meet all the requirements for thermal-technical properties upon transmission of heat in stable as well as unstable temperature conditions based on the standardised values.
The ceilings must also be compliant with respect to sound insulation by fulfilling the specifications of building acoustics concerning soundproofing based on standardised values.

4.5.8 Stairs and ramps

Staircases, if installed, must be considered as one of the most important structural part of the building in terms of safety and all relevant standards should be fulfilled.
Each floor to be erected must be accessible from a minimum of one staircase (main staircase). Another staircase (auxiliary) is designed mainly as part of the escape way or emergency way in line with the standardised values and must be understood as a complex requirement for fire safety of the staircase and its construction.
The lowest permissible stair clearances of the staircases are determined by the standardised values. All fliers in one flight of stairs must be of the same height, and also of the same width (for direct flights).
The slope of the staircase flight must follow the classification of the building.
The lowest permissible stair clearance of the staircase flight, dimensions of the landing and half landing and other requirements for safety are determined for separate buildings by a special regulation (requirements for safety of work and technical equipment) or by standardised values.
The surface of the landings of internal staircases must be horizontal without sloping in either cross or longitudinal directions, when not defined otherwise in special regulations.
Ladder staircases may be designed for occasional use by a limited number of people (e.g. access to the roof).
The staircase room must be lit and ventilated.
In some cases, sloping ramps can be designed instead of staircases. Technical specifications concerning sloping ramps are determined by standardised values.

4.5.9 Railings

All passable areas in the construction site where there is a danger or fall and that are accessible must be equipped with a guard railing (or, as the case may be, with a different kind of protection) that must safely resist a load acting in both horizontal and vertical directions.
The railings must be installed on a free border of the passable area, in places where the free space in front of this area is deeper and wider than the standardised values in dependence of the classification of the passable area.
The lowest permissible height of the railing including the handrail is specified by special regulations.
If there is a danger of slipping backward or falling in, then the foot of the rail must be equipped with a protective batten with a minimum height of 100 mm.
It is not allowed to use a composite material.

4.5.10 Chimneys and fume ducts

Chimneys and fume ducts must be designed and erected in a way guaranteeing safe exhausting and dispersion of combustion products into the atmosphere while meeting all operating conditions for the connected equipment. The fume line consisting of the fume duct and the chimney must not reduce the output of the fuel consumers. Materials used for chimneys and chimney inserts must not reduce the fuel consumer output. Materials used in the production of chimneys and inserts must be made of non-flammable or hardly flammable materials with properties meeting relevant ČSN and other regulations.

4.5.11 Lightning Protection

Protection against lightning must be installed in constructions and facilities where the lightening might endanger human life or health or cause extensive damage, explosions, etc. and shall be carried out in line with the applicable provisions of CSN standards and Czech guidelines.
The absorbing installation of the lightning conductor must be designed in a way capturing all lightnings directed towards the protected building. It must be of a suitable shape and be located on the surface of the protected building in place where there is an increased danger of thunder-stroke.

4.6 Roads

New roads will be connected to the existing site roads through new roads and paved areas. The new roads must be built to allow not only easy access to the buildings but also to enable sufficient manoeuvring space for transport equipment.
The road load capacity will be 26 tons per vehicle. The road construction will be designed for class V of the traffic load with the design level of D2 road deflection.
Excavations outside the construction pit for the new buildings will be carried out in a thickness necessary for the structural layers of the roads.
The road surfaces will be designed to be drained into the field where swales and seepage ways will be provided.
Subsoil - the ground must have the required bearing capacity according to ČSN 72 1006.
The paved areas will be designed and built to meet the requirements for access to the buildings and they will be appropriately integrated into the site of the existing WWTP. Roads and paved areas will be lined by curbs.
When intervening with the existing roads, the demolition material must be sorted out according to its usability and stored separately.
In principle, the surface of traffic areas shall be saw cut of at least 300 mm back from the edges of any excavation.
If there remains a strip of road narrower than 1.50 m, then this part shall be totally removed and rebuild.
The road structure will be designed in accordance with applicable Czech standards and regulations depending on the required load capacity of 26 t, the transport load class V and the design level of deflection - D2.

4.7 Cable routes

The cables will be laid between the sludge management facility in combined pipelines with cable shafts. The cable routes will be made of plastic tubes laid in layers in a sand bed. Outdoor cable routes will be connected to the indoor cable routes in the individual buildings. The cable shafts will be located at the points of direction change, at the turning points from the main route and at the locations of the height change of the tube route. The new combined cable route will be connected to the existing cable routes in existing shafts S009 and S054. The cable routes must be structurally secured against water and the cable shafts must be drained.
In all sections of the cable route there must be about 20% reserve of free tubes for the future addition of additional cables. All cabling must then be provided with sealed entries to the individual buildings from the cable routes using a watertight, gas-tight and fireproof sealant.

Throughout the combined route, a grounding line FeZn 30x4 mm will be laid in the natural ground, connecting all the earthing connections in this part of WWTP and it will be connected to the existing general WWTP earthing system.
This earthing line will lead inside all the shafts and into the structures for the switchboard and technological equipment earthing.
The following types of cables will be laid in cable routes.

- 0.4 kV power cabling
- Signaling and control cabling
- High voltage power distribution cables
- Process measurement cables
- Control system cabling
- Cable distribution for PZTS, CCTV, EKV, EPS and telephones

4.8 Street lighting

The installation of the cabling shall be made using all-plastic CYKY cables. The cables shall loop the individual poles. The lighting posts shall be connected to earthing conductors along the entire route. This grounding system shall be connected to the main earthing network at the WWTP.

The cable distribution on site shall be buried in a cable trench 35/80. The cables shall be laid in a 10 cm thick sand bed and shall be marked with a red warning foil. Cable under roads shall be laid in a depth of 120 cm in cable protection sleeves.

4.9 Landscaping

Landscaping includes surface levelling, humus laying, thickness 15 cm (as minimum), seeding and sowing of the areas. It concerns the areas, affected by construction, i.e. demolition of existing structures with subsequent construction of new stuructures and buildings. The existing groud at the WWTP is flat and the ground elevation will not be changed.
Landscaping includes the felling of existing trees and shrubs and planting of new trees and shrubs in vacant grassy areas.

4.10 Particular requirements for buildings

4.10.1 Digesters

Generally:
Four circular cast-in-site reinforced concrete digesters will be constructed in a double-line arrangement. Each tank will be equipped with an inlet and discharge pipeline and a gravity safety overflow. A balancing and mixing tower with a gravity safety overflow will be installed on the discharge pipeline of the service line.
The shape design will take into account the minimization of heat losses, the maximum efficiency of mixing and the installation of the integrated gasholders. The digesters will be equipped with the central reinforced concrete column for installation of the integrated gasholder
The average heat permeability coefficient of vertical structures of tank: $U \leq 0,2$ W.m-2.K-1.
Mixing efficiency: maximum difference in the concentration of suspended solids at various points inside the tank - 10%
Operator and maintenance manhole DN 800 with a blinding flange
For easy maintenance and inspection of the integrated gasholders, the digesters will be fitted with reinforced gallery with reinforced concrete railing.
Design and construction of digesters incl. integrated gasholders shall be carried out in line with the applicable provisions of ČSN standards, in particular with ČSN EN 12255-8 and ČSN 75 6415.

Tests:
All tests required by applicable standards and regulations will be carried out, in particular:
Static strength test
Water and gas tightness tests according to ČSN 75 0905 and ČSN 75 6415;
Test of heat tank jacketing according ČSN EN 13187 – Thermal behaviour of buildings.

If the test is not successful, each test must be repeated until satisfactory. Only then can the next test be made.
Records and protocols of successful tests are a prerequisite for putting the digesters and gasholders into operation, including other accessories into operation and these will be part of the as-built design documentation.

4.10.2 Digested sludge storage tanks

Two circular cast-in-site reinforced concrete digested sludge storage tanks will be constructed. Each tank will be equipped with an inlet and discharge pipeline and a gravity safety overflow.
For easy maintenance and inspection, the digested sludge storage tanks will be fitted with reinforced gallery with railing. The tanks will be covered with a segment dome roof.
Tests:
All tests required by applicable standards and regulations will be carried out, in particular:

- Static strength test;
- Water tightness tests according to ČSN 75 0905;

If the test is not successful, each test must be repeated until satisfactory. Only then can the next test be made.
Records and protocols of successful tests are a prerequisite for putting the digested sludge storage tanks into operation, including other accessories into operation and these will be part of the as-built design documentation.

4.10.3 Electric substations

To ensure the required operating temperature inside the substations, the substations will be equipped with industrial air conditioning.

4.10.4 Sanitary facilities of the operational buildings

All buildings will be equipped with at least washbasin with hot and cold water on each floor for operational reasons.
The digester engine room building, mechanical sludge dewatering and sludge drying buildings will have a room for the staff and sanitary facilities (WC, washroom with hot and cold water).

4.10.5 Corridors for Operational Staff

Unless explicitly permitted, the substations must not be used as the passage for the operators either from one part of the building to another or out.

4.11 Demolitions

4.11.1 General

The construction or its parts have to be removed (pulled down, dismantled etc.) in such a way that the safety, life and health of persons are not threatened, there is no fire emerging, or an uncontrollable damage of stability of the construction or its part occurring during the works.
During the removal of constructions or their parts neither the stability of other constructions nor the operation ability of the technical equipment networks within the reach of the construction must be threatened.
The surroundings of the removed constructions must not be excessively disturbed by this activity and its results, especially noise and dust.
Demolition of structures will be carried out ca 1.0 m under the existing terrain.
Backfill of the demolished structures will be done to the point elevation of -0.15 m under the existing terrain. Levelling up to the treated terrain will be included into Landscaping.

4.11.2 Removal of debris

Demolition is carried out with a particular regard to separation of the individual types of materials.
Disposal of debris and waste material from the removed constructions has to be carried out according to the Czech law, applicable provisions of CSN standards and relevant statements of Environmental Authority.

4.11.3 Dangerous waste

Dangerous waste and used oil have to be separated from harmless waste in the course of demolition works; it is necessary to store them separately, dispose of them and transport them to the point of collection and proper disposal in lien with applicable legislation.

5 Mechanical Works

5.1 General Requirements

In the following are outlined the general and particular minimum requirements for mechanical installations for the Brno-Modrice WWTP Sludge Management project.
It shall be the responsibility of the Contractor to provide all detailed design of the installations, to ensure full coherence of all the equipment installed and to comply with the present minimum quality requirements. Unless stated otherwise in these Requirements, all equipment must comply with the relevant standards and regulations upon completion of the Works.
Construction and assembling shall be according to local laws and regulations or if not available according to EN standards.

5.1.1 Suitability of Design and Equipment

During the selection and/or design of equipment and installations, particular attention shall be paid to the following:

- Safety of operation and easy maintenance
- Well-proven and reliable components
- Ability to withstand the service conditions
- Inaccessibility for vermin, dust and humidity
- Precautions to minimize corrosion
- Spare parts available in Czech Republic
- Service available in Czech Republic
- Minimization of noise

5.1.2 Environment

All equipment shall be rated for the ambient temperatures relative humidity and altitude at the Site. Necessary frost protection by means of insulation and, if so required, also electric heat tracing shall be considered in the design.
The Contractor shall in his design and selection of equipment take into consideration under which conditions each item shall be in operation. Equipment placed in the open shall be designed for solar radiation induced temperatures or in some way protected from direct sunlight.
Items placed in or near sewage shall be efficiently protected against the intrusion of humidity and water.
Equipment placed where the risk of condensation prevails shall be provided with drainage holes placed in the lower part of the equipment.

5.1.3 Programme of Works for Machinery

The programme of works for machinery to be supplied and installed shall be divided into the following parts:
Part I Manufacturing period:
Design and manufacture of all equipment to be supplied under the contract including inspection and works testing.
Part II Shipping period:
Delivery of all equipment from factory to the Contractor's on site storage including all freight loading, offloading, customs duties and clearance.
Part III Erection period:
Removal of the materials and equipment from off or on-site storage, delivery to erection site and installation.
Part IV Site testing:
All machinery shall be tested in the presence of the Engineer before being put into operation.
Part V Running-in and Tests on Completion:

All installed machinery shall be adjusted so as to comply with the operation requirements and actual conditions. Manuals and other documentation as specified in Section xxx shall be provided by the Contractor.
All parts of the technological and process equipment (machines, pumps, accessories, instrumentation, etc.), including wiring and cables, must be marked with appropriate codes identical with the as-built documentation and technological schemes and PIDs to ensure clear identification, which is visible and accessible.

5.1.4 Co-ordination

It is the responsibility of the Contractor to ensure full coherence between the equipment delivered according to the present mechanical specifications and the specifications for electrical and civil works.
The Contractor shall also be responsible for all sub-contractors and suppliers of equipment and materials. No direct formal communication between the Employer and the sub-contractors will be permitted.
It is the responsibility of the Contractor to secure that sub-contractors and suppliers get all the relevant information of the present specifications.
The Contractor shall appoint and provide an experienced mechanical and electrical engineer to monitor and co-ordinate all aspects of the mechanical and electrical works.

5.1.5 On Site Manufacturing

It is the obligation of the Contractor to provide all installations within the working area as he considers necessary for on-site manufacturing and shaping of materials and equipment. The working site may be used as intermediate storage for equipment at the Contractor's own risk and at his own cost.
It shall be noted, that the Contractor's obligations on taking the necessary safety precautions shall apply for the working camp area as well.

5.1.6 On Site Storage and Safekeeping

The Engineer shall be informed by the Contractor about machinery delivery dates well in advance of the anticipated time of arrival of the items.
In general all equipment shall be stored according to the manufacturer's requirements. If equipment and/or machinery is to be stored on site the Contractor shall either:

- Adequately package all items to enable the equipment and materials to be stored in the open without any deterioration whatsoever, or
- Provide an approved store, complying with the following minimum requirements: Rotating mechanical equipment: Covered, ventilated, dust and vermin proof area. Pipes, valves, steelwork etc.: Sheeted on open hard standing area.

The storage site as defined above shall be arranged by the Contractor at his own expense within the contract price.
The Contractor shall be responsible for the operation, safe keeping and maintenance of all equipment on site during storage.

5.1.7 Erection

The Contractor shall make his own arrangements for unloading of equipment and materials supplied and shall be responsible for any damage occurred. The Contractor shall at his own expense provide all tools, meters, gauges, temporary provisions as well as skilled and unskilled labour for the erection of the mechanical installations so that it can be installed complete and in good working order.

5.1.8 Equipment and Manufacture

The Contractor shall guarantee all mechanical equipment against faulty or inadequate design, improper assembly or erection, defective materials or workmanship, as well as leakage, breakage or other failure. Materials used shall be suitable for operation conditions.
All equipment shall be designed, manufactured and assembled in accordance with recognized and acceptable engineering and shop practice and selected for long life and minimum maintenance. Individual parts shall be manufactured to standard sizes to the extent possible, so that repair parts furnished at any time can be installed on site.
Mechanical equipment shall be new and shall not have been in operation at any time prior to delivery, except as required by tests.
It is the Contractor's responsibility to ensure that the components of the systems are compatible as to dimensions, ratings and operational characteristics and integrated to form a fully efficient system complying with the specifications.

5.1.9 Machinery Guards and Labelling

Machinery shall be guarded to prevent injury to persons, and meet international and Czech safety regulations.
Adequate guards shall be supplied and installed throughout the installation to cover all drive mechanisms. All rotating and reciprocating parts, drive belts etc. shall be securely covered to the satisfaction of the Engineer to ensure the complete safety for both maintenance and operating personnel. However, whilst all such guards shall be of adequate and substantial construction, they shall also be readily removable for gaining access to the equipment.
The Contractor shall arrange for the supply and fitting of warning labels for all machinery operated under automatic control.
All identification information and warning labels shall be in Czech language.
Guards for machinery shall be constructed of stainless steel mesh or other corrosion resistant material.

5.1.10 Lubrication

Equipment shall be adequately lubricated by systems, which require attention not more frequently than weekly during continuous operation. Lubrication systems shall not require attention during start-up or shutdown and shall not waste lubricants.
Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easy accessible from the normal operating area or platform. Drains shall be located so as to allow for collection of waste oil into containers without removing the equipment from its normal position.
A list of recommended lubricants and their equivalents shall be included in the operation and maintenance instructions and recommended lubricants mist be available in the Czech Republic.

5.2 Corrosion Protection

5.2.1 General

Mechanical equipment shall be protected against corrosion by painting or other convenient treatment to a degree sufficient for the intended function and placement of the actual works.
Where the Contractor has a possibility to select different coatings that comply with technical requirements then the coating that has the smallest possible impact on workers health and safety has to be used. Documentation of the choice should be made available to the Engineer.
Dry surfaces, e.g. outer sides of valves, shall be categorised and protected against corrosion acc. ČSN ISO 12944. Wetted or submerged surfaces, e.g. inner sides of valves, shall be categorised and protected against corrosion acc. ČSN ISO 12944.

5.2.2 Galvanizing

Where steel or wrought iron is to be hot-dip galvanized, it shall be carried out by the hot-dip process and shall conform in all respects with ČSN EN ISO 1461.
During off-loading and erection utmost care must be taken in order to avoid any damages to the galvanized surfaces. Galvanized items in stock shall be stacked so as to provide adequate ventilation to avoid wet storage staining.
Small areas of damaged galvanized coating may according to agreement with the Engineer be restored, and thoroughly cleaned by a brush to ensure clean surfaces. Application of two coats of zinc-rich paint or application of a low melting point zinc alloy repair rod or powder to the damaged area, which is heated at 300 °C.
Where galvanized steel will be in contact with aggressive solutions and/or atmospheres, the galvanized surfaces shall receive further protection by painting in accordance with the paint specifications given below.
The geometry of galvanized steel parts shall be thoroughly checked after galvanising. Any deformations shall be corrected without damaging the zinc layer.

Inspection and Documentation of Hot Dip Galvanising:
The inspection and quality assurance of the hot dip galvanising carried out by the Contractor shall be in conformity with ČSN EN ISO 1461. Documentation for this inspection and quality assurance shall be issued and become part of the Quality Assurance documentation. After components have become hot dip galvanised, machining is not allowed.

5.3 Steel Constructions

Steel constructions shall be designed as to resist the static and dynamic forces they are exposed to. The Contractor must specify in his offer the most important materials used.

5.3.1 Cast Iron

All grey iron castings supplied shall be to the appropriate grade in EN 1561. All castings are to be free from blowholes, flaws and cracks.
No plugging, filling, welding or "burning-on" will be accepted.

5.3.2 Stainless Steel

Stainless steel used in the Works shall be delivered in line with ČSN class 1.4435, 1.4436 or 1.4571. if not specified otherwise. However the Contractor shall determine if the stated minimum requirements are sufficient for the particular application and if necessary select a higher grade.
Material thickness in constructions of stainless steel shall be at least 3 mm when not otherwise stated. Welded tubes shall have a wall thickness of at least 2 mm.
Material certificates are required for all stainless steel. Certificates shall comply with EN 10204-3.1B. Certificates shall be part of the QA-documentation.
All stainless steel material, pipes, flanges etc., shall be stamped according to their type, grade and pressure class. In addition all stainless steel shall be accompanied by an authentic manufacturer's certificate to enable verification of origin and date of manufacture. Certificates shall be part of the QA-documentation.

5.3.3 Aluminium and Aluminium Alloys

Due to the corrosive atmosphere, the use of aluminium or aluminium alloy requires the approval of the Engineer in all cases.
Immersed installations or installations which are periodically immersed must not be constructed from aluminium or aluminium alloys.

5.4 Welding

5.4.1 Welding in General

All welders shall be qualified and have a valid certificate as per applicable regulations. The certificate shall prove that the welder has passed the tests satisfactorily.
All welding works shall be performed under the most convenient working conditions; hence all welding work shall be carried out at the manufacturer's workshop. Field welding will be allowed only after prior approval by the Engineer. Modern, effective equipment and techniques and latest welding technologies are to be utilised. All welding shall be performed by welders qualified and experienced in the particular type of welding required
Records of welding procedures and welder performance qualification tests for work done shall be maintained by the Contractor for review by the Engineer.
The method and procedure adopted for welding in workshops and at site shall be approved by the Engineer before production starts.
Welding of Pipelines
The Contractor shall supervise the site, the welders and their work during the entire working period. For this purpose the Contractor shall use a qualified welding engineer or alternatively, if accepted by the Engineer, an engineer with documented thorough theoretical knowledge and practical experience in the performance and evaluation of the welding work.
It is the sole responsibility of the Contractor to document that welding and welding inspection fulfils all specified requirements.

Welding Preparation
Items material grades, wall thicknesses and pressure ratings shall conform to the requirements laid down in the applicable drawings and specifications.
Each pipe or component shall be visually inspected to ensure that it has not sustained any visually determinable damage. Disposition of damaged items shall be resolved in consultation with the Engineer.
All requirements for welding preparation contained in the qualified welding procedure specification shall be strictly adhered to.
All welds shall be 100% visually examined.
Ten percent of the welds shall be tested. The following methods can be applied:

- Radio-graphic
- Ultra-sonic
- Penetration.

Ultrasonic examination may substitute radiography where radiographic examination is impractical and may be used as general back-up for radiography in case of interpretation/verification problems.

5.4.2 Welding of Stainless Steel

The welding method shall be the tungsten inert gas method (TIG) or the metal inert gas method (MIG) for workshop as well as on-site welding. Irrespective of the method chosen the inner surface of the weld shall be protected by clean inert gas. When welding the oxygen content of the mixture oxygen/inert gas must not exceed 20 ppm.
In order to guarantee high quality welded joints, piping and other quality stainless steel components shall as far as possible be prefabricated in workshop.
For stainless steel welding the following shall be observed:

- Only butt weld jointing of pipes is allowed during erection work,
- Where butt welds are used, the penetration shall be completed, if necessary with root run,
- No surface defects reducing the corrosion resistance or discoloration of the surface will be accepted,
- After welding the weld shall be carefully pickled and passivated, and
- The welds shall be thoroughly washed in clean water after pickling and passivation.

5.5 Bolts

All bolts, screws, nuts and mounts shall correspond to the material secured by bolts. This also applies to chemical anchors.
Bolts shall have an over-length of minimum 3 mm and maximum 12 mm for bored in or embedded bolts as well as flanged joints.
Bolts, washers and nuts for galvanised steel items and for coated steel items shall be hot dip galvanised. Washers shall always be used for bolts fastening coated steel in order to prevent destroying the coating.
Bolts, washers and nuts for stainless steel items like flanges shall be of stainless steel of similar grade or higher.
To prevent galling, strain hardening, crack and contact corrosion, it is necessary to apply molybdenum-sulphide or similar to thread and washers.

5.5.1 Chemical Anchors and Anchor Bolts

Holding down bolts of sufficient length shall be provided and fixed for securing the whole of the machinery to the foundation.
Chemical anchors shall be supplied in quality suitable for conditions under which they are permanently exposed to the action of water.
Alternatively an injection technique can be applied.
Fixation of mechanical equipment to concrete structures can be done by anchor bolts, which can be placed during casting, or by drilling. No anchor bolts may get in contact with reinforcement bars in the concrete structure. Anchor bolts used for installation of stainless steel equipment shall be made of stainless steel of equivalent quality.
For all other purposes hot dip galvanised anchors shall be applied.

5.6 Steel Pipework

All pipes and assembling parts under this Contract shall be of first quality, truly circular, and uniform thickness, free from scale, lamination and other defects, and shall be designed and suitable for the operational pressures and temperatures.
Pipework shall be arranged, as to ease the dismantling and removal of pumps or major items of equipment i.e. by the installation of dismantling joints where appropriate.
A dismantling joint shall be included in the suction and delivery pipework of all pumps for easy dismantling.
All pipework shall be fixed adequately with supports. When passing through walls, pipework shall include puddle flange.
All piping inside buildings up to 1m outside the buildings shall be made of stainless steel. Other materials can only be accepted after prior acceptance from the Engineer.
All piping inside shall have permanent marking, stating standards and material identification numbers.
Pipe ends shall be sealed with PVC cabs during transportation.
Welded stainless steel pipes shall have a wall thickness of at least:

Internal diameter (mm)	Wall thickness (mm)
200 or less	2.0
250	2.5
300	3.0
400	3.0
500	4.0
600	4.0

5.6.1 Pipes from Stainless Steel

Pipework for aquatic-, biogas- and air media shall be stainless steel pipes if not otherwise stated. Material shall be according to requirements for stainless steel.
Pumping mains and pressure pipes shall minimum be rated for PN 10.

5.6.2 Flanges and Pipe Bends

Flanges for stainless steel pipes shall be executed of similar quality as the piping.
All flanges must be rated for PN 10 and drilled according to DIN 2501.
Bends shall have minimum the same wall thickness and be of same material grade as the joining pipes.

5.6.3 Dismantling Pieces

A sufficient number of dismantling pieces shall be incorporated in each pipeline. The dismantling pieces shall be made of stainless steel and shall have an axial adjustment capability of at least ± 25 mm to facilitate easy dismantling and installation of pumps, valves, non-return valves, measuring devices, etc. Threaded rods and nuts through two opposite flanges shall secure the dismantling piece in the position determined during installation, so that the system represents a rigid connection of two adjoining pipes.

5.6.4 Čistící systém

Každá část, která může být oddělena od potrubního systému armaturami, musí mít dostatečný počet tvarovek pro odvodnění a čištění. Přesný počet a umístění těchto tvarovek bude určen po dohodě see Správcem stavby.

5.6.5 Installation of Piping

Pipelines shall be level, plumb and properly aligned, respectively installed to the required slope. Utmost attention shall be given to all pipes connected to machinery and appliances for not transmitting forces and moments to the equipment.

5.6.6 Pressure Test of Pipes

The Contractor shall perform pressure tests in line with applicable ČSN for all pressure piping.
The Contractor shall advise the Engineer in due and shall provide and mount all for the pressure tests necessary equipment.
If pressure tests are made against closed valves the guidelines from the manufacturer of the valves regarding the highest single side pressure against closed valve shall be complied with.
Hydraulic pressure tests shall be carried out by the use of potable water.
During pressure tests a minimum of 1.5 times maximum allowed operating pressure shall be maintained.
The Contractor shall prior to pressure testing verify on the spot that the piping is fully evacuated from air.
After successful and approved pressure test the piping shall be emptied and the pressure test fluid shall be disposed of.
After the pressure tests have been finalised the Contractor shall elaborate a report, a copy of which shall be submitted to the Engineer. The report shall as a minimum include:

- Pressure Test Procedure,
- Unambiguous references to piping or part of piping and shut-off,
- Specification of test pressure,
- The period of the pressure tests,
- Results and signature of acceptance, and

A description of atypical testing results, their causes and corrective action.

5.7 Stairs, Walkways, Platforms and Handrails

All stairs, walkways, platforms and handrails shall meet the applicable regulations and relevant standards including safety precautions.

5.7.1 Handrails

The handrails must comply with all relevant standards, including safety regulations, by its design, location, installation and fittings. The handrails shall be made of hot dip galvanized steel or stainless steel. The use of composite material is subject to the consent of the Engineer and composite materials for outdoor installations are ruled out.
The Contractor shall submit working drawings of the handrails to the Engineer for approval.

5.7.2 Staircases and Galleries

Staircase must comply with all relevant standards, including safety regulations, by its design, location, installation and fittings. The Contractor shall design the staircases for the actual point load.
Treads shall be with non-slip pattern surface.
Material: Stainless steel or hot dip galvanised steel.

5.7.3 Access Ladders

They must comply with all relevant standards, including safety regulations, by its design, location, installation and fittings.
All ladders must be anti-skid depending on the environment and the working conditions.
Material: stainless steel, the use of composite material is subject to the consent of the Engineer and composite materials for outdoor installations are ruled out.

5.7.4 Open Mesh and Chequer Plate Flooring

Open mesh flooring and gratings shall generally comply with applicable standards and regulations . Such flooring and gratings shall be of rectangular mesh and non-slip. These meshes and floorings may be made of stainless steel or hot zinc plated (galvanized during production) steel. The use of composite material is subject to the consent of the Engineer and stainless steel must be used for outdoor installations.

5.7.5 Hatches

Hatches shall consist of a frame with a hinged cover. The frame shall be designed for mounting in recesses in the concrete slab. Hatches on dry wells shall be watertight.
A handle for opening of the hinged cover shall be integrated in the cover. The cover shall be provided with a safety mechanism, which locks the cover in open position whenever opened. The mechanism shall be manually released before the hatch can be closed again.
The hatches shall be designed with a load-bearing capacity based on the location.
Heavy hatches shall be provided with spring-loaded mechanisms or similar facilities which reduce the force required for safe opening and closing of the hatch. The hatches shall be made of hot dip galvanised steel. Alternatively hatches may be made of composite material or stainless steel.

5.8 General Equipment

5.8.1 Lifting Equipment - Cranes

Hoists and cranes shall be provided everywhere necessary for the maintenance of the plant to avoid heavy lifts for the operation staff on the WWTP. E.g. equipment such as pumps, mechanical thickeners, dewatering equipment, etc. and workshop etc. shall be serviced by cranes or hoists.
The cranes or hoist shall enable to bring the equipment to a point were further transport is possible e.g. by a fork lift.
Hoists shall be of the hand operated or electrical operated type with lifting chain and designed to run on the lower flange of the lifting beam.
The hoist shall be rated for the heaviest single lift under erection or maintenance operations.
The max. loading capacity must be set 10% higher than the heaviest load considered.

Crane runways and overhead cranes must be designed in accordance with valid legislation and the complete technical documentation must be provided. The crane runway for the overhead crane also includes a service platform that allows for repair or specialist service of the hoisting system along the entire length of the crane runway of the overhead crane.
Hoist shall be electrical operated for service lifting equipment with a mass exceeding 150 kg. For equipment used more often than once a week, the el. control will be installed for a loading capacity over 100 kg.

Electric cranes must be equipped with a precision lifting system that allows for precise and sensitive lifting and lowering, a load-securing brake in the event of a power outage and limit switches for all end positions. The delivery must include all electrical cables necessary for the operation.
All connections must be equipped with vibration-resistant terminals.
All motors must be protected by thermistors.
All connections must be equipped with vibration-resistant terminals.
All motors must be protected by thermistors.
The local switchboxes for each crane will be equipped with LEDs, switches and an emergency stops for all drives.

The power supply for cranes and lifting equipment will be based on a trailing cable or a contact trolley line.
The chains of all lifting equipment and cranes must be hot dip galvanized and must be able to reach the floor / ground or the lowest serviced area below the floor level. For use in water (e.g. submersible pumps), the chains must be made of stainless steel.
The maximum load of the lifting system and the crane must be clearly marked with large, easily legible data/letters in accordance with the relevant standards.
Suspensions, gearboxes, wheels and motors must be designed in accordance with applicable legislation.
Surface treatment and coatings:

- Preparation of steel surfaces prior to application of the paint system according to DIN EN ISO 12944
- Finishing varnish for steel structures of the cranes - gold-yellow RAL 1004, for steel, Kci crane runways - black,
- layer thickness 60 µm.

5.8.2 Ventilation

Forced mechanical ventilation shall be provided everywhere either safety, heat and/or odour problems are expected. Ventilation rate shall comply with national standards for health and safety.
In order to avoid odour emissions to the surroundings (the Dry pumping stations, pump sumps, buildings for mechanical thickeners, sludge dewatering, sludge drying, etc.) shall be covered and mechanically ventilated. The exhaust air from these structures shall be exhausted in free air or treated in a biofilter if stated so in order to remove any odorous compounds which could cause nuisance complaints.
Whenever forced ventilation is required the noise level shall be minimised. The noise level must meet the requirements of the applicable regulations (in particular Government Regulation 272/2011 Sb., as amended, on health protection against adverse effects of noise and vibrations).
All intakes and exhausts shall be covered for all weathers.

5.8.3 Drive Units

Drive units for the equipment shall be designed for 24 hours continuous operation. The nominal rating of the gear shall be at least equal to the nominal kilowatt output of the attached motor. Each gear shall be a totally enclosed unit with oil or grease lubricated antifriction rolling bearings throughout.
All drives, couplings and other moving parts shall be efficiently covered on all sides with safety guards.
Long-life seals on the input and output shafts shall be fitted up to prevent the escape of lubricant and the ingress of dust, sand and moisture.

The Contractor shall ensure that the lubricants used for initial filling and specified in the maintenance manual is adequate for prolonged operation in ambient temperatures of up to 55°C. without overheating.
The gearboxes shall be marked with manufacturer's identification together with the rated shaft speeds, output power and maximum ambient temperature.

5.8.4 Motors

Motors shall comply with the relevant standards and norms.
Motors shall be designed for the temperatures and humidity occurring on Site and the installation in which they operate.
The motors shall be designed and marked for operating conditions according to ČSN EN 60034

The motors must be delivered in a design corresponding to the relevant equipment.

The degree of protection provided by enclosure for motors shall be min. IP 54.
Protection grade for outdoor motors shall be min. IP 55 and equipped with a drainage hole in the lowest point
The degree of protection for submerged motors shall be minimum IP 68.
The motors shall be cooled in order that the permissible operation temperature is not exceeded.

5.8.5 Bearings

All bearings shall be generously rated and sized to secure satisfactory and stable running without vibration under all conditions of operation for a minimum life of 50,000 hours running.
The intervals between lubrication shall be maximized (not less than 2 weeks) and shall be defined for each individual item and included in the operation and maintenance manual.

5.8.6 Suppression of Noises

All plant offered should be quiet in operation. The noise level must meet the requirements of the applicable regulations (in particular Government Regulation 272/2011 Sb., as amended, on health protection against adverse effects of noise and vibrations).

5.8.7 Penstocks

Každé stavidlo musí být vybaveno ručním kolem odpovídající velikosti pro požadovanou funkci a pokud to bude nezbytné, musí být dodán odpovídající pohon tak, aby se zajistilo, že požadovaná síla působící manuálně na kolo nepřesáhla 250 N. Výška ovládacího kola bude přibližně 1 metr nad provozní úrovní, pokud nebude výrobce nebo normy neuvádí jinak.
Kola musí být označena směrem zavírání, upřednostněný směr ve směru hodinových ručiček.
Vřetena musí mít strojně řezané robustní trapézové nebo čtvercové závity. Musí být zhotovena z nerezové oceli, manganové oceli nebo z manganového bronzu.
Všechna vřetena musí být nestoupavého typu.
Vřetena musí být navržena tak, aby zajistila těsné uzavření, a to při zachování volnosti pohybu desky během provozu a k minimalizaci klouzavého opotřebení těsnění.
Těsnicí plochy z neželezných kovů budou vytvořeny z přesně obrobeného bronzu nebo z bronzových proužků uložených a uchycených k obráběným vybráním pomocí zápustných šroubů odolných proti korozi.
Gumové těsnicí plochy musí být zhotoveny z vysoce kvalitního syntetického kaučuku.

5.8.8 Gate valves

Gate valves must meet the relevant standards in line with DN pipelines.
Unless otherwise specified, each valve shall be provided with a suitable hand wheel of adequate diameter for the duty required. Gearing shall be supplied where necessary, to ensure that the required operating force applied by hand to the rim of the wheel does not

Hand wheels shall have smooth rims and the direction of closing, which shall be clockwise, cast on them.
Valve stems shall be of stainless steel.
Stem seals shall be the O-ring type with two such seals arranged for easy replacement of O-rings and shall be accessible for maintenance.
Valves shall carry identification plates or marks in accordance with appropriate standard.
All materials used in manufacture of the valves shall conform to the following minimum standards:

- Ductile Iron
  DIN 1693 GGG-50
- Dezincification Resistant Brass
  BS 2874 Grade CZ132 (EN 12167)
- Stainless Steel
  DIN X 20 Cr 13
- O-rings
  NBR Rubber.

5.8.9 Knife Gate Valves

The body shall be made of cast iron. The gate and stem as well as connecting parts shall be made of stainless steel. Stem nut shall be of dezincification resistant brass.
Materials for seals shall be suitable for use with wastewater.
Unless otherwise specified, each valve shall be provided with a suitable hand wheel of adequate diameter for the duty required. Gearing shall be supplied where necessary, to ensure that the required operating force applied by hand to the rim of the wheel does not exceed the permitted values.
Hand wheels shall have smooth rims and the direction of closing, which shall be clockwise, cast on them.

5.8.10 Non-return Valves

The non-return valves shall be of the swing type with lever and counterweight and position indicator.
The non-return valves shall be manufactured from cast iron.
The tightness of the non-return valves shall be secured with renewable accurately machined non-ferrous facing strips or with rubber sealing, which shall be easily renewable as well.
All materials used in the manufacture of non-return valves shall conform to the following minimum standards:

- Cast Iron EN 1561 Grade 220
- Gunmetal BS 1400 Grade LG2
- Stainless Steel BS 970 Grade 431 S29

5.8.11 Ball Valves

The ball valves shall be of the two-way type and be provided with a handle for easy opening.

5.8.12 Conveyer systems

Dopravníky musí splňovat podmínky pro zatížení kalem. Musí být odolné proti nadměrnému obrusu částicemi, obsaženými v kalu.

5.8.12.1 Shaftless Spiral-conveyer

Design required; incl. anti vibration supports, trough with connection flange, feeding and discharge chute.
Materials: in accordance with the material to be transported, but have to meet at least following specifications: supports, suspension and trough stainless steel, trough lined with PE, spiral made from special steel painted or stainless steel.

Motor:
Protection class IP 54 with thermo protection

5.8.12.2 Belt conveyers

Mainly consisting of support and frame with sound absorbing, oil- and sewage resistant bearings, a oil- and sewage resistant belt with plies of fabric; incl. motor.
Completely encased to avoid odour nuisance.
Material: Frame, supports, enclosure, baffles and chutes: stainless steel
All other parts: cast iron, hot dip galvanised steel or steel with corrosion protection according to general specifications.

5.8.13 Pumps

Where applicable all pumps shall be works tested before delivery to Site.

General

- In each pumping installation all pumps shall be equal with respect to manufacturer and type.
- On the suction pipe before the pump an isolating valve shall be incorporated (only dry mounted pumps) and on the delivery pipe an isolating valve and a check valve shall be incorporated (both dry and wet mounted).
- All delivery pipes from pumps shall be provided with connecting branch with ball valve and manometer.
- Dry mounted pumps are preferable to submersible pumps. However, pumps shall be secured against flooding.
- Submersible pumps may be eccentrioc only.
- For dry mounted pumps the connection on both suction side and pressure side of the pump shall be via flexible connections.
- Single stage pumps with low speed motors are preferable;
- Positive displacement pumps (especially screw pumps) must not have rotor speeds at the highest motor operating frequency higher than 150 rpm (unless otherwise specified).
- Pumps shall be arranged for priming by means of an adequate positive suction head in all possible operating conditions.
- The operation cycle of the pumps shall include alternating also of the stand by pump. The pumps shall be dimensioned for minimum 10 starts per hour.
- For centrifugal canal-wheel type pumps the max. velocity at discharge flange is 3,5 m/s.
- Discernible noise caused by hydraulic turbulence and cavitation will not be accepted.
- Water hammers in the piping system shall be eliminated by installing surge vessels, special valves or similar.
- The pump impeller shall be selected for maximum efficiency. Pumps shall operate right to BEP (Best Efficiency Point) at start condition and to the left of BEP at stop conditions.
- The pump type shall be determined by the Contractor for maximum meantime between failures (clogging etc.) which shall be minimum 60 operation days.
- Impellers of the minimum or maximum diameters in relation to size of pump house shall not be used.
- Pump housing shall be fabricated from cast iron and impellers shall be of wear and corrosion resistant steel.
- When using frequency converters for speed control the pumps shall be equipped with external ventilation if speed control is possible below 35 Hz.
- All pumps shall be equipped with thermal switches for thermal protection.

5.8.14 Slewing Davits for Submersible Pumps

Slewing davits shall be provided for all pumps up to 250 kg, however a slewing davit is only required in case the pump is not served by an overhead crane.
The slewing davit shall be capable of lifting/lowering the above specified submersible pump and shall have the following features:

- shall be mobile and easy removable by one man

- davit based on DIN or ČSN ISO
- hoist in compliance with DIN or ČSN ISO
- davit with manually operated wire hoist
- davit complete with all necessary fastening material (fastening material hot dip galvanised)
- slewing radius of davit to be such to permit unloading of raised pump at a place accessible by forklift
- the lifting height shall be sufficient to allow slewing the crane with pump to pass the obstacle height (e.g. handrail)
- davit including all accessories have to be in accordance with current national safety regulations
- material:
- - davit: hot dip galvanized steel, stainless steel structure or aluminium
- -manual wire hoist material – hot dip galvanised steel or stainless steel with a safety ratchet block (for the winding drum)
- - lifting wire, thimble and shackle: – hot dip galvanised steel or stainless steel
- - pully: according to the material of the lifting gear

5.8.15 Submersible Pumps Suitable for Dry Installation, General

The submersible pumps suitable for dry installation shall have the following features:

- performance in excess of actual demand by at least 10 %
- casing with large-flow cross-section and replaceable wear ring where applicable
- impeller with large, unobstructed flow ways to ensure non-clogging and non-stringing operation
- impeller with means to reduce end thrust
- common motor/pump shaft supported in anti-friction bearings with grease and/or oil lubrication. Shaft not to be in contact with pumped medium.
- Intake and discharge side of pump with flanged connection
- Due to the dry installation of the pump, the motor cooling system must be highly efficient. Cooling shall be based on indirect cooling.
- type of seal: mechanical seal suitable for liquids with a high concentration of abrasive solids

Drive

The motor shall have the following features:

- dry-running three-phase asynchronous motor in watertight casing
- protection type IP68
- insulation class F
- operating mode S3 or S9 (Frequency converter)
- internal indirect cooling
- moisture/water sensor device to prevent damage to motor windings and bearings
- tandem mechanical shaft seal
- thermo element in coil for motor protection
- pump completely cabled

5.8.16 Submersible Pumps, for Wet Installations, General

The submersible pump for wet installation shall have the following features:

- performance in excess of actual demand by at least 10 %
- casing with large-flow cross-section and replaceable wear ring where applicable
- impeller with large, unobstructed flow ways to ensure non-clogging and non-stringing operation
- impeller with means to reduce end thrust
- common motor/pump shaft supported in anti-friction bearings with grease and/or oil lubrication. Shaft not to be in contact with pumped medium.
- Intake and discharge side of pump with flanged connection

- The motor cooling system must be highly efficient. Cooling shall be based on indirect cooling.
- Duck foot bend for automatic coupling of pump to discharge pipe.
- guide bar system for lowering/lifting of pump
- fixing components
- type of seal: mechanical seal suitable for liquids with a high concentration of abrasive solids

Drive

The motor shall have the following features:
- dry-running three-phase asynchronous motor in watertight casing
- protection type IP68
- insulation class F
- operating mode S3 or S9 (frequency converter)
- internal cooling
- moisture/water sensor device to prevent damage to motor windings and bearings
- tandem mechanical shaft seal
- thermo element in coil for motor protection
- sensor for bearing temperature
- pump completely cabled

5.8.17 Screw-Type Centrifugal Pumps, Wet installation, General

The screw-type centrifugal pump shall be suitable for wet installation and handling of liquids with long stringy solids as well as liquids of high solid concentration. The pump shall have the following features:
- performance in excess of actual demand by at least 10%
- impeller with large, unobstructed flow ways to ensure non-clogging and non-stringing operation
- capable of pumping liquids with 10 – 12 % dry solid content
- capable of pumping activated sludge and oil water mixtures
- steep performance curve
- high efficiency
- casing with replaceable wear liner
- common motor/pump shaft supported in anti-friction bearings with grease lubrication. Shaft not to be in contact with pumped medium
- duck foot bend for automatic coupling of pump to discharge pipe
- guide bar system for lowering/lifting of pump
- fixing components.
- double mechanical stuffing box

5.8.18 Screw-Type Centrifugal Pump, Dry Installation General

The screw-type centrifugal pump shall be suitable for dry installation and handling of liquids with long stringy solids as well as liquids of high solid concentration. The pump shall have the following features:
- performance in excess of actual demand by at least 10 %
- impeller with large, unobstructed flow ways to ensure non-clogging and non-stringing operation
- capable of pumping liquids with 10 - 12 % dry solid content
- capable of pumping activated sludge and oil water mixtures
- steep performance curve
- high efficiency
- casing with replaceable wear liner
- pump and motor on common base frame
- pump shaft supported in anti-friction bearings with grease lubrication

- pump with stuffing box packing

Drive

The drive unit shall have to the following features:
- dry-running three-phase asynchronous motor
- protection type IP 54
- insulation class F
- thermo element in coil for motor protection.

5.8.19 Progressive Cavity Pumps (Eccentric-Screw Pump), General

The eccentric-screw pump for conveyance of sludge shall have the following features:
- self-priming, rotary, valve less screw pump
- direction of rotation reversible
- suction chamber with venting and flushing attachment
- performance in excess of actual demand by at least 10 %
- anti-friction bearings with grease and/or oil lubrication
- type of seal: mechanical seal
- shaft at mechanical seal position to have wear resistant coating or wear sleeve
- sensor on suction side to prevent dry running
- pressure switch on discharge side
- pump and motor assembled on common base frame complete with coupling
- all fastening material to be included
- pin-type/ball joints connecting drive and rotor to be greased for service life; gastight and watertight sealing.

Drive

The drive unit shall have the following features:
- three-phase asynchronous motor
- protection type IP 54
- insulation class F.
- thermo element in coil for motor protection.

5.9 Particular Equipment

5.9.1 Mechanical Thickeners

The centrifuge installation shall be able to operate independently 24 hours per day and 7 days per week. The whole plant shall be operated automatically without plant operators permanently present.
A flushing system shall be applied for cleaning.
The inlet and outlet of each centrifuges unit shall be furnished with taps for sludge sampling.
All steel constructions, pipes, etc. in contact with the sludge and reject water shall be made of stainless steel.
Each of the centrifuges with auxiliary internal and external equipment shall be controlled as autonomous units, including minimum solenoid valves, pressure control and level electrode in the discharge hopper. The separate control unit shall include e.g. logic module, variable frequency drive, contactors, protective motor switches etc. The control unit shall include control for internal functions such as working time, cleaning time, alarms etc. Moreover signals for controlling external equipment such as sludge pump, polymer unit etc.
Polymer Dosing System for Mechanical Thickener
The units shall prepare, dilute and dose a polymer solution prepared from dry polymer powder. The unit shall also be suitable for the dilution and dosing of liquid polymer from polymer drums.

Powder hoppers shall be filled by means of vacuum conveyors to ensure dust free handling.
Polymer dosing pumps shall be provided with variable capacity and as well as in-line dosing/mixing systems for mixing the influent sludge and polymer shall be included. The dosing pumps shall be of the progressive cavity pump type with max rotation speed of 200 rpm. Each pump shall be protected against overload by means of pressure switch on the pressure side of the pump and the pumps shall be furnished with an automatic dry running protection.
Necessary tanks shall be included.
The tanks shall be fitted with a low level switch, a dry running switch for the dosing pump, a pump connection valve and a bottom drain valve.
A valve system shall allow flexibility in the polymer dosing. Hence switching from one polymer dosing unit to the other can be done by means of valves and each polymer dosing pump can by change in the valve position supply either of the thickeners.
All steel constructions, pipes, etc. in contact with the sludge and reject water shall be made of stainless steel. Polymer pipes are accepted as PEH pipe.
The polymer unit shall be located and arranged in a way that gives no obstructions for filling with polymer, service, and maintenance.

5.9.1.1 Sludge Feed Pumps for Mechanical Thickeners

Type:	progressive		cavity
rpm:	max	150	rpm
Installation:	dry		

Each pump shall be protected against overload by means of a pressure switch on the pressure side of the pump; moreover the pumps shall be furnished with an automatic dry running protection.
Mechanical Thickened Sludge Pumps
Pumps shall be of the progressive cavity type. The revolutions per minute at maximum performance shall not exceed 150 rpm. The pumps shall be provided with inlet feed screw or similar to prevent clogging of the inlet.
The pumps for mechanical thickened sludge shall be located in a way that mechanical thickened sludge by gravity is delivered/dropped into the pumps. The pumps shall be equipped with an automatic system for capacity control e.g. by a combination of weight sensors and VFD-control of pumps.
The pumps shall be mounted in the sludge dewatering building equipped with dry running protection and local control panels.
Each pump shall be protected against overload by means of a pressure switch on the pressure side of the pump.
The pumps shall have mechanical seals.
Auxiliary equipment for the mechanical thickener
Flush water system, crane and gangways shall be delivered to secure easy operation and maintenance.

5.9.2 Thermal Hydrolysis Unit

The Thermal Hydrolysis unit (THP) for waste activated sludge shall be based on steam explosion. The steam required must be generated at a boiler from high heat (HH). The high grade heat shall be provided by a cogeneration unit, which runs on the biogas generated by anaerobic digestion. The waste-heat boiler should be able to use part of the biogas directly if needed, in order to supplement the steam provided.
The THP unit must be fully automated and operated 24 hours per day and 7 days per week.
The THP unit shall be equipped with all necessary auxiliary equipment to ensure trouble free operation, as well as the required measures and precautions to guarantee safety against the high temperature and pressure hazards. If required, instructive guidelines on high temperature and pressure equipment operation must be provided to the operators.
The THP unit shall ensure the thermal hydrolysis process by heating the treated sludge at a minimum temperature of 140^0C, for a period of at least 20 minutes and at a pressure of 10 bar. After the reaction period, the treated sludge must be cooled by means of a heat exchanger system which uses treated effluent from the existing treatment plant. Supplementary addition of treated water shall be used to further decrease sludge temperature and the DS concentration.
With regard to the possible fouling of the unit, the required capacity must be achieved throughout the period between two periodic cleaning operations (cleaning max. once a year).

Positive displacement sludge pumps in the THP unit will not have a maximum rotor speed higher than 125 rpm.
The THP unit shall be of a well proven technology, which shall have many years of satisfactory operation in a substantial number of wastewater treatment plants throughout the world.
All steel constructions, pipes, etc. in contact with the sludge and reject water shall be made of stainless steel, and those parts made out of cast iron, properly coated against corrosion.
The THP unit shall be furnished with taps for sampling of the inlet secondary sludge and the outlet hydrolysed sludge.
The installation must be properly sealed against odour or potential gas escape.
The THP unit shall be provided with a local automatic control panel for all internal control as well as for auxiliary equipment. Signals for all operation modes and alarms shall be included.

5.9.3 Final Dewatering Equipment

The dewatering facility shall be based on fully automated centrifuges. The dewatering installation shall be able to operate independently 24 hours per day and 7 days per week. The whole plant shall be operated automatically without plant operators permanently present.
A flushing system shall be applied for cleaning.
The inlet and outlet of each centrifuges unit shall be furnished with taps for sludge sampling.
All steel constructions, pipes, etc. in contact with the sludge and reject water shall be made of stainless steel.
The dry solid (DS) concentration in the discharge is of high importance as in influence the subsequent sludge dryer.
The centrifuges shall be arranged for optimum access for easy inspection and maintenance.
Each centrifuge must be controlled as a separate unit, including valves, pressure control and level electrodes in the drainage pit. The separate control unit must contain, for example, a logic module, frequency converter, contactors, motor protection switches, etc. The control unit must contain internal function controls such as running hours, cleaning time, alarms, etc. In addition, signals for controlling external equipment such as pumps, dosing of polymers must be provided.
The reject water shall be collected in drains with visible covering allowing the observation of the reject water quality and the reject water sampling.
The centrifuges shall be of a well proven type, which shall have many years of satisfactory operation in a substantial number of wastewater treatment plants throughout the world.
The centrifuges shall be provided with a local automatic control panel for all internal control as well as for auxiliary equipment. Signals for all operation modes and alarms shall be included.
The centrifuges shall be equipped with all necessary auxiliary equipment to ensure trouble free operation.
Polymer Dosing System.
The units shall prepare, dilute and dose a polymer solution prepared from dry polymer powder. The unit shall also be suitable for the dilution and dosing of liquid polymer from polymer drums.
Powder hoppers shall be filled by means of vacuum conveyors to ensure dust free handling.
The flocculant dosing station must have a minimum of two tanks.
Polymer dosing pumps shall be provided with variable capacity and as well as in-line dosing/mixing systems for mixing the influent sludge and polymer shall be included. The dosing pumps shall be of the progressive cavity pump type with max rotation speed of 200 rpm. Each pump shall be protected against overload by means of pressure switch on the pressure side of the pump and the pumps shall be furnished with an automatic dry running protection.
Necessary tanks shall be included. The tanks shall be fitted with a low level switch, a dry running switch for the dosing pump, a pump connection valve and a bottom drain valve.
A valve system shall allow flexibility in the polymer dosing. Hence switching from one polymer dosing unit to the other can be done by means of valves and each polymer dosing pump shall by change in the valve position supply either of the belt filter presses.
All steel constructions, pipes, etc. in contact with the sludge and reject water shall be made of stainless steel. Polymer pipes are accepted as PEH pipe.
The polymer unit shall be located and arranged in a way that gives no obstructions for filling with polymer, service, and maintenance.

Sludge Feed Pumps

Type:	positive displacement
rpm:	max. 150 rpm

installation dry mounted
Each pump shall be protected against overload by means of a pressure switch on the pressure side of the pump.
The pumps shall have mechanical seals.
Auxiliary Equipment
Flush water system, crane and gangways shall be delivered to secure easy operation and maintenance.

5.9.4 Digester installations

Material and design have to meet all valid regulations according to current Czech laws and/or ATEX, EN and ISO standards and guidelines.
Mixing agitators
To create optimum process conditions (totally mixed sludge and equal temperature distribution) for the methane bacteria in the digesters it is necessary to establish an effective mixing of the total volume of digesters. The mixing should be based on an external system, where no equipment is installed inside the digesters.
The mixing system shall be designed for complete mixing so that floating sludge layer and sedimentation of sludge at the bottom is avoided. Complete mixing shall be proved by taking out samples from the top and the bottom of the digesters. The samples shall have a DS content with a deviation of maximum 1 %DS point (± 0.5% DS).
All parts in connection with the sludge shall be stainless steel.
Gas holders on digesters
The installation of three-membrane gasholders is preferred for the installation of gasholders integrated on the digesters. The gasholders must be designed to ensure that the sludge particles are not entrained into the biogas.
A pressure pipe connection and a pressure sensor with an output for automatic data transmission must be provided.
A safety valve must be provided if the pressure is exceeded to an impermissible limit value and it should be designed as a water seal with anti-freeze protection. A foam level detector with SCADA transmission will be installed. In addition, equipment (spraying nozzles) must be fitted to disintegrate the layers of foam and floating sludge.
The gas holder must additionally be fitted with a screwed lid with transparent peer-hole DN 500 and a double wiper (both inside and outside) and explosion-proof point and level switches.
The gas holder with installed equipment shall be gas-tight with gaskets resistant to methane gas and H_2S.
Gas piping from stainless steel:
Material: steel stainless including flanges and fittings.
Compensators:
Elastic pipe connections with both-sided friction bearings:
as rubber compensator, UV-resistant, resistant to digester gas (EPDM) resp. for pressure pipes from nitrile rubber (NBR) with stainless flanges; as axial compensator from multiple walled elastic tubing from stainless steel, both-sided welded stainless steel flanges, inner protection tube from stainless steel.

Fine filter for bio gas
Bio gas used in gas motor shall be treated in a fine filter to separate dust and moisture. The filter shall be equipped with: condensate plug, flushing device, water sealing with two pressure gauges, explosion proof.
Flame Arresters
In front of all gas consumers flame arresters shall be provided made from stainless steel.
Integrated heating of the digesters
It will be connected to the heating system of the sludge management system and will provide heating of the digesters in case of THP downtime or ensure additional heating of the digesters under unfavourable temperature conditions. The proposed system is subject to approval by the Engineer at all stages of the design and implementation.
Sludge heat exchangers

The sludge heat exchangers, if designed, will be either of a tube type, with the diameter of the sludge pipeline not being less than 150 mm. The heat exchangers should be made of stainless steel and with all pipe insulations.
Alternatively, the spiral-type heat exchangers can be installed, based on the counterflow principle, with a horizontal axis and a cover on both sides with easy removal of the hinges. The spiral-type heat exchanger must be of a standard design and well-proven in practice.
The heat exchanger type must be approved by the Engineer at the time of designing the heat management system of the digesters.
Heat supply system
The biogas produced in the digester shall primary fuel a combined biogas engine power and heat plant, which shall generate electric power and heat to be utilised for heating the digesters and sludge dryer.
All heat supply pipes and the return pipes shall be provided with efficient insulation.
The heating system shall be designed and executed with non-return valves, automatic valves, gate valves, temperature meters sufficient for proper operation of the system
Gas Torch
The gas torch shall have an increment capacity suitable maximum amount of produced gas from the digesters. The gas torch shall be equipped with automatic ignition, wind shield valves. Torch shall be equipped with all safety equipment including: Break for gas pressure with solenoid valve, flame arrester, blow off valve etc.
Material of combustion chamber shall be made of heat resistant stainless steel, and gas touched parts from stainless steel according to specifications for stainless steel.
Gas torched must be fitted with combusted gas volume metering.
Gas Desulphurisation Plant
A gas desulphurisation plant shall be provided. The plant can be designed either for wet or dry operation. It shall include all control and safety devices, displays, pumps and blowers incl. one additional stand-by aggregate.
A H_2S on-line sensor shall be installed.
The desulphurisation plant shall operate autonomously, and the control panel shall be installed in a non EX classified area.

5.9.5 Boiler

The boiler will be equipped with two burners that are designed both for combustion of biogas and natural gas.
The heat will be produced in CHP cogeneration units with the support of dual-fuel boilers. Therefore, all the heat sources must be interconnected in one or more thermal circuits that serve both the requirements of the dryer and the digesters. Building heating must also be connected to the system.
Boiler and Burner
Boilers, burners and safety systems must comply with applicable standards and regulations.
The boilers must be equipped with a fully modulated dual-fuel burners supplemented with gas fittings, valves and accessories meeting the requirements of the relevant Czech standards and regulations.
The burner power must be capable of continuous or step regulation in a range of 25 - 100%.
Required boiler efficiency at least 93%.
The boiler room must be heated in case of boiler downtime.
The boiler electrical control system must be equipped with all the necessary automation, including sensors, etc. for fully automatic operation depending on the heat demand.
Water/water Plate Heat Exchangers
Water/water heat exchangers shall be plate heat exchangers.
The heat exchangers shall be equipped with stainless steel un-welded plates in a quality to the water quality.
The pressure drop over the heat exchangers after fouling must not exceed 0.2 bar neither on the primary nor the secondary side.
The main control loop for the heat exchangers shall be based on a control valve on the primary side and a temperature measurement on the secondary side.
Circulating Pump System
The circulating pump system in the boiler circuit shall consist of two 100 % pumps (alternatively 3 x 50 %) equipped with speed control (frequency converter).
Motor protection degree shall be IP 54 or better.
Pressure Holding System and Thermal Expansion

Boilers will be fitted with an expansion vessel.
Water Treatment in the Boiler-Gas motor Circuit
The water treatment system shall in principle comprise

- Softening station
- Iron removal, if applicable;
- De-aeration;
- Chemical dosing for pH-control;

The water quality shall fulfil common Western European standards and the requirements set by the boiler and gas motor manufacture.
Thermal insulation
All pipes for recirculation of sludge from digester to heat exchanger shall be provided with thermal insulation.
All pipes between boilers and heat exchangers shall be insulated.
All pipes between biogas engine and heat exchangers and boilers shall be insulated.
All insulated pipes shall be covered with a protective sheet of aluminium.
Heat meter
A heat meter for installation on the return line on the boiler circuit shall be included.

5.9.6 Combined Biogas Engine Power and Heat Plant

5.9.6.1 Plant requirements

The combined biogas engine power and heat plant shall minimum include the following main units:

- Biogas engine, complete with accessories, starting system, integrated lube oil system, vent and drain system, control and protection system, etc.
- Biogas supply system consisting of gas train and pipe connection to the biogas engine, including all necessary components.
- Synchronous alternator with complete air-cooling system and directly connected brushless exciter and controls, and with automatic power factor regulation system.
- Air intake system with the admission provided from the engine room complete with filtration and noise suppression systems.
- Heat exchanger for cooling water, oil cooler and intercooler.
- Exhaust gas pipe system with exhaust gas silencer.
- Exhaust gas heat exchanger for recovery of heat from the combustion gas with automatic by-pass of the exhaust gas when the heat recovered from the exhaust gas exchanger is not utilised.
- Emergency cooling water radiator system, 100% cooling capacity, which automatically switches on if the heat recovered from the cooling water heat exchanger is not utilised.
- All fittings and piping between the engine and the various heat exchangers, radiators and coolers.
- Lubricating oil tank equipped with oil pump etc. for oil change.
- Ventilation system for the biogas engine room comprising fans and air grilles. The ventilation system shall be sufficiently rated for the combustion air and for removing excess heat from the room. Cross ventilation should be achieved.
- All necessary power and control panels..

5.9.6.2 Biogas Engine

The biogas engine shall be a 4-stroke multi-cylinder spark-ignition turbocharged engine for biogas. The engine shall have high efficiency and be suitable for continuously stable operation with the stated gas flow and quality. The gas motor shall be designed for continuous operation with a yearly non-operation time maximum total 48 hours.

The engine together with the alternator and the necessary mechanical accessory equipment shall be placed on the common frame of the aggregate. The exhaust gas heat exchanger, silencer shall be located either on the same frame or adjacent to the engine on a separate frame.
The following design features shall be applied:

5.9.6.3 Exhaust System

The exhaust system shall include but not be limited to the following:

- Exhaust gas heat exchanger with automatic by pass system.

The exhaust gas heat exchanger shall be connected with the steam generator system.
The materials used for the exhaust gas heat exchanger shall be compatible with the material of pipes, and shall cause no corrosion or erosion.
The noise level at the engine flue gas outlet (behind the noise silencer) shall not exceed the value of 55 dB(A).
The exhaust system shall be insulated to reduce the heat transmission inside the room as much as possible and keep the surface temperature under dangerous values. The insulation shall be removable and reusable

5.9.6.4 Cooling Water System

The cooling water system shall include but not be limited to:

- Cooling water pumps for circulation of water through biogas engine, intercooler, lubrication oil heat exchanger, external cooling system etc.
- Cooling thermostatic systems for engine cooling and external cooling
- Expansion tank
- Facility for temperature gauge and high temperature switch
- All necessary piping, valves, vents, drains, etc.

5.9.6.5 Alternator

The alternator shall be designed to be situated together with the engine unit on the combined frame.
The alternator shall be of the self-ventilated, brushless, self-exciting, self-regulating standard type with data as follows:

- 3x400 V, 50 Hz, PF 0,8
- Nominal power according to nominal power of biogas engine
- 3-phase star, 4-wire with non-earthed neutral

Voltage adjustment range:	5% rated voltage
Voltage exactness (static)	1% at no load at full load a power factor of 0.8-1 rpm variation 3%
Voltage curve at no load, deviation	<5%

The insulation of alternator and exciter windings shall be Class F in accordance with IEC 85. However, the temperature raise limit during operation shall not exceed that for Class B insulation.

5.9.6.6 Monitoring:

An industrial operator panel shall be installed for supervision, alarm handling, parameter setting and other operation.
All main functions shall be monitored. An interface shall be established in order to monitor all main functions at the central SCADA system at the treatment plan.
Monitoring must enable remote connection to the control centre of the servicing company in line with the current design.
Prior to dispatch from the works, the complete bio gas motor are subjected to factory acceptance test (FAT) under load and the operational, output and consumption data described in the following documented in a test protocol. Such protocols serve as proof of specified technical performance. If so

desired, the test run of the complete bio gas motor system shall be carried out in the presence of the Engineer.
The following values are to be recorded in a test protocol during the test run (measurements at load points 100%, 75%, 50% in compliance with DIN 6271):

- engine output
- fuel consumption
- engine cooling water temperature
- lube oil pressure
- lube oil temperatures
- boost pressure
- exhaust gas temperature per cylinder

5.9.7 Gas Holding and Utilisation System

The gas holder shall be complete automatic pressure control and pressure regulation system (adjustable) and pressure blow off. It shall be equipped with safety devices with limit switches and filling level indicators.
All steel parts in contact with gas shall be from stainless steel

5.9.8 Pressure Tests of Gas Systems

Pressure test and commissioning of all gas related parts with non explosive gas (O_2 content in system lower than 5%) with nitrogen or CO_2 in accordance with local law and technical regulations.
Protocols and reports of pressure and leakage tests shall be issued by the Contractor.

5.9.9 Sludge Drying Plant

The sludge drying unit must be considered as a low temperature process, which is to indicate that it shall operate at a temperature below 100 ^{o}C.
The sludge drying unit be able to run on combustion of either the biogas produced from the anaerobic digestion process, or on natural gas. It should also be able to use waste heat provided by other sections in the sludge treatment line.
The evaporated water and the amount of gasses released during the drying process have to be treated before emission to the environment.
There must be present an integrated condensate unit, which can reuse the energy stored in the vapours resulting from the sludge drying process.

5.9.10 Treated Wastewater for Reuse Supply System

Wastewater pumped from the WWTP effluent used as a service water must pass through an automatic self-cleaning filter system with inlet water parameters corresponding to the requirements of the respective systems such as nozzles, sprinklers,etc.

5.9.11 Spare Parts

Spare parts sufficient for the operation of the entire sludge line for 24 months shall be provided by the Contractor immediately prior to the acceptance of the Works. On the basis of manufacturers' recommendations, the Contractor shall provide the required spare parts for all the equipment and prepare their list. The contractor and the manufacturers of selected spare parts shall submit an attachment to this spare parts list, which shall contain only the minimum required compulsory spare parts.

5.9.12 Tools

A complete set of tools, including spanners and special tools needed to service, maintain and dismantle most important parts of the system shall be provided by the Contractor immediately prior to the takeover of the Works. Based on manufacturer's recommendations, the Contractor will provide the tools required for all the equipment and draw up their list.

6 Electrical Works

6.1 General

In the following are outlined the minimum requirements for the Electrical Works at the new sludge treatment management at Brno-Modrice WWTP. Unless stated othwreise in these requirements, all equipment must comply with the relevant standards and regulations, as amended, upon the completion of the Works.

6.1.1 System of Units

The SI system of units shall be used throughout the Contract.

6.1.2 Design Temperature

The Contractor shall in this design account for the temperature rise deriving from installed equipment and from solar radiation in such a way that the rated performance and stability of the plant is guaranteed under the prevailing climatic conditions.
Attention shall be given to the design of panels.
The maximum temperature inside the panel should not exceed 35°C or the maximum temperature for any electrical part in the panel. The switchboard equipment must be operable at ambient temperatures up to 40°C.

6.1.3 Degree of Protection

All terminal boxes, cabinets, lighting fixtures, etc. shall have degrees of protection by enclosure, according to IEC 144 as follows:

Panels	IP54
Other material	IP55

Other requirements are as specified in the relevant chapters.

6.1.4 Condensation

All enclosures shall be designed to minimize condensation with provision for ventilation and drainage as appropriate. Openings for ventilation and drainage must not give access to vermin.

6.1.5 Voltages

Electricity available is A.C., 230 V ± 10% single phase, 50 Hz and 230 V/400 V ± 10% three phases, 50 Hz. The phase factor shall be better than 0.98. The voltage drop from transformer to any consuming equipment must not exceed 8%.

6.1.6 Marking

Each item of equipment shall be provided with a rating plate giving the type and serial number together with its ratings and service conditions. Labels and nameplates shall be provided as necessary to clearly identify the function and circuit designation of equipment. The supply voltage shall also be written on the rating plate. All panels, switches, boxes, cables, motors etc. shall be labelled.
All rating plates, nameplates, labels and wiring plates shall be of non-corrodible material. Inscriptions shall be clearly legible from the operating distance and shall be in national language throughout. Notices indicating danger to personnel shall be in local language. Details and locations of all such plates, labels, etc. shall be subject to the Engineer's approval.

6.2 High Voltage Switchgear and Transformer Stations

6.2.1 General

High voltage switchgear and transformer stations shall be designed for safe, reliable and maintenance free operation under the environmental conditions at the sites.
The components of the stations shall be a standard construction provided with standard equipment and delivered ready for easy connection and reliable and safe operation.
The stations shall consist of:

- High voltage section with power circuit breakers, earthing connectors, over voltage protection equipment, volt and ampere measuring transformers.
- Transformer section with power transformer(s).
- Low voltage section.
- Earthing system.

The layout of the station shall allow for easy access to the equipment inside the station. Further, easy replacement shall be allowed, in particular replacement of the transformers.
Protection equipment, control switches and indicating instruments for the high voltage switch and transformer station shall be installed in a dedicated control panel.
The high voltage equipment shall be rated for continuous operation with maximum load of the and slight overload.
All materials shall be "ready made" and prepared for easy site installation with a minimum of work required onsite.

6.2.2 Power Circuit Breakers and Disconnectors

Power circuit breakers and disconnectors shall be three-pole types, and fully enclosed metal cladding draw out circuit breaker system with 2 feeder inlets, sectioning, transformer outlets and measuring systems.
Load disconnectors shall have characteristics commensurate with the circuit they supply and a load break capacity in excess of the total load of the circuit they supply.
Power circuit breakers rated switching capacity shall be at least equal to the total load of the circuit they supply. Power circuit breakers shall be provided with adjustable instantaneous short circuit and overload trips relays to allow for changes in the site load, and to allow for plant expansion. The prospective fault level must not be higher than the breaker capacity, and the time/current tripping characteristics shall be chosen and set with due regard to the equipment performance and circuit data, and to assure discrimination between series connected power circuit breakers. The power circuit breaker closest to a fault shall clear the fault. If it fails the upstream power circuit breaker shall clear the fault.
Power circuit breakers shall be fitted with a protection system to comprise the following facilities:

- Single phase failure trip.
- Earth fault trip.
- Thermal overload trip.
- Short circuit trip.

Safety elements of some technologies shall be automatically controlled from the protection equipment (gas alarm, high temperature alarm, overcurrent, short circuit and I^2t thermo).
All power circuit breakers shall be remote controlled from the master station and control panel. All power circuit breakers shall be fitted with an operator handle enabling manual switching.
All cables shall be connected through terminals. Terminals shall be suitable for the dimension of the cables and conductor material used.
All available signals shall be provided for telemetry and wired to the PLC for remote control and monitoring.

6.2.3 Transformers

The power transformers shall be three-phase transformers with voltage level **22 kV**/0,42 kV suitable rated for continuous load of the treatment plant under worst climatic site conditions.
The transformer rating under standard conditions shall be in accordance with IEC-60076.
Transformer losses (no-load and load losses) shall be designed to a minimum.
Transformers shall be constructed and be of the naturally air-cooled (ONAN) oil filled type and meet or exceed the requirements of IEC 60076.
The three phase transformer windings shall be connected in a delta-star formation with group 4 phase displacement.
Winding insulation shall be to Class 'A'. The temperature rise shall be limited to the maximum operating temperature for Class 'A' materials as defined in IEC 60076 de-rated for the climatic conditions.
Tap selection shall be by means of a five position externally operated manual control off-circuit tapping switch. A mechanical tap position indicator shall be provided and the switch shall be padlockable in any position. A suitable padlock shall be fitted to each tap changer and be supplied complete with two keys.
A label warning that power must be switched off before the tap changer is operated shall be fitted.
Windings shall be braced to withstand dynamic stresses due to short circuit conditions. Full details shall be provided of the arrangements for taking up or eliminating coil shrinkage during service. The core and winding shall be designed so that the loss is minimum.
The complete transformer arranged for service shall be capable of withstanding an impulse voltage on the primary windings in accordance with IEC 60076.
All joints shall be arranged so that they may be tightened externally.
Each transformer must be fitted with an identificaton plate.

6.2.3.1 Testing and commissioning

Power transformers shall be routine tested at the manufacturer's works in accordance with BS 171. The Engineer will require witnessing the following tests:
- Measurement of winding resistance.
- Ratio, polarity and phase relationship.
- Impedance voltage.
- Load losses.
- No-load losses and no-load current.
- Induced over-voltage withstand.

Further witness tests shall also be carried out in accordance with the following:
- Impulse voltage withstand. If the manufacturer can provide evidence covering impulse voltage withstand tests for transformers of similar type and design, Type Test certificates will be acceptable.
- Temperature rise. Where transformers of identical design and rating are being supplied, only one unit needs to be subjected to the full Temperature rise test and Type Test certificates supplied for the duplicate units.

Prior to dispatch to site the Contractor shall pass to the Engineer, in triplicate, copies of the all test certificates for approval.

6.2.3.2 Instruments

The measuring transformers shall at least include load for the following instruments, all within class 1:
- Three voltmeters (one for each phase).
- Three ammeters with overload scale to 150% of IN.
- kWh meters.
- kVArh meters.

Measuring instruments installed in the substations must be equipped with the possibility of communicating with the SCADA system or with impulse outputs for connection to the existing energy metering system.

Current transformers shall be suitably rated and designed to carry out appropriate metering and protection functions as indicated.
The rated burden of current transformers shall not be less than the sum of burdens of all relays, instruments and related loads.
All available signals shall be provided for telemetry and wired to the PLC for remote control and monitoring.

6.2.3.3 Earthing system

The transformer station shall be provided with an earthing system less than 1 ohm.
Earthing must be designed in line with the applicable regulations, norms and standards.
Before proceeding with the design of each earthing system, the Contractor shall measure soil resistively for particular locations of the transformer station.
The earthing system for each transformer station shall be interconnected with the common equipotential bonding bar (CEBB) for the Site. This interconnection shall be made of a copper strip or wire.
The earthing system shall be provided with testing joints mounted in a separate earthing cubicle. Testing joints shall be provided for each earth rod and for the connection point to the earth for the WWTP.

6.3 Low-voltage assemblies

6.3.1 General requirements

Assemblies shall meet relevant standards and other regulations.
Assemblies shall provide minimum of 20% spare space for future use after installation is completed and when handing over. The spare space shall be provided as coherent space in whole and empty sub-sections.
Building installation such as illumination, socket outlets, electrical heaters etc. shall be energised from assemblies intended solely for building services.

6.3.1.1 Construction

Assembly enclosures are to be fabricated from electro-galvanised mild sheet steel and cold rolled sections bolted together. All steel parts shall be treated effectively against corrosion after manufacturing. The treatment shall include sand blasting, anti-grease, primer and coating. Paint must be sprayed and kiln-dried.
Assemblies shall be constructed so that normal maintenance may be carried out from the front. Front doors and covers shall be hinged and lockable with a common key for each section. Assembly enclosures shall provide a minimum protection of IP44.
Assembly design is to be of a modular type allowing the assembly to be broken down into sections for ease of transportation and installation. The preferred module size adopted is 600x600 mm. Height of assemblies must not exceed 2100 mm measured from finished floor level to the highest point of the assembly. Isolator handles, control switches, push buttons, indicator lamps and instrumentation shall not be less than 500 mm and not more than 1750 mm above finished floor level.
The individual switchboard panels must be lit. The lighting will be activated automatically when opening the relevant panel and deactivated when closing the panel.
Solid barriers shall be provided to segregate each load compartment from other compartments and the busbar chamber, to prevent objects falling into lower live compartments, and to restrict fault travel to other compartments.
Assemblies shall be regular shaped and rectangular, and where possible designed and constructed for floor mounting over cable trenches.
Minor assemblies may be designed and constructed for wall installation. All cables must enter or exit assemblies through a glanding plate provided with the appropriate sizes and types of cable glands (bushings).

6.3.1.2 General Electrical Requirements

Assemblies shall be rated to the levels specified in the particular specification for operation on a 420 V, 3 phase, 5 wires (TN-S), 50 Hz supply. Control voltages shall be 242 V and 24 V. The size of the 24 V supply unit is to be based upon actual consumers connected plus future expansions of the plant.
All components shall function properly within a supply tolerance of -15 % to +10 % on the 420/242 V and -2,5 % to + 2,5 % on the 50 Hz frequency.
Signals to and from instrumentation shall be for analogue 4-20 mA, and for digital 24 V DC. Instrumentation will be supplied at 24 V DC.
All component installed in assemblies shall be CE-labelled, and must be capable of withstanding the dynamic and thermal stresses, without detriment, resulting from the prospective fault current.
Voltmeters and ammeters shall be door mounted square type 96x96 mm pointer instruments with black scale on white background. Indicating instruments shall have a scale which provides 25% spare capacity of normal working indication.
The system of tripping devices for the circuit breakers shall be designed and set to ensure full selectivity. E.g. short-circuit in any circuit shall be cut off by the breaker that is closest to the short.
The branch circuits shall be protected by means of circuit breakers.
Relays shall have indication of status (on/off) by signal lights (LED) and by a mechanical arrangement. Relays shall have a test button. The relays shall be connected via a standard socket mounted on DIN-rails.
Pilot and indication lamps shall be of the LED type and provided with a common lamp test facility.

6.3.1.3 Access

All apparatus, equipment and components within assemblies must be so arranged that they can easily be identified and worked on, and, as necessary, removed for repair and maintenance. Sensitive equipment must not be installed on covers, doors or hinged assemblies. It is a requirement of this Specification that any piece of equipment shall be removable without disturbance to any other piece of equipment.

6.3.1.4 Internal Wiring

All wiring within assemblies must be supported in trunkings appropriate during construction. Component terminals must never take the weight of wires. All supports for wiring must be either screwed or stud welded. Adhesive type supports are expressly forbidden.
All wires shall have stranded copper conductors.
Wiring at different voltages and AC and DC must be segregated in accordance with IEC 60364.
Wiring shall not be less than 300/500 volt grade with an insulation temperature withstand of not less than 70° C. Wiring is to be sized according to the prospective fault current level.

6.3.1.5 Terminations

All terminals and terminal blocks must have each termination numbered. Power supply terminals are to be identified with colours and/or numbers corresponding to phase designations. Depending on the type of terminal, cable lugs shall be attached to wires or cores.

6.3.1.6 Earthing

All normal non-current carrying metal work of an assembly must be bonded to the earth connection point within the enclosure. All doors, covers or assemblies must be permanently connected. All earth conductors must be single core multiple stranded and PVC insulated for mechanical protection, coloured green/yellow spiral striped.

6.3.1.7 Transient protection equipment

Transient protection equipment shall be connected to the incoming power supply cables. The equipment shall be placed in its own section of the assembly and located as near as possible to the feeder cables. All phases and the neutral shall be provided with over voltage/transient protection devices. Status (available/defect) of the transient protection equipment is to be signalled to the PLC.

6.3.1.8 Busbars

Assemblies shall be equipped with separate earthing and neutral busbar.
Busbars shall be of hard drawn electrolytic copper. Ends and joints must be protected against corrosion.
Busbars must be sized for the prospective fault current level and duration. Due regard shall be given to the method of supporting, regarding current withstand and thermal/mechanical stresses.
Busbars shall be enclosed in a separate chamber.
Easy access shall be available to the busbars for future connections.

6.3.1.9 Assembly ventilation

All sections that contain equipment susceptible to heat that may be generated in normal operation shall be fitted with forced air-cooling.
Filters shall be provided to maintain the integrity of the dust and moisture protection rating of the assembly. Fans shall be thermostatically controlled and automatically switched on, on rising temperature level in the section.
Indication of fan failure or section over temperature shall be included on the section door and signalled to the PLC.

6.3.1.10 Circuit breakers

Circuit breakers for supply of final sub-circuits to equipment shall have a rated switching capacity at least equal to the total load of the circuit they supply.
Circuit breakers will be installed in all defined outlets, in particular switch boxes connectign flexible cabling.
The switches must be locable in on and off positions.

6.3.1.11 Motor Controllers

Each electric motor must have its associated control and protection equipment.
Motor controllers are to be designed in accordance with the manufacturers' recommendations for the motor type, characteristics, size and duty. Facilities for padlocking in on/off positions are to be provided.
Thermal relays for motor protection shall be adjustable and comply with IEC 255, and must be rated for the ambient conditions, and must not deviate in accuracy due to temperature or ageing, and must be chosen so that the full-load current corresponds to approximately the middle range of operation of the relay. A tripped relay shall be reset by hand via a push button. Two auxiliary contacts shall be provided for signalling. Single phase failure shall be incorporated on all phases with a sensitivity not exceeding the values stated in EN 60947.
Motor starters shall include the following:

- Motor circuit breaker, suitably rated lockable moulded case circuit breaker, with short circuit protection.
- Suitably rated miniature circuit breaker for the control circuit.
- Contactor suitably rated for direct on line start.
- Adjustable thermal overload protection.
- Complete control circuit.
- Set of main and auxiliary terminals and a 15% spare capacity.
- Door mounted:
  - Hours run counter, non re-settable type, to 99.999,9 hours.
  - Indicating lamps for:
  - thermal trip
  - running
  - emergency stop activated (if applicable)
  - Selector switch for hand-off-automatic (HOA) control. In position:
    Hand: The operator controls operation of the motor by means of start/stop push buttons. The automatic control system is bypassed.

    Off: The motor is switched off and inoperative. The automatic control system is bypassed.

Automatic (Auto): The motor is controlled by the automatic control system, i.e. the PLC. The start/stop push buttons are inoperative.

- Push buttons for:
  overload reset

  reset after emergency stop

- Auxiliary contacts for remote monitoring.

Local at the motor a local panel for hand operations shall be installed. The panel's user interface consists of:

- Start stop buttons
- Indicator lamps for:
  - thermal trip
  - running
  - emergency stop activated (if applicable)
  - hand mode selected

Circuits for manual operation shall be hardwired to ensure limited operation of the plant if the automatic control system fails.
The running indication lamp and hours run counter shall be driven solely by means of a dedicated current actuated relay.
Every safety and protection device for the motor e.g. thermistor switch imbedded in motor windings etc., shall be hardwired into the motor control circuit to ensure immediately disconnection of the motor in the event of a failure.
The control circuit shall be design such that a tripped motor cannot re-start automatically, but only after the fault has been cleared and after reset by hand via a door mounted push button.
The motor circuit breaker shall be fitted with a door mounted operating handle, which can be padlocked in off position. When locked in off position the motor cannot be energised under any circumstance.
All available signals shall be provided for telemetry and wired to the PLC for remote control and monitoring.

6.3.1.12 Frequency Converter Motor Controller

In addition to the required standard motor starter fitting-out mentioned above, frequency converter motor starters shall be performed according to the following:
Earth leakage protection shall be incorporated either using electronic relays or by adding residual current protection to the motor circuit breaker. Attention is drawn to the fact that the earth leakage protection must be of a type, which is capable of functioning with frequency converters.
If the frequency converters employed are incorporated with overload protection the latter may be utilised for motor overload protection in lieu of thermostat protection relays. If the frequency converters cannot provide the function of motor overload protection, thermostat protection relays shall be adopted.
Each frequency converter shall be clearly labelled with the number of the motor/pump, which it is serving. The frequency converter shall be placed so its internal control panel is placed approximately 1600 mm above finished floor level. If installed inside an assembly provision shall be made for adequate ventilation.
When the panel hand-off-automatic (HOA) selector switch is in position:

- Hand: The operator controls operation of the motor from the front of the frequency converter. The automatic control system is bypassed.
- Off: The motor is switched off and inoperative. The automatic control system is bypassed.
- Automatic (Auto): The motor is controlled by the automatic control system.

Manual control shall be performed from the front of each frequency converter where the operator shall be capable of starting/stopping and turning up and down the pump revolutions.
Each frequency converter shall be configured to display the following current values on request:

- Ampere [A]
- Power factor (0-1)
- True power [kW]

- Apparent power [kava]
- Revolutions per minute [RPM]

All available signals shall be provided for telemetry and wired to the PLC for remote control and monitoring.

6.3.1.13 Labelling and Marking

Text on labels shall be in the Czech language. The marking must corresod to applicable regulations and norms.
All marking shall comply with the documentation for the assembly e.g. circuit diagrams and wiring diagram etc.
Each assembly shall be provided with a label displaying the assembly's identification number, and describing the function of the assembly. The height of text applied shall be minimum 10 mm.
Labels identifying each front of assembly mounted devices e.g. ammeter, selector switches, push buttons, lamps, etc., shall be provided on the face of the assembly. Labels identifying and denoting the function of apparatus and group of equipment located behind doors e.g. motor controller etc. must be placed on the respective front door. The height of text applied shall be 4-5 mm.
All labels shall be with black engraved letters on white background. Only uppercase letters may be used.
Assemblies shall be fitted with a warning label, warning against electric shock. The warning label shall be engraved to give black letters on a yellow background, and be preceded by the lightning flash symbol.
Labels shall be fixed with countersunk chromium plated or stainless steel screws. Self-adhesive labels will not be accepted.
Internal labels designating components shall be fixed to non-removable equipment. Internal labels must be visible and must not be obscured by assembly wiring, etc.
Labels on the face of assemblies shall be so placed that levers in any position do not cover them.
Each and every component or piece of equipment within assemblies must be tagged with an independent reference number. Marking shall be executed by adhesive marks of plastic impregnated tissue.
Each internal wire shall be identified pursuant to circuit diagrams by means of ring type plastic makers at both ends, placed on the wire before termination.
Terminals for connection of power cables shall be marked with phase nomination and group number.
Terminals for connection of control and instrument cables shall be numbered.

6.3.1.14 Documentation

One set "As built" drawings e.g. circuit diagrams and wiring diagram etc. for the assembly shall be provided and placed in a dedicated location within each assembly.

6.3.2 Switchboards

The Works will use such types of switchboards that provide comprehensive solutions to the switchboard cabinet. Cabinet manufacturer covers (but not only) common types of cabinets (painted steel, stainless steel, plastic, IT, small cabinets etc). Also provides wide pallet of accessories (internal installation components, aircondition units, etc..) designed for supplied cabinets. Cabinets will provides compatibility to common installation components (cable glands, bus bars, different manufacturers installation units based o mounting to base plate and also on standardized rails).PThe abbreviation **CaMa** will be used to designate the required standard.

6.3.2.1 Motor Control Cabinets (MCC)

pos	Specification		n/a	applicable
	MCC`s for process units One door version: ☒, width: 800mm Double door version: ☐, n.a. Overall dimensions: width: 800mm height: 2000mm + 100mm base depth: 600mm		☐	☒
	Cabinet base height: 100mm		☐	☒
	Cabinet lock: Double-ward key, no handle ☐ Double-ward key, with handle ☒ Double-ward key, with special handle system and padlock ☐ Others ☐			☒
	Cabinet material	Steel, painted: RAL 7035	☐	☒
	Free space approx.: 10%		☐	☒
	Double door version: IP 55		☐	☒
	Document wallet		☐	☒
	Cabinet fan: Supplier: CaMa		☐	☒
	Cabinet filter Supplier: CaMa		☐	☒
	Temperature monitoring inside the cabinet: Supplier: CaMa		☐	☒
	Cabinet internal light	☒ limit switch	☐	☒
	Service plug, 230VAC	power supply after main switch	☐	☒
	Cable entry to the cabinet: From below ☒ From above ☒ From backside ☐ From left side ☐ From right side ☐		☐	☒
	Location (Room / Coordinates): - Distribution area		☐	☒
	Emergency Stop Included		☐	☒
	Cabinet light – optical sensor with manual switch On/Off/Auto		☐	☒

6.3.2.2 CPU Control Cabinets (MCC)

pos	Specification		n/a	applicable
1	Standard : CaMa One door version: ☒, width: 600mm Double door version: ☐, n.a. Overall dimensions: width: 600mm height: 2000mm + 100mm base depth: 600mm		☐	☒
1	Cabinet base height: 200mm		☐	☒
1	Cabinet lock: Double-ward key, no handle ☐ Double-ward key, with handle ☒ Double-ward key, with special handle system and padlock ☐ Others ☐		☐	☒
2	Cabinet material	Steel, painted: RAL 7035	☐	☒
2	Free space approx.: 10%		☐	☒
2	Double door version: IP 55		☐	☒
2	Document wallet		☐	☒
2	Cabinet fan: Supplier: CaMa		☐	☒
2	Cabinet filter Supplier: CaMa		☐	☒
2	Temperature monitoring inside the cabinet: Supplier: CaMa		☐	☒
2	Service plug, 230VAC	power supply after main switch	☐	☒
2	Cable entry to the cabinet: From below ☒ From above ☒ From backside ☐ From left side ☐ From right side ☐		☐	☒
2	Location (Room / Coordinates): - Distribution area		☐	☒
3	Emergency Stop Included		☐	☒
3	Cabinet light – optical sensor with manual switch On/Off/Auto		☐	☒

6.3.2.3 Local control cabinets (LCC)

pos	Specification		n/a	applicable
1	LCC`s for Production areas Standard: CaMa One door version: ☐ Double door version: ☒ Dimensions: width: 800mm height: 1000mm depth: 300mm		☐	☒
2	Cabinet lock: Double-ward key, no handle ☒ Double-ward key, with handle ☐ Double-ward key, with special handle system and padlock ☐ Others ☐		☐	☒
3	Cabinet material	Steel, painted: RAL 7035	☒	☐
		Stainless steel: 1.4301	☐	☒
4	Free space approx.: 25%		☐	☒
5	Ingress protection degree: Double door version: IP 55		☐	☒
6	Document wallet		☐	☒
7	Cable entry to the cabinet: to be defined in detail engineering From below ☒ From above ☐ From backside ☐ From left side ☐ From right side ☐		☐	☒
8	Location (Room / Coordinates): Process area		☐	☒
9	Emergency Stop Included		☐	☒
1	Cabinet light – optical sensor with manual switch On/Off/Auto		☐	☒
1	Temperature control unit (heating / cooling unit)		☐	☒

6.4 Control system

New solution will be based on components providing 100% (or higher ☺) compatibility to current solution. Request is based by unified spare parts set of existing and new solution of components. Supplier confirms the compatibility by the manufacturers certificate of compatibility. All components will be covered by long period spare parts guaranties (at least by laws required 10 years from contract finalization).
All installed segments of PNET will be covered by measuring protocol certifying the proper functionality of each segment. The metallic patch cords enough to be certified by manufacturer.
Process network will be based on wide band (at least 100Mbit) ethernet solution, providing possibility easily switch to different types of media (metallic, optical, wireless). The network will be fully compatible with the common standards used in the office network environment.
PNET will provide wide variety of structures – line, star, ring and also mixed.
PNET provides communication to component based automation units, decentralized peripheries, real time communication, sharing peripheries between multiple masters.
All devices will be identified by assigned IP address and also the unique device name on the network. Communication is master-client based, cyclic data exchange is a standard. Connection of networks with the same address ranges (or not unique names) is also possible using special components.
PNET standard must be open solution based on alliance of automation components manufacturers, solution based on proprietary solution of manufacturer is not accepted
PNET is the standard for industrial networking in automation. It connects devices, systems, and cells, facilitating faster, safer, less costly and higher quality manufacturing. It easily integrates existing systems and equipment while bringing the richness of Ethernet down to the factory floor.
Standards Profibus/Modbus could be used in seldom cases when required devices doesn’t support PNET solution. All exceptions will be confirmed by contractor in written form.

All installed segments of PNET will be covered by measuring protocol certifying the proper functionality of each segment. The metallic patch cords enough to be certified by manufacturer.

6.5 Wires colours

Pos	Specification		n/a	applicable
1	Protective ground	YELLOW-GREEN	☐	☒
2	Neutral conductor	LIGHTBLUE	☐	☒
3	Other conductors	Load current 400 VAC L1: BLACK L2: BLACK L3: BLACK	☐	☒
		UPS (uninterruptible power supply) L1: BLACK L2: BLACK L2: BLACK	☒	☐
		230 VAC Control voltage Live wire RED (in cabinet) BLACK (external cables) Common return (grounded): RED (in cabinets) BLACK (external cables)	☒	☐
		24 VDC Control voltage + 24 VDC DARKBLUE 0 VDC DARKBLUE/WHITE	☐	☒
		Measuring circuits (4...20mA, 0....10VDC) + (towards) DARKBLUE - (backwards) DARKBLUE/WHITE	☐	☒
		External Voltage ORANGE	☐	☒
		Voltage prior to main switch: ORANGE	☐	☒

6.6 Equipment / wires / cables labelling

The installed components will be labelled with indelible descriptions located on the switchboard installation components so that when replacing a damaged component, it will not be necessary to change the labels, too. All conductors in the switchboard will be provided with indelible descriptions at the end of the conductors, using both the initial and the target conductor marking. In justified cases, where use of both the initial + target marking will not be possible, the target marking will be used.
All stranded conductors will be provided at both ends with wire-end ferrules unless the manufacturer of the terminal specifies otherwise. Screw connections will be used to connect the conductors.

It is not allowed to place more than one conductor into one terminal, serial connection of signals by means of a double wire-end ferrule is allowed.

6.7 Environmental conditions

6.7.1 Temperature

Pos	Specification	n/a	applicable
1	In Cabinets max.40°C ☐ max.35°C ☒	☐	☒

	max.30°C ☐ max.25°C ☐		
2	Ambient temperature, distribution area max.40°C ☐ max.35°C ☐ max.30°C ☐ max.25°C ☒	☐	☒
3	Ambient temperature, process area max.45°C ☒ max.35°C ☐ max.30°C ☐ max.25°C ☐	☐	☒

6.8 Electrical supply

Pos	Specification		n/a	applicable
1	Specification of the supply net (Net configuration)	TN-C / TN-C-S (L1,L2,L3,N,PE)	☐	☒
2	Specification of the supply net (Net-frequency)	50 Hz ±1% Hz	☐	☒
3	Voltage between individual phases	3 x 420 VAC ±10%	☐	☒

6.9 Electrical Installations

6.9.1 Lighting

Lighting shall be installed in all rooms of the plant as follows. Lighting outside shall be installed along roads, on structures, at the gateways and at each corner of the buildings. Lighting outside shall provide a light level sufficient for safe orientation. Lighting outside shall also include spotlights near installations that require regular maintenance or supervision such as bridges, screens, tanks etc..
For operating faciliters, the average lighting intensity must comply with applicable regulations and standards with the variations not exceeding 25%:
The Contractor shall, if required, present a protocol of measurements to the Engineer.
Luminaries for the control room, offices etc. shall be of the decorative type designed to be used with computer monitors. Other luminaries for the administration building shall be a type suitable for the specific use. Luminaries in the working areas of the plant shall be the industrial type and as a minimum be in protection class IP 67.
Lighting in each room shall be controlled by means of manual switches placed at each door in the respective room.
All luminaries and associated gear shall be earthed.
All cables to be used in lighting installation shall be PVC-insulated copper cables with a minimum cross sectional area of 1.5 sq.m.
Cables for connection of the fluorescent luminaries to the fixed installation shall be flexible cables with a minimum cross sectional area of 0.75 sq.mm.

6.9.2 Outdoor Lighting Equipment

The outdoor lighting system shall be provided with all equipment necessary including poles, fixtures, cables, foundations etc.
No masts for road light must exceed a height of 4 m. Illumination of tanks etc. shall take place from equipment installed on railings etc. No equipment must be able to blind outside the plant.

Each lighting pole shall be provided with terminals and fuses housed inside the pole.
Fixtures shall be made of weather resistant material. Changing of bulbs shall be easy and not involve special tools. The protection class shall IP55 or higher.

6.9.3 Emergency Lighting

Emergency lighting shall be provided for all commonly used spaces (operator's rooms, corridors, substations, rooms with installed technologies, etc.)
The emergency lighting shall automatically switch ON when the normal power supply fails. The emergency units shall be supplied from a battery unit that can provide light in a minimum of 1 hour.
The units shall be complete units provided with housing (IP44), fluorescent light (18W), battery, charger, indication of battery OK etc..
Recharging of the battery shall be automatic.

6.9.4 Socket Outlets

Socket outlets stations shall be provided for power supply of maintenance equipment such as welding units, power tools and hand held lamps.
Socket outlets stations shall be provided for indoor and outdoor locations and the maximum distance to any station shall not exceed 35 meter.
The socket outlets shall be installed in a socket outlets station, a box made of glass-reinforced polyester. The box shall be in protection class IP55.
The number of 230V socket outlets shall be based on the area of each room and each socket outlets shall cover no more than 7 m^2.
400V socket outlets shall be installed where required due location of machinery, maintenance procedures etc.
230V AC socket outlets, the socket outlets shall have active earthing contact. When a plug is not inserted, the plug holes shall be covered by a lid.
230V socket outlets shall be 13A CEE-types, according to BS 1363.
400V AC socket outlets, the socket outlets shall have active earthing contact. When a plug is not inserted, the plug hole shall be covered by a lid. The plug 32A 5P 400V is standard.

6.9.5 Earthing System and Equipotential Bonding

A five-conductor earthing system (TN-S) pursuant to IEC 60364 with separate protective conductor (PE) and neutral (N) conductor shall be established from the power transformer(s) and throughout the new installations to be established. The N-conductor must not be connected to the PE-conductor at any point within the installation.
A common equipotential bonding bar (CEBB – CZ=PA) shall be installed connecting:

- Power transformer low voltage (LV) earthing points.
- Plant protective conductor system (PE).
- Building reinforcement.
- Plant cross-bonding system.
- Earthing system for external lightning protection system.
- Lightning and overvoltage arresters.

The common equipotential bonding bar shall be made of copper and have a cross sectional area such that it can act as the circuit protective conductor on each item of the plant and equipment connected to it. The bar shall be clearly labelled to identify its purpose and bolted firmly to the building wall mounted on 50 mm distance pieces. Cable termination shall be made with compression-type cable lugs bolted to the bar.
An equipotential zone shall be created throughout all installations encompassing all metal structures. Extraneous metalwork, building reinforcement, metal supporting structures and machinery equipment i.e. pipes, conduits, pumps, motors etc. shall be cross-bonded and connected to the common equipotential bonding bar.
An earthing system for power transformers shall be established as specified in this specification.

The earth resistance of the earthing system shall be as low as is practicable but shall in any event be such that the electrical resistance between the common equipotential bonding bar and the general mass of one earth group shall not exceed 4 ohm.
Earth groups within the plant shall be interconnect between them forming the general earthing system of the plant with Rp $\leq$ 1 Ω. Distance between 2 different earth groups shall be at least 20 m. Electrodes of earth socket shall be buried with the superior part at the minimal depth of 0.8 m.
Every construction shall be connected to the earth group through at least two points.
Protective conductors (PE) shall be made of stranded copper with overall green/yellow plastic covering.

6.10 Soft Starters

In general, soft starter means shall be applied for motors od 3 do 10 kW. Only electronic soft starter drives will be accepted. The softstarter shall ramp symmetrical on 3 phases and shall be with by-pass contactor.
On the front of the unit the following indicating lamps shall be found:

- Alarm
- Normal operation

Operating and failure signals shall be provided and wired to the PLC.

6.11 Frequency Converters

Frequency converters shall comply with:
Frequency inverters will be deployed for drives with a power output of more than 10 kW or less based on operational reasons or requirements of the relevant technology.
Frequency converters shall be 400 V grade, equipped with EMC-filter and fully enclosed to a degree of IP44 and fitted with self-cooling fans venting through filters.
Frequency converters shall be micro processor based, fully configurable and fitted with an internal multilingual alphanumeric control panel with keypad-display for user interface for monitoring, adjusting parameters, manual control and configuration of the converter. Frequency converters shall come with an extensive library of pre-programmed application macros to allow rapid configuration of its in and outputs.
Frequency converters shall have the following configurable in and outputs:

- Two analogue (4-20 mA) inputs.
- Two analogue (4-20 mA) outputs.
- Six digital inputs.
- Three digital outputs.
- Communication port for communication with SCADA (preference given to PNET)

All frequency converters will be configured in accordance to specific conditions of operation. It covers integrated or external network filter, output filters for long distance motor units and proper power of unit based on installation conditions. Operator interface is coverd by advanced operator panel which provides all information in readable and understandable form, only alphanumeric displays using 7 seg displays are not allowed as base interface. All installed types (single manufacturer solution is strongly preffered) will be covered by one configuration (software) tool provided free of charge by the manufacturer including updates. Easy integration to control system (SCADA) project is a must. Communication link for configuration will be realized by common cable type (USB, mini USB, ethernet etc) without additional configuration converters. Backup / restore of FC configuration using the configuration tool as well as offline configuration (also view of backup parameters settings) is a must. Online monitor of drive is a standard.
Supplier will provide as an “As build” documentation in digital form backup of all installed frequency drives, installation data medium covering configuration tools and set of parametrization cables.

6.12 Emergency Stops

In general emergency stop for emergency shutdown is mandatory for any machinery, which can expose personnel to risk of injury during normal operation.

Emergency stop push buttons are required adjacent to every pump (except drain/sump pumps), motor valves and valve actuators and at aerated tanks for stop of the blowers.
Emergency stop shall be housed in tough high visibility yellow enclosures with red mushroom button which stand out well amongst other equipment and must be clearly labelled: "EMERGENCY STOP" (note the text shall be in local language and in English). The button shall stay in off position when activated and can only be brought back to normal position, when reset.
Every emergency stop circuit shall be hardwired into the motor control circuit to ensure immediately disconnection of the motor in every mode of control.
The motor control circuit shall be designed such that a tripped motor will not re-start automatically when the emergency stop is reset. A stopped motor can only re-enter service when the emergency button has been reset and after reset by hand via a door mounted push button in the motor panel.
Status of each emergency push button shall be signalled to the PLC and to a indicating lamp on front of the motor panel.

6.13 Motor Installations

Each electric motor is to be provided with an isolating safety switch mounted in vicinity of the motor. For motors with a nominal current above 250 A, the safety switch facility shall be provided by means of the motor circuit breaker.
Each safety switch shall be clearly labelled with the number of the equipment, which it is serving and have one volt free auxiliary contact to be wired to the PLC for status indication.
Safety switches may be of the off-load type and shall be padlockable in off position. Safety switch enclosures shall provide a minimum protection of IP44.
Where safety switches are to be located outdoors they must be provided with a rain shield, which will hinder ingress of water to the operating handle and prevent corrosion. The rain shield is to be constructed from galvanised sheet steel.
Power and signal cables from a panel and to motor shall be terminated in a junction box mounted in vicinity of the motor.
The safety switch may be used in lieu of junction box for the power cables only.
Junction boxes for motors are to be with bottom cable entry through cable glands.
Motors with minimal efficiency class IE3.
Motor insulation with class F as a minimum.

6.14 Junction Boxes

General junction boxes are to be constructed of marine grade aluminium complete with lid and captive gasket to a degree of IP 67. The necessary number and size of entries together with terminals are to be designed according to circuit requirements. General junction boxes shall be suitable for direct mounting with external fixing holes, and are to be labelled with reference number.
Terminals are to be arranged at different heights for different services and a barrier is to be provided to shield instrument circuits from power circuits at different voltages. Terminals are to be of the necessary number and size and determined according to respective circuit requirements.

6.15 Cable Entries

Cable entries from one room to another or from outside to inside shall be performed by watertight and fireproof multi cable penetration seals to provide an efficient barrier against fire, smoke, flooding and vermin.
The cable penetration system shall comprise a steel-mounting frame packed with insert blocks to accommodate the cables and to fill out surplus room. After cable installation the insert blocks shall be compressed to complete the sealing.
Each mounting frame shall be embedded in walls.

6.16 Cables

Cable sizes, types and construction must be chosen with due regard to the connected equipment requirements, ambient conditions, installation method, and fault and over currents. Generally, the cable manufacturer's published data are to be used in determining cable adequacy.

Power cables shall be selected such that the voltage drop does not exceed the maximum value defined in IEC 60364 at any point in the installation.
XLPE power cables shall comply with IEC 60228 and generally with IEC 60502, and must not have less than 1,5 mm² cross section. Generally, XLPR power cables are to comprise stranded copper conductors with an extruded XLPE insulation, laid-up in an extruded bedding, galvanised steel wire armouring and an extruded PVC oversheath.

6.16.1 Cable Segregation

Cables operating at different voltages and for different purposes shall be proper segregated. Throughout installations four continuous separate tracks shall be established for:
- Power cables for technical power.
- Power cables for building services.
- Power cables energised by frequency converters.
- Signal cables.

Distance between the above-mentioned cables must not be less than 200 mm.
Power cables are cables operating at $U \geq 50$ V. Signal cables are cables operating at $U < 50$ V.

6.16.2 Cable Trays, Ladders and Trunkings

Cable trays, ladders and trunkings shall generally comply with IEC 60364 and shall be constructed from mild steel sheet either hot-dipped galvanised or zinc sprayed, perforated, and of such a design that it is rigid in construction. The choice of manufacturer is to ensure that bends, tees, intersections, reducers, risers, and droppers are included as standard in the product range - the manufacture of these and the like items on site is expressly forbidden.
Cable trays, ladders and trunkings shall be sized and provided with isolating barriers in accordance with the spacing and segregation requirements of cables.
Where the cable trays, ladders and trunkings are cut, drilled or where the galvanising is damaged in any way the surfaces shall be adequately treated to restore them to the original galvanised standard.
Supports shall be provided at intervals to assure that the maximum deflection allowed by the manufacturer for the given loading is not achieved. The weight and quantity of cables placed in cable tray or ladder must not exceed the manufacturer's recommendations. On selected cable trays, ladders and trunkings sufficient space must be left for additional cables necessary for the future plant extension. The number of cables installed shall be limited ensuring the resulting space factor will not exceed 45%.
Joints between sections of cable ladder or tray or trunkings shall only be made via fish plates and domed headed bolts forming part of the tray, ladder and trunking manufacturer's standard accessories - welded joints will not be permitted. Likewise, cable trays, ladders and trunkings shall only be bolted to supports.
All vertical cable trays, ladders and trunkings must be provided with perforated covers of equal treatment fixed in place by means of bolts until 2 meter above floor level.

6.16.3 Conduit Systems

Conduits within buildings and structures shall be either super-high impact heavy gauge PVC conduit, installed with solvent welded joints, or shall be manufactured from galvanised steel and shall be installed with screwed fittings. Conduits installed external to buildings shall be galvanised steel. Where galvanised steel conduits is cut or where the galvanising is damaged in any way the surfaces shall be adequately treated to restore it to the original standard.
Fixings and accessories associated with conduit systems shall be either manufactured from non-corrodible materials or suitably coated to render them non-corrodible. No conduit shall be smaller than 20 mm diameter.
All main race trays vně budov a objektů musí být uložena v kolektorech nebo kabelových trasách. The installations are to ensure cables maintain required segregation by providing at least one cable tray for each type of cable (signal cables supply cables, machine installations and building installations). As regards cable routes, the general rule is that the line will have a diameter of 100 mm and, in any case,

such a size that the cables only fill up half the capacity. The inspection shaft will be installed in a maximum distance of 100m.

6.16.4 Installation of Cables

Cables installed on trays, ladders and trunkings must be so arranged that there are no crossings or interlacing of cables. The trays, ladders and trunkings must be sized for the cables' bending radius and weight. Cables shall be secured to the tray and ladder by means of ultra-violet stabilised tie-wraps at the necessary intervals commensurate with the cable size and weight. All cable tray, ladder and trunkings routes must be complete before cables are installed.
Cables individually run and direct mounted on walls or ceilings must only be installed after building trades and painters have finished their work. Cables may only be installed in vertical and horizontal planes and bee aesthetically acceptable taking the most unobtrusive routes possible. Single hole plastic fixing cleats only shall be used.
All cables terminating at equipment are to employ screwed cable glands only - the use of epoxy putty is expressly forbidden.
Cables exposed to direct sunlight shall be able to withstand exposure.

6.16.5 Cable Identification

Cables and cable cores shall be identified at both ends by means of sleeve bands bearing the cable/core reference number, which shall relate to the reference number shown on the drawings. Where multiple cables are laid in troughs, duets, clipped on tray over long runs through several rooms in buildings, or laid in ground close together, intermediate markings to identify specific cables shall be applied.

6.17 Instrumentation

6.17.1 General

In the following are listed the minimum requirements for the instrumentation.
All field instrumentation elements including the transmitter will be designed for 24V DC power supply. The local control cabinet (LCC) will always have 24VDC power supply with a 50% residual current supply, a storage battery and DC UPS that will provide at least the following status signals:

- Collective fault
- On battery operation
- Low battery (less than 85% capacity)

Data point transfers to SCADA is preferred in digital form, PNET interface for plant network connection is required in the maximum possible extent.
In the event that this connection is inappropriate, standardized signals will be used in the form of analogue/digital inputs/outputs of the control system.
Standard equipment
Analogue inputs / outputs

- Each current loop will be equipped with surge protectors with integrated coarse and fine protection for signal lines. The surge protection terminals will also act as connecting terminals for the signal conductors (this will not be ensured by an additional terminal level in the LCC switchboard)
- Each measuring circuit will be equipped with a fuse switch disconnector and a tube fuse
- If the sensor / transmitter is not fitted with a galvanically isolated analogue output, the measuring circuits will be additionally equipped with galvanic isolation in the LCC. Priority is given to passive galvanic isolators.
- The PLC modules used to collect signals enable software setup of the signal type - 0-20mA / 4-20mA

- The PLC modules used to collect signals enable the 2wire / 4wire software setup (active current loop feed/ passive sensor)

Digital inputs / outputs

- Each sensor will be fitted with a isolation circuit, i.e. surge protection with integrated coarse and fine protection for signal lines or isolation relay. The surge protection terminals/isolation relays will also act as connecting terminals for signal wires (this will not be performed via an additional terminal level in the LCC switchboard)
- Each measuring circuit will be equipped with a fuse switch disconnector and a tube fuse
- For impulse signals with a higher frequency of status changes, electronic relays will be used in order to ensure sufficient lifetime of the supplied equipment.

The measured parameters will be transmitted via analogue loops, 4-20 mA, or using digital potential-free outputs, and these signals will be concentrated in suitable locations in the switchboards where they will be connected using remote inputs (I/O cards) and communication (PNET) by optical or metallic connections to the control system. Alternatively, a communication link will be established in the concentration switchboard which will be properly connected in the switchboard or transferred to communication towards the control system.
The control system element connection must comply with „KDM_wiring_standards“– see Annex 22.

6.17.2 Local Pad-lockable Stop Switch

Adjacent to each machine (motor) shall be installed a local stop switch. The stop position shall be pad-lockable, and it shall be impossible to start the machine when locked.
The switch shall include the following positions/functions:
- **O** **:** Stop, pad-lockable, power supply is cut-off
- **I** **:** Automatic, control from panel.

The switch shall be installed in the power circuit for the motor and all phases shall disconnect in the OFF position.

6.17.3 Level Switches

Level switches shall be provided for measuring of high and low alarm levels and for control of drain pumps. High level alarm for the reservoir shall be with a level switch.
The level switches shall be the floating type with a built-in change-over contact system.
The contact system shall be casted in a polypropylene housing in protection class IP67.
A mercury free contact system is preferred.
Cables from the level switches shall be connected via junction boxes provided with terminals.

6.17.4 Level Transmitters

Level transmitters shall be provided for continuously measuring of media levels and for control of the machinery.
Analogue level measuring shall be based on the hydrostatic measuring principle based on the pressure generated by the height of a liquid column. The pressure acting on the pressure measuring cell built-in the sensor shall be converted into a level-proportional electrical signal.
The sensor shall be suitable for installation in wastewater/sludge and the sensor house shall be made of polypropylene or similar material. The housing shall be in protection class IP68 and the sensor cable shall be steel wire armoured up to the junction box.
The transmitter shall be installed in the panel.
The level transmitter shall provide the PLC with a 4-20 mA level proportional signal and additionally provide the sensor with the necessary power supply. The transmitter shall automatically compensate for the atmospheric pressure. The compensation shall be electronic.
The accuracy of the level measuring system shall as a minimum be ±0.5% of the full scale. The full scale shall be selected according to the location of the level measuring. The linearity shall be better than 1%.

It shall be possible to change the full scale for the sensor by using a special programming device connected to the sensor.

6.17.5 Flow Transmitter

The flow meters shall be based on ultra sonic transmitters on flumes or magnetic on pipes.
The transmitter shall include a pulse signal that gives a pulse for a specific accumulated flow.
The transmitter shall include an analogue current loop that gives instant flow value in a specific units.
Transmitters shall include maintenance interface that gives possibility for basic and also advanced settings of transmitter. Both settings should be covered by maintenance password.
The enclosure for all equipment shall be IP68.
The technique shall be microprocessor based.

6.17.6 Temperature Transmitter

The temperature range shall as minimum be 0-50°C with an accuracy better than 0.5 %. Sensor includes also transmitter installed in head of sensor for conversion to 4-20mA current loop. Sensors can be connected to control system using process bus. There will be at least one temperature sensor installed in each distribution area and connected to control system. Temperature limits can be activated for monitoring using SCADA HMI including acoustic signalization and alarm message.
At least one sensor for external temperature measurement will be installed.

6.17.7 pH Transmitter

The pH meter shall cover a range 0 - 14 pH with a accuracy better than pH 0.02 at any temperature. It shall be installed for easy access for calibration.

6.17.8 Phase compensation

Automated power factor gear for correcting power factor shall be incorporated. Fixed capacitor banks will not be permitted.
All required gear for power factor correction shall be supplied as one unit fully enclosed to a degree of IP22. The unit shall comply with EN 60439 and be designed to maintain: $1 > \cos \varphi > 0{,}98$ at all load conditions.
Compensation must be capable of ensuring both inductive and capacity components of idle energy.
On the front of the unit the following instruments are to be found:

- Power factor [0-1-0].
- Step indicator (to indicate the current step).
- Indicating lamps:
  - Alarm
  - Normal operation

The alarm signal shall be wired to the PLC.
Capacitors shall be PCB-free, with a loss < 0.2 W/kVAr.
Power factor correction units shall incorporate suitably rated internal overcurrent protection of the capacitors and be with common phase sensing for correction of all three phases simultaneously. Single-phase correction is not required.
A six steep capacitor bank shall be provided as a minimum. Each step to be suitable sized with due regard to the inductive loads.
When installed in circuits with thyristor-controlled motors antiresonance coils must be fitted to suppress the influence of harmonics, in particular the influence of the 5 harmonic.

6.18 Measurement system

6.18.1 El. power

It will be measured at all locations relevant for operation, balancing and evaluation.

As regards the main switchboards (RH) and motor switchboard (RM) power lines, multifunctional panel wattmeters with measuring current transformers will be installed with the possibility of communicating with the SCADA system where the values will be displayed in the relevant visualization sections and from where they will be further communicated to the sub-metering system.
As regards process units units powered by main or motor switchboards, multifunctional panel wattmeters with measuring current transformers will be installed with the possibility of communicating with the SCADA system where the values will be displayed in the relevant visualization sections and from where they will be further communicated to the sub-metering system.
As regards the most significant actuators powered by motor switchboards, multifunctional panel wattmeters with measuring current transformers will be installed with the possibility of communicating with the SCADA system where the values will be displayed in the relevant visualization sections and from where they will be further communicated to the sub-metering system.
Significant actuators powered by motor switchboards will use static el. meters to measure active energy ideally installed in the panel of the switchboard sections. The el. meters will have a communication or impulse output that will be connected directly (via concentrators) or indirectly (via the SCADA system) to the sub-metering system.
In the case of metering the generation of electricity in the CHP units, officially verified meters with communication outputs for direct connection to the sub-metering system concentrators will be used.

6.18.2 Biogas

Biogas will be measured at all locations relevant for operation, balancing and evaluation.
In locations with the potential presence of biogas with a high moisture content and condensate condensation potential, or where a significant pressure loss could incur due to the installation of conventional gas meters, use will be made of non-mechanical gas meters with the ability to measure operating and rated flow rate and gas volume, methane content in the gas, combustion heat, etc. The measured values will be transmitted via the communication system to the sub-metering system.
The sites for these meterings are, in particular:
Biogas output from the digesters
Biogas input into residual gas burners
Biogas input to the CHP power supply system
In places where there are no such potential threats (gas humidity, condensation, pressure loss), conventional mechanical gas meters with impulse output connected to the sub-metering system may be used, or for larger equipment or power distribution systems with an installed converter for determining the standard volume of gas connected by means of a communication system into the sub-metering system.
The sites for these meterings are, in particular:
Power supply of steam generators
Hot water boiler (both boiler rooms) distribution

6.18.3 Natural gas

Natural gas will be measured at all locations relevant for operation, balancing and evaluation.
Due to the fact that natural gas is not likely to be more humid and condensed, conventional mechanical gas meters with impulse output connected to the sub-metering system may be used or for larger equipment or power distribution systems with an installed converter for determining the standard volume of gas connected by means of a communication system into the sub-metering system.
The sites for these meterings are, in particular:
Power supply of steam generators
Hot water boiler (both boiler rooms) distribution
In the event of a significant pressure loss due to the installation of a gas meter, the measurement will have to be provided by a meter with a lower pressure loss, or by adjusting the technical and operational conditions to the natural gas distribution.

6.18.4 Heating water

It will be measured at all locations relevant for operation, balancing and evaluation.
The measuring points will be equipped with a calorimeter (flowmeter, 2x temperature sensor, evaluation unit), which will be able to use the communication system to transmit information

concerning at least the sum of the energy, the sum of flow, instantaneous power, instantaneous flow and both the measured instantaneous temperatures.

6.18.5 Steam

It will be measured at all locations relevant for operation, balancing and evaluation.
The measuring points will be equipped with a calorimeter (flowmeter, 2x temperature sensor, evaluation unit), which will be able to use the communication system to transmit information concerning at least the sum of the energy, the sum of flow, instantaneous power, instantaneous flow and both the measured instantaneous temperatures.

6.19 Test

Test procedures will be developed using testheets. These test procedures will be submitted by the Employer and, once approved, a valid revision of testheets including test documentation matrix will be issued. Only approved test documents will be accepted by the Employer. The Contractor undertakes to incorporate the Employer's comments in the testing procedures.
The objective of the test is to verify that the system works in accordance with the Contract and the detailed design.
All tests of equipment and of the complete system shall be performed in accordance with the Contractor's approved Quality Assurance system.
All tests have to be documented in test forms defined as part of Quality Assurance system covering:

- Date of test.
- Description of test.
- Actual method of test.
- Output of test.
- Remarks regarding deviations from the expected output.
- Accepted/rejected.
- Tester shortmark
- Supervisor's signature.
- Comments.

Handling of Deviations
Before the report is completed and can be approved; all significant deviations have to be corrected.
In case of deviations, the following issues have to be decided:

- What are the consequences of the deviation? Which part of the installations will be influenced by a revision, and which tests already accepted will have to be done over again (if any)?
- Date of a new test of the revised system included repetition of already accepted tests.

The acceptance test report shall be approved when significant deviations have been corrected and tested.
All tests have to be planned so the Employers Representative has the possibility to comment on the tests planned and to supervise the tests. That means that all tests shall be announced at least two weeks in advance. This goes also for any repetition of tests.

6.19.1 Electrical general

The following electrical functions shall be tested, and shall be verified to be in accordance with the Employer's Requirements:

- Earth resistance and boundary system.
- Function of all emergency stop circuits.
- Function of all safety circuits.
- Lighting systems.
- Emergency power supply system. The external power supply shall be switched off and it shall be verified, that the emergency power supply system starts up automatically. Furthermore it shall be verified, that all emergency control functions start up automatically (automatically by-pass of waste water, handling of alarms etc.)

- Signal test of all signals according to signal lists. All signals shall be tested from source to software. For analogue signals range and scale shall be verified.

6.19.2 Panel Factory test

The Panel factory test shall as minimum covers:

Power section

- Control of all power circuits
- Control of isolating
- Control of tightening moments
- Control of component sizes
- Control of conductor dimensions
- Control of conductor colours
- Control of wiring numbers
- Control of loose connections
- High voltage tests
- Control of phase orders
- Control of measurement transformers
- Operation of fuses, motor protection, disconnectors etc.
- Control of fault current relays with tester
- Control of setting of thermal relays etc
- Control of fuses
- Control of settings of softstarters etc.
- Control of Cu rail connections
- Control of PE-conductors
- Control of PE-conductors for doors
- Control of PE-conductors to all flanges (EMC-requirement)
- Control of PE-conductors to all scomponents (transformer and DC-units)
- Control of PE-conductors to PLC-parts
- Control of PE-conductors to plug outlets
- Control of EMC correct connection of components (shields to back plates)

Control section

- Control of control voltage, primary and secondary
- Control of conductor dimensions, control circuits
- Control of conductor colours, control circuits
- Control of wiring numbers
- Control of loose connections
- Control of lamp test
- Control of lamps
- Control of operations (buttons etc.)
- Control of documentation
- Control of PLC digital inputs
- Control of PLC digital outputs
- Control of PLC analogue inputs
- Control of PLC analogue outputs
- Control of analogue loops
- Control of fixing and protection of wires
- Control of codes for components in sockets
- Control of tagging of components
- Control of dimensions of terminals
- Control of terminal numbers
- Control of tagging of internal wires
- Control of setting of electronic components

Miscellaneous

- Control of section covers
- Control of labelling
- Control of panel marks and certificates
- Control of earth system
- Control of covered race trays
- Control of sufficient spare capacity and room
- Control of cleaning
- Control of drawings in panel
- Control of handles and locks
- Control of front layout
- Control of component layout in accordance with the documentation

After installation on site

- Control of inside temperatures under max. load
- Control by use of thermal photographing under max. load

6.19.3 List of the Spare Parts and Toolkits

6.19.3.1 Spare parts

The Contractor shall with the tender provide a spare parts schedule including description and prices of spare parts, which are recommended to be kept in stock for general maintenance for a 2-years operation period.

6.19.3.2 Tools

The Contractor shall provide all special hand tools needed for the proper maintenance of all the equipment delivered.
Special electrical tools are tools or instruments that are specifically used for testing of electrical circuits..

7 SCADA

n the following are outlined the minimum requirements for the SCADA Works.

7.1 Standards

The Contract shall be executed in compliance with the directives, norms and standards listed in General Section, listed below and elsewhere in the present description.

7.2 General

A computer based control and monitoring system (also known as a SCADA system: Supervisory Control and Data Acquisition System) shall be provided for automatic control and monitoring of the treatment plant.
The system, in the following known as the CMS (Control and Monitoring System), shall be used for the following:

- Supervision of the treatment plant
- Monitoring of alarms and status of the treatment plant
- Changing of timers and parameters
- Calculations
- Real-time collection and storing of data and alarms
- Handling of data and alarms
- "Forced" stop and start of components from the operator stations.
- Automatic control of part of the treatment plant process

The control part consists of a distributed system with distributed local intelligent controllers (PLC) to carry out the control and monitoring of the equipment connected to the PLC. The PLC will work autonomously if the communication network fails and the control will continue.
The system shall be designed to operate 24 hours a day without any necessity of attendance from the personnel.
The requirements for the control and monitoring system are described in the following.
Automatic control of the component shall be possible when the control switch for the component in the front of the panel is in the position "auto".
By-pass of the PLC control will be possible when the control switch is in the position "manual".
All equipment shall be standard factory manufactured components existing in at least 1000 units.
The CMS shall be prepared for an extension of the number of parameters (input/output signals, timers, counters, set points, measurements, calculations etc.) with a minimum of 20%.
The control and monitoring system shall as a whole have an accessibility which is better than 0.99 (i.e. the system is in average not in operation in 4 days during one year, or 8 hours every month).
Mean time between failures (MTBF) for the system as a whole shall be better than 1000 hours.
Mean time to repair (MTTR) for the system as a whole shall not be more than 8 hour including time for transport of the staff to the site, provision of spare parts and including time for locating of the fault.
Accessibility is defined as MTBF/ (MTBF+MTTR).
Accessibility for individual components shall as a minimum be as follows:

- PLC 0.995
- I/O's 0.99
- PC's 0.985
- Printers 0.98
- Network 0.995

7.3 Monitoring system, hardware, general

7.3.1 UPS

An UPS system shall be provided for the whole control and monitoring system and the instrumentation at the treatment plant.
The UPS system shall ensure the operation of the control and monitoring system and protect the system from loosing data in case of a power cut. The capacity of the battery shall be sufficient for operation in 1 hour.
All equipment necessary for operation of the control and monitoring system shall be provided from the UPS system including the following:

- The server station including all connected equipment
- The operator stations including all connected equipment
- The PLCs
- The communication network
- The instrumentation.

The UPS system for the treatment plant shall fulfil the following requirements:

- Efficiency AC/AC: min 90%
- Overload, 1 min.: 150%
- Disturbance: <10%
- Power factor: >0.9
- EMC: VDE 871-B/0875-E
- Acoustical noise: max. 55dBA.
- Ethernet communication for remote monitoring

It shall include indication of:

- Power source (grid or battery)
- Charging
- Battery OK
- Inverter OK
- Charger OK
- Grid ON
- See also to chapter 6.15.1

7.3.2 Server/monitoring and monitoring stations

The computers shall be of the Personal Computer type, well-reputed make and in the firm's professional series with long term support of provider.
For each station there will be extended service support for at least 3 years included in a contract. Maintenance contract will be independent of control system supplier by direct service tag ID provided at system level.
As a minimum the computers shall fulfil with the following requirements:

7.3.3 Monitors

The monitors shall be for presentation of graphical pictures and text in colour. Device shall allow connection to PC placed in technical area of operators room without loosing signal quality.
As a minimum the monitor shall comply with the following requirements:

- Resolution: 3820 x 3160 pixel
- Size: The actual size of the screen picture shall be 32"
- Brightness: 250 cd/m² or better
- Viewing angle: 270 deg. or better
- Interface: Display port

7.3.4 Graphic printers

The graphical printer shall be for alphanumeric and graphical color printing of graphs and screens pictures from the colour monitor.
The printer shall have these parameters:

- A3 format print
- A4 format print
- minimum 2x paper boxes
- interface ethernet for direct connection to the network (terminal bus segment)
- 2 x full set of all cartriges (excluded initial cartrige from producer)
- Manual in Czech language
- 1000 paper sheets for each format (A4, A3)
- Printer should be produced by some of an established manufacturer of printers, with a local service support, a professional product line.
- 2 pieces of printer should be delivered

7.3.5 Operator station hw configuration

- Processor Intel® Core™ i7-7700 7th gen / 4 cores 3.6GHz,
- RAM 2 400 MHz, UDIMM, Non-ECC 16GB
- graphics card 4x output DP (virtual desktop configuration supported up to 4 monitors)
- System disc 256GB disk SSD (M.2 preffered)
- RAID controller supporting RAID 0/1/5
- 2x 1024GB HDD disk SATA (7 200 rpm) RAID 1
- Windows 10 64 bit

- 4 ports USB 2.0
- 4 ports USB 3.0
- 2x microphone input
- 2x audio output
- 1 LAN RJ45, 1GBit support

7.3.6 Server station configuration

- CPU Xeon, RAM 64 GB ECC,
- Blade 2U max including rail system for cabinet installation
- System disc 256GB disk SSD (M.2 preffered)
- RAID Controler
- RAID 1, 6x1TB HDD
- 1U LCD+keyboard+trackball KVM unit
- redundant power supply

- MS Windows 2012 R2 / 2016 Standard edition,
- 20x CAL included,
- 2x LAN RJ45, 1GBit support

7.3.7 Operator panels in cabinets

- Processor Intel® Core™ i5 7th gen
- LCD 21" 1920x1080 touch screen
- RAM Non-ECC 8GB
- System disc 512GB disk SSD (M.2 preffered)
- RAID controller supporting RAID 0/1/5
- 2x 512 GB HDD disk SATA (7 200 rpm) RAID 1
- Windows 10 64 bit

- 4 ports USB 2.0
- 4 ports USB 3.0
- 1x microphone input
- 1x audio output
- 1 LAN RJ45, 1GBit support

7.3.8 LAN network area storage

- 5x 2.5 / 3.5“ bay
- 8GB RAM
- Quad core CPU 2GHz
- RAID 0/1/5/6/10 supported
- 2x GLAN, 2x USB3.0
- 5xHDD 10TB included

7.3.9 Monitoring stations - notebook

For maintenance purpose a notebook with following specification should be delivered:

- an established manufacturer, professional product line
- Running time of battery min. 4 hours
- Weight less then 2 kg
- Integrated touch pad + wireless mouse
- Durable transport bag for notebook and accesories (cables, convertors, power adapter, mouse, etc.)

7.4 Monitoring system, software

All programs shall fulfil the following requirements:
- Be standard programs to the extent possible
- Be easy to modify and replace
- Be tested and free from faults.

- All software shall be in national language versions; however special software only relevant for the developer engineer can be in English version

The operating system software for the operator stations shall be Microsoft Windows, newest version, local language version. For the servers the operating system shall be Microsoft Windows Server 2012 R2 / 2016 or if released at the time of implementation its replacement.
All PCs shall have updated virus protection system. The virus protection system shall be with subscription in order to keep the system updated all the time. 2 years subscription included
For HMI, the Wonderware InTouch process visualization is currently deployed, installed in 2012 - Wonderware historian software and a set of support applications. (AS viewer, DB Client, etc.). The new sludge management system design will be integrated into the existing SCADA system so that the operator can use a uniform environment controlled from a single workstation. The existing system is developed in the form of a redundant solution to operator workstations, where two dispatcher workstations located at the WWTP control room are equipped with 2 large LCD panels that can display most of the technology simultaneously and other workstations (8 pcs) are located at the plant with LCD touch sensitive panels used for local control by the staff in charge of the relevant technological part of the operation. This system will be kept after the Works completion. Likewise, all SCADA functionalities will be maintained or expanded so as not to reduce the existing user comfort.
SCADA HMI processing will maintain the existing solutions that optimise system interventions by not requiring multiple application modifications (dispatcher workstations vs. local workstations) at the same time but only the master application modification
The Works will include SCADA HMI updates to the latest available version, including migration of existing technology. The OS of the stations will be migrated from the existing MS Windows 7 to MS Windows 10 (current OS version at the time of the Works handover).

- 1x Wonderware system platform 50k tags at least
- upgrade of the licensed SW of the dispatcher workstations
- upgrade of licensed SW- operator's panels in operation
- Migration of the HMI project application to the current version of HMI Wonderware InTouch
- Migration of support applications
- Replacement of HW dispatcher workstation equipment
- Replacement of HW equipment of operator's panels in operation
- The supplied HW will be covered by the manufacturer's service contract for at least 3 years on site, next business day. The certificate of support validity and contact details will form part of the handover of the Works.
- In the event of incompatibility with InTouch and Historian versions,
    - 1x version upgrade SW- Wonderware Historian 50k Tags + 5x client will be performed
    - 1x server HW upgrade with Wonderware Historian including OS server

All HW workstation equipment will be migrated to match the OS manufacturer's HCL.

7.4.1 SCADA standard software

Licence for increase the configuration with 50% after finalizing of the project shall be included. Furthermore the licence shall cover all monitoring stations including laptops and PDA to be logged on at the same time.

7.4.1.1 Function

The functional requirements for the program system shall fulfil the following:
- Be possible to co figurate
- Collect data as real-time values
- Store and handle the real-time data including performing of arithmetic and logical functions
- Undertake control and monitoring

- Undertake alarm and fault handling
- Undertake self diagnosis of the computers

The program system shall collect data, handle and store data while other activities are undergoing.
Measurements, ON/OFF signals and alarms shall be collected continuously and be indicated on the flow pictures.
The interval between collections of scan data shall be adjustable between 1 to 30 sec.
The data base shall be arranged in a way that automatically connects a new signal to the report system and the system that generates curves.
Conversion of a measured value to a value in the data base shall be automatic.
The program for communication (driver) between the control centre and the PLC must not limit the performance of the communication line.

7.4.1.2 Access Levels

The use of passwords shall limit the access to the control system for the operators. A minimum of three levels shall be included.
Level 1: Will allow the operator to acknowledge alarms, initiate prints, monitoring of data and screen pictures.
Level 2: As level 1 including changing of parameters, stop and start of motors and access to application programs in the PLC.
Level 3: Will provide the operator with universal access to the system.

7.4.1.3 Operator Dialogue

The human/machine-dialogue shall be user-friendly and the system shall be easy to operate for persons with little or no knowledge of computer systems.
Frequently used commands shall be operated from function keys or via the mouse.
Operation of the system shall be based on an extensively use of the mouse to promote fast and easy selections.
The operation shall be interactive and it shall be possible to display messages with information that is helpful for the operator.

7.4.1.4 Automatic Start

After an uncontrolled stop of the control system it shall automatically restart.
The internal clock shall be supplied with battery back-up and it shall automatically be adjusted. The time synchronization on level NTP will be used. Contractor will provide the NTP server.

7.4.1.5 Parameters

A parameter is a named specific numerical digit that can be changed by the operator.
Changing of parameters shall be possible from the operator station including changing of parameters in the PLC.
Changing of parameters shall among other things include the following:

- Timers
- Counters
- Limits
- Alarm level.

Changing of parameters shall be easy and by using interactive messages. For all parameter types the native formats will be used (prepare list of allowed formats).

7.4.1.6 Control and Monitoring

Control and regulation of equipment shall be undertaken of the PLC that the equipment is connected to and the control and monitoring shall continue even if the communication fails to the control centre.
Deviations shall be detected and monitored as a message or an alarm.

7.4.2 User interface

This will be provided using faceplates for specific technological components while it is expected that use will be made of the existing user concept SCADA HMI. The existing KDM standard library is expected to be used.

7.4.3 Faceplates “Analogue metering”

Check document “KDM Standard library” Annex 23.

7.4.4 Data processing

7.4.4.1 General

All data necessary for control and monitoring of the plant shall be collected.
The program shall collect the real-time data that is necessary for a correct calculation and transmission of all service parameters.
The program shall be arranged in a way that allows the operator to select the service parameters. In addition it shall be possible for the operator to extent the number of service parameters.
The data collection shall function independently of all other program facilities in the control centre.
All data shall be identified with the timestamp of collection. The timestamp precision shall not be worse than 0.5 sec.
The cycle time for data collection shall be adjustable by the operator from 1-30 sec. The data collected is named scandata. It is accepted that scandata only is logged when there is a relevant change in the value. This option will reduce the extent of the logging. All changes shall nevertheless be logged. This goes for parameters, analogue values, states etc.
Calculation of the minimum mean-value of the scandata shall be possible within an interval of 1-30 min. (basic time). The calculated mean values are named basic data. These basic data are used for calculation of hour-, daily-, monthly and yearly mean values that are used in the reports.
The data shall be stored in accordance with the values indicated below:

TYPE:	DATA USED FOR:	STORED IN:
Scandata	Generating of basic data and curves	12 month
Basic data	Print of daily curves	180 days
Hour mean	Daily reports and curves	12 months
Daily mean	Monthly reports and curves	10 years
Monthly mean	Yearly reports and curves	10 years

It shall be possible to delete data. The program shall however automatically prevent data to be deleted that have been stored less than indicated in the above table.
It shall be possible to select the parameters for data collection and the time interval for the data collection.
The program for calculation shall have access to all elements, name, parameters and data in the system.
It shall be possible to include time marking of the calculation program in order to control the calculations after a calendar program.
Programming of the calculations shall be in a high level language.

7.4.5 Data presentation

7.4.5.1 Reports and Lists:

The format of reports for indication on the monitor and for printing shall be generated from data base programs. It shall be possible to select the data to be indicated on the monitor or printed from menu commands that automatically will start the report in question. It shall be possible to print reports automatically.

It shall be possible to select the following reports from the menu:

- Event list
- Alarm report
- Daily report
- Monthly report
- Yearly report.

The data base program shall include the possibility of configuration and editing the format of the reports.

Format and lay-out of all reports shall be approved by the Engineer.

General Lay-out of Reports:

- Date and time for printing of the reports shall be indicated.
- The period the report covers shall be indicated.
- In column no. 0 the period shall be indicated.
- Data shall be indicated in column no. 1 and onwards. A minimum of 8 characters shall be included in each line.
- In line 1 and 2 the name and component number shall be indicated (space for 16 characters).
- In line 3 the unity shall be indicated.
- In the following lines the measured value or calculated value shall be indicated for the data.
- The second last line shall include the mean value for the period of the report.
- The last line shall include the accumulated value for the period of the report for the data collections.

7.4.5.2 Daily Reports

- The periods shall be of 1 hour each. The hour-mean value shall be included for each hour.
- The daily mean shall be included in the second last line.
- All measurements and parameters shall be included in the report.
- The accumulated value for sum up values (water quantities etc.) at the time the report ends shall be included in the last line.
- The daily report shall automatically be printed.

7.4.5.3 Monthly Reports

- The periods shall be of 24 hours each. The daily mean value shall be included.
- The monthly mean value shall be included in the second last line.
- All measurements and parameters shall be included in the report.
- The accumulated values for measurements at the time the report ends shall be included in the last line.

7.4.5.4 Yearly Reports

- The periods shall be of 1 month each. The monthly mean value shall be included.
- The yearly mean value shall be included in the second last line.
- All measurements and parameters shall be included in the report.
- The accumulated values for measurements and parameters at the time the report ends shall be included in the report.
- The report shall automatically be printed the 1st of January.

7.4.5.5 Alarm Report

The alarm report shall be printed at the operator's request. It shall be possible to select start and stop time for the period of report.
Automatic printing of the report shall at a defined time be possible.
The report shall as a minimum include the following information:

- Device tag ID
- Alarm text (min. 25 characters)
- Time for start of the alarm
- Time for acknowledge of the alarm
- Time for stop of the alarm
- Alarm priority
- Name of person that acknowledged the alarm
- The actual alarm value
- The maximum value for the high alarm
- The minimum value for the low alarm.

Time shall be indicated with year, month, day, hour, min, and sec. in order to clearly identify the alarm.

7.4.6 Data collection

Curves shall be selected via a menu. It shall be possible to select pictures of curves of 1 year, 1 month, 7 days, 24 hours, 6 hours, 1 hour and 1/4 hour.
It shall also be possible to select historical curves from and to a specific date. It shall for example be possible to shown curves of 24 hours duration from 5 days ago.
It shall be possible to indicate a minimum of 8 different curves on the same picture. Each curve shall be presented in a different colour.
The unit, the Y-axe and the name of the curve shall be indicated in the same colour as the curve.
Static and dynamic screen pictures shall be shown. For dynamic pictures the screen picture shall be updated every time new data is being recorded.
Zoom-in and zoom-out shall be possible for the X- and Y-axe direction.

It shall be possible to print the actual digital values for the curves including the time for the actual value.
Print of curves shall be initiated by activating a function key or by operating the mouse.
Configuration of screen pictures of curves shall be easy and only involve a few commands.
Screen pictures of curves shall be provided with explanatory text and date and time for print shall be included. It shall as a minimum be possible to include up to 60 curves.

7.4.7 Alarm system

Any alarm shall be reported and indicated as follows:

- By an acoustic signal
- On the monitor on the screen pictures
- By printing an alarm text on the monitor in a separate field of the monitor. The field shall be dedicated to alarm messages.
- By printing an alarm text on the alarm printer

It shall be possible to provide all alarms with an alarm priority. The indication of the alarm shall depend on the specific alarm priority. Up to 5 alarm priorities shall be provided.
Alarms shall always be indicated, in the field on the monitor, on the screen picture (if the picture is on-line) and printed on the monitor.
The following information shall be stored in the alarm data base:

- Device tag ID
- Year, month, day
- Time for start of the alarm
- Alarm priority
- Description of component

- Component no.
- Alarm message (min. 80 characters)
- Time for acknowledgement of the alarm
- Time for stop of the alarm.

It shall only be possible to acknowledge (reset) the alarm from the operators station.
It shall be possible to acknowledge single alarms or all the alarms shown on the monitor. This applies for flow pictures as well as for alarm files.
It shall be possible to suppress commuting alarms. It shall be clearly indicated if an alarm is suppressed.
Alarm shall also be indicated on the process flow pictures and the picture for the individual component.
It shall be possible for the system to handle up to 1000 alarms and alarm messages.
It shall be possible for the operator to edit the alarm messages.

7.4.8 Configuration

It shall be possible for a skilled designer to extent and change the control and monitoring, the reporting and the process configuration.
The configuration shall be carried out via a well documented standard program specifically designed for configuration of the system (not via programming in a standard high level programming language).
The program shall be easily accessible, and it shall be easy to use the program. The program shall preferably be the interactive type with explanatory messages to the operator.
Changing or extension of the configuration shall include removing and/or adding of components (motors, valves, instruments etc.), and it shall include all disciplines such as addresses, conditions, alarms, reports, monitoring etc.
Access shall be limited via password.
The program for configuration shall include a check program that will detect and disclose all errors.
It shall be possible to print the configuration.
Only fault free configurations shall be operational.
It shall be possible to carry out the configuration by the following ways:

- By down-loading of the new configuration from the programming unit connected to the communication network
- By direct connection of the programming unit to a PLC
- On-line

Back-up of the configuration shall be stored on disks.
And it shall be possible to print parameters, cross reference lists etc.

7.5 Communication, general

7.5.1 PLC network

The local area network shall be an optical ring connection. In case of an error, it shall be alarmed and the communication shall be able to find the alternative path. It shall be possible to detect any errors.
Each device will provide status information by a potential free contact connected to PLC DI for fast error detection on operator level.
The optic fibre cables shall be of the glass type and with at least 100% pairs of spare cores. All cores shall be terminated in patch boxes in the panels. Patch cables shall from here be connected to optical switches.

7.5.2 Data distribution structure

It will be maintained at the basic level of the circular segment, or expanded as needed. The main circular segment (*TerminalBus*) is used to connect individual processor units, to ensure inter-communication and to connect the operator's level.
Each CPU will be also be equipped with a additional data segment to which the relevant peripherals, sensors and action elements (*ProcessBus*) will be connected. In terms of stability and redundancy, it is recommended to maintain at least a basic level of security using a circular structure, as with

TerminalBus. Since the structure may be complex in terms of the final solution layout, wireless connections will be provided, if necessary for the bridging part of the circular structure.
During the construction, wireless connections will be used as a temporary solution to data communications at the *TerminalBus* level to ensure the possibility of concurrent operation of the original and new parts of the technology.
Modular switches with the possibility of ring technology will be used as active elements, which can be expanded with metallic or optical ports, as needed, or with the optional addition of another optional port module.
The connection of the *TerminalBus* to the LAN operator's segment due to the connection of other applications will be done via HW routers.
Modular switches provide information about switching to backup communication route of the circular segment either in the form of digital contact or data communication to the master system so that the failure point can be efficiently allocated.
Optical data segments will be implemented using optical cables, glass design with LC connector preference on optical boxes. Optical cables will be used, as a minimum, in 12x optical fibre design. All optical cable fibres will be terminated in the optical box and fitted with a transient connector. Each unused connector will be provided with dust-proof protection.

7.6 PLC system, hardware, general

7.6.1 Control panel (dashboards)

Control panels for PLCs, control valves and all instruments shall be designed, supplied and installed:
The design covers: one-line diagram, circuit diagrams, signal lists cable lists.

7.6.2 Programmable Logic Controller (PLC)

The PLC shall be an industrial type suitable for installation under the conditions on the site.
The PLC shall mainly be used for the following:
- Control and monitoring of the equipment connected
- Collect and store data from the equipment connected
- Communicate with the other PLC and the control centre.

PLCs shall be for installation inside the panels behind transparent windows.
The PLC shall be provided with all hardware necessary for the operation including the following:
- CPU with indication of RUN, CPU FAULT etc. The scan time shall be less than 200 ms when running the final application software.
- Power supply
- Mounting base frames
- RAM or Flash memory. The RAM memory shall be provided with battery back-up for 2-4 years and indication of BATT LOW. The application shall be stored in Flash or other kind of memory not depending of battery. The data shall be stored in RAM with battery back-up. In case of battery fault and loss of data, a set of back-up data shall automatically be loaded from the Flash, so the PLC can be automatically restarted without use of the programming unit. An alarm shall be forwarded to the monitoring system. All data memory of CPU will be configured as retentive.
-

The capacity (available memory for programming code/data and calculation power) of the CPU shall be sufficient for a 50% expansion of the programs and data.
- Digital I/O-modules
- Analogue I/O-modules
- Interface for communication
- Interface for the programming unit
- Interface for the operator panel
- Other necessary interfaces
- Key operated switch with the following positions: Stop, Run, Programming mode

If the communication fails the PLC shall continue its operation without any interruption.

At a power cut the status of the I/O's shall be in a predefined position.
Start after a power cut shall be fully automatic whit individually delayed starts of every motor
A system error shall automatically be transmitted to the control centre.
A drop-out of communication shall automatically be detected and monitored at the control centre.
The Analogue Input/output-modules shall fulfil the following requirements:

- Minimum resolution of 11 bit
- Accuracy of minimum ±1% of full scale
- Input channel filtering that rejects high frequency noise that couples into the analogue input signal
- Configurable per channel for current or voltage input
- Separately isolation of each channel.

The Digital Input-modules shall fulfil the following requirements:

- Be galvanic isolated from the internal PLC logic
- Be with indication of position
- Each signal shall separately be protected with fuses
- Be protected against high-voltage peaks of up to 2KV.

The Digital Output-modules shall fulfil the following requirements:

- Be provided with no-voltage contacts
- Have selectable OFF or ON position
- Be with indication of position
- Each signal shall separately be protected with fuses
- Be protected against high-voltage peaks of up to 2KV
- Be provided with surge suppressor diodes that is reverse wired across the load.

7.7 PLC system, software, general

7.7.1 Inspection and control programmes

7.7.1.1 System software:

The system software for the PLC shall control the data collection, storing and data handling.

7.7.1.2 Standard Functions:

Standard programs shall as a minimum include the following function modules:

- Analogue input and output with scale in metrical units and with max. and min. level
- Digital input and outputs
- Counters
- Oscillator
- Comparators
- Logical modules
- Arithmetical modules for calculations
- Timers
- Ramps
- Integrators
  1. grade filter
- 3 point regulator where the following parameters shall be adjustable:
  - death band
  - threshold zone
  - start and stop
- Limit on signals

- Internal check of PLC. The check shall include Run/stop/error status of the CPU, error in bus communication, error in an i/o card, battery error etc. The errors shall be displayed at this detailed level at the SCADA system.

7.8 Control

7.8.1 Automation

The automation system covers the PLC system and the SCADA system.
The test shall cover a number of different issues:
- Usability (general operation of the automation and SCADA system).
- Efficiency (performance).
- Accuracy (correct handling of values and calculations).
- Security (protection against unauthorised use of the SCADA system).
- Flexibility (verification that the automation system is suitable for upgrading).

Below, each issue is described. At the end of each item, a number of criteria for passing test are described.

7.8.1.1 Usability

This section describes the tasks to be performed to test the usability of the program.

7.8.1.2 Installation and start up

The purpose of this test is to make sure that the installation and start-up procedure functions well and is described correctly in the Operation and Maintenance Manual.
The test shall:
- Perform an installation procedure in accordance with the O&M Manual
- Check if the procedure is in accordance with instructions
- Check if the program can start up normally
- Perform a normal removal of program
- Make a subsequent reinstallation

The criteria for passing the final test will be:
- No errors occur during the installation procedure
- The procedure is in accordance with the instructions
- The program is able to start up normally

7.8.1.3 Normal Operation

The purpose of the test of the normal operation of the SCADA system is to make sure that it is possible to operate the program in a logical way and in accordance with the specifications/documentation/O&M Manual.
During the test of the normal user operation, the test operator shall:
- Guide him-/herself through a large number of menus and dialog boxes and test a large number of various commands
- Print different kinds of reports

The criteria for passing the final test will be:
- Every activity of normal operation leads to the expected result, and activating a command leads to the expected dialog box
- A printing command leads to printing of the correct output

Handling of errors:
The purpose of this test is to verify correct and logical handling of errors.
The test operator shall:
- Provoke a number of errors and verify that the system responds to these errors as described in the requirements

- Report any unexpected error during all tests in order to verify robustness

The criteria for passing the final test will be:
- Indications of errors must be reasonable, and the user shall be able to continue the work on a well-defined basis.

Handling of Help functions:
The purpose of the test of the handling of help functions (on-line or in manual) is to make sure that the on-screen help function is adequate and works in accordance with the requirements and the actual program. In particular, it shall be verified that terms are used consistently.

The operator shall perform the following tests:

- The help system shall be consulted a large number of times in different situations. The operator shall focus on the existence of relevant help, on clear language, on relevant link(s) to more help and on consistent use of terms
- The text in the on-line help shall be read and compared with relevant specifications

The criteria for passing the final acceptance test will be:

- The on-line help function provides relevant help to the operator in most situations, and the terminology is clear and consistent.

7.8.1.4 Efficiency

The purpose of the efficiency test is to verify that the operation and response times are at an acceptable level.
The verification of efficiency values shall be based on well-defined situations. The operator shall perform different kind of situations:
- Changing a set-point/sending a command
- Open a new diagram
- Open an graph
- Require a report based on historical data's

Five different types of response times have to be taken into account:
- Response time for a transaction, which is the time interval from sending a command until the result is visible and the user can send a new command. Sending a command can be executed by the "Enter"-button, by a mouse click etc. This type of transaction is defined as typing data in an input data field with no calculations, change of diagram etc. related to the transaction
- Response time for opening a new part of the program, such as a new diagram. Opening a diagram for the first time after start of the program may take longer time
- Response time for opening a graph showing curves for 24 hours. In this case, the response time is the time interval from sending an "open graph" command until the result is visible
- Response time for opening a report showing values for 1 month. In this case, the response time is the time interval from sending an "open report" command until the result is visible
- Response time for creating a background job such as a printing command

The criteria for passing the final acceptance test will be:
- The response time for sending a command is almost negligible (less than 1 second). Return of the value from the PLC shall be fulfilled within 2 seconds
- The response time for opening a new diagram is less than 2 seconds
- The response time for opening a graph is less than 10 seconds
- The response time for opening a report is less than 20 seconds

All tests shall take place from the secondary operator station (not the server).

7.8.1.5 Accuracy

The purpose of the accuracy test is to verify that the system generates correct output results.

Based on the detailed project for automation the functionality described here shall be verified.
All functions shall be simulated so electrical connections the software and correct parameter settings can be verified.
The real check of the results will be done manually. A selection of output data will be made, and manual recalculation of this output data will be performed. The documentation will include all the intermediate results.
The system has to be designed in a structure with well-defined modules or classes. The classes shall be defined with interfaces where inputs and outputs are available for investigation. A complete test is divided into several accounts. The number of accounts shall be sufficiently high to allow verification of the sequence between two accounts by use of a pocket calculator.
The criteria for passing the final test will be:
- Manual calculation proving correct relations between all generated accounts.

7.8.2 Security

The purpose of this test is to verify correct security functions in accordance with the requirements.
A number of security levels have been specified.
For each security level, the following has to be verified:
- A person at each level (if defined) shall be able to log into the system and have access to the system in accordance with his/her status. It shall also be verified that the user does not have access to part of the system not covered by his/her rights. This test shall be performed for a person at each level
- Each person defined shall be able to change his/her own password
- The administrator shall be able to define and remove users and to change a user's password. If specified, the administrator shall be able to look into database structures, as well
- The designer shall be able to look into database structures and source codes. The test of access to source code can be carried out on the development system, only

The criteria for passing the final acceptance test will be:
- The number of users has been successfully defined at different levels
- A user has successfully logged in and out
- A user successfully changed his/her own password
- The administrator has successfully changed the password of a user
- The system has been successfully accessed at the different levels

7.8.2.1 Flexibility

The purpose of this task is to verify that the structure of the system is suitable for upgrading to additional functionality. The source code and programmers' documentation shall be investigated.
The test shall verify that:
- The program and database structure of the program developed have well defined interfaces in order to add new modules and new technical solutions under existing SCADA systems
- The source code is well documented with comments and descriptions in the code and variables are described in a logical way
- The compilation and installation of the software are well described

The criteria for passing the final acceptance test will be:
- The structure of the documentation is in accordance with the specifications
- Investigation of several classes, selected arbitrarily proves a comprehensive amount of relevant code line comments so that the source code is understandable
- The compilation and installation of the software are adequately described in the documentation.

7.8.3 Distributed peripheries

A major change compared to the current condition of the original sludge management will be made at the level of process signal collection and connection of sensors or actuators. The existing conception of ED switchboards, which are equipped with IO cards with input signals via multicore cables,is

inflexible, and, last but not least, in the case of partial damage to some of the I/O module, it is also expensive.
The existing Modřice WWTP thickeners use a model of distributed peripherals, which allows for flexible (in terms of size) deployment of signal collection point islands based on the ET-200SP IO system. This is an IO module system that originated from the evolution of the previous ET-200S series and is released as native for the S7-1x00 series. Its deployment along with the older S7-300 / 400 series is also completely trouble-free and will enable extension of the preserved systems, if needed, while maintaining the same component base for optimizing operational spare parts.
The distributed peripherals will be fitted as close as possible to their sensors in order to minimise cable connections, the peripheral modules will be connected to the CPU in the maximum possible extent using an optical data link to eliminate atmospheric discharge damage. Peripheral modules installed in outdoor spaces will be placed in LCC heated cabinets fitted with a back-up power source, 24V DC, to provide operational information even in case of power outage until starting up the alternate power supply with the backup storage battery capacity of at least 12Ah (including the data route operation).

7.8.4 Sensors, actuators

As in the case of the distributed peripherals, a conceptual change will be made to the connection of sensors and actuators according to the following criteria

7.8.4.1 Connection of sensors

A strongly preferred solution is via a communication network to a collecting concentrator. For the sake of simplicity, PNET connection sensors are considered in the *Processbus* segment. If available for the relevant sensor, it will always be fitted with a local display to display the value and enable visual check of the function.

7.8.4.2 Connection of actuators

The individual actuators (flap valves, gates, drives) will be designed with an integrated control cabinet from the manufacturer to enable local control without the need for additional control cabinets. Each element will be equipped with a service switch including signalling to the control system. The service switch is used to ensure safe switch-off of the equipment for maintenance and repair purposes.

8 Testing procedures and taking over of the works

8.1 General Requirements

The Contractor's project plan shall include a programme for completing such inspections and tests in a co-ordinated manner and in accordance with the requirements of the contract.
The tests are broken down into the following stages:

- Inspection and Testing during Construction;
- Pre-Commissioning of Individual Components (dry and wet tests);
- Commissioning tests (of entire sludge management plant);
- Process Performance Test (during trial operation);
- Performance guarantees and Verification Tests (during 1-year trial operation)

The Contractor shall provide all labour, plant, materials and services required for testing and inspecting the Works.
All tests shall be performed in presence of the Engineer of a person appointed for this purposes, unless the Engineer specifies otherwise in writing. The test records shall list deficiences to be eliminated by the Contractor in the form of a snag list.
The Engineer may request additional tests demonstrating the contract performance. All such tests shall be carried out at the cost of the Contractor.
The Contractor shall submit to the Engineer full details of inspections and tests to be carried out at least 21 days in advance. Attendance at and acceptance of tests and inspections of the works shall not prejudice the right of the Engineer to reject any part of the works if it subsequently fails to comply with the requirements of the contract.
The Contractor shall keep a record of all tests and inspections, irrespective of whether or not they show compliance with the contract and shall issue this record to the Engineer on completion of each test and inspection.

8.2 Inspection and Testing during Construction

8.2.1 Off site inspection and testing

All major items of plant and equipment shall satisfactorily pass a factory acceptance test (FAT) to design working conditions prior to dispatch. The Contractor shall complete routine and functional works tests to ensure the item is in compliance with the specifications. The Contractor shall give the Engineer the opportunity to attend and witness such tests by giving notice in due time in accordance with the Contract (Sub-clause 9.1 of the General Conditions of Contract).
No material or item of plant and equipment shall be delivered to site without prior inspection, testing and certification, where applicable, unless the Engineer confirms, in writing, that such inspection, testing and/or certification, is not required.

8.2.2 On-site inspection and testing

On-site inspection and testing during construction includes soil tests for building construction works, tests of concrete and other building materials, tests of weldings and other tests in order to validate that the construction works fulfill the quality requirements specified in the Employers Requirements.

8.3 Tests on completion

8.3.1 General

All tests on completion will be conducted by trained and experienced staff. The person of the Contractor responsible for conducting the tests on completion shall have at least five years of experience with commissioning and performance testing of similar equipment.

8.3.2 Pre-commissioning

The pre-commissioning and commissioning tests under dry and wet conditions as appropriate shall include all procedures and functions, safety, emergency as well as normal procedures.
The Contractor shall set out, in his construction documentation, a full list of the pre-commissioning tests to be carried out under the contract to prove compliance with the Employer's requirements and the general technical specifications. Such tests shall include, but not necessarily be limited to:

Test of structures and pipes

- Leakage and pressure tests; and
- Construction materials testing.

Tests of mechanical equipment

- Tests of correct direction of rotation of motors;
- Tests of automatic operation;
- Tests of manual operation;
- Tests of capacity of all machines individually and as part of the entire plant; and
- Tests of quality of materials.

Tests of electrical equipment

- Tests of alarm systems;
- Tests of the emergency switch system;
- Tests of manual operation;
- Tests of all interlocking systems;
- Tests of indications;
- Tests of all panel functions;
- Tests of safety systems;
- Tests of all signals to the SCADA and PLCs;
- Tests of modifications of the control systems (new start and stop level etc); and
- Full test of all signals to and from the PLCs, instruments and signal converters.

All testing under "dry" conditions shall be completed to the satisfaction of the Engineer prior to the introduction of "wet" conditions to the plant.

8.3.3 Commissioning tests

Upon successful completion of all individual tests of all the equipment, the Contractor will commence commissioning tests. During these tests, the Contractor shall demonstrate functionality of individual process units and the entire plant for a period of 72 hours. The commissioning tests will be completed and the plant will be ready for trial operation if the entire plant (all process units together) will be in continuous operation in automatic mode for 72 hours without failures and while meeting all predefined performance parameters approved by the Engineer.
The commissioning test programme shall be submitted by the Contractor to the Engineer no later than 21 days prior to the requested date of the commissioning tests commencement. Without an approved programme, the contractor shall not start the commissioning test.

When commissioning, it is necessary to ensure emission measurements for air pollution sources been delivered by the Contractor within the Works in accordance with the procedure and to the extent required by the relevant regulations. The Contractor shall ensure authorized emission measurement to be conducted by an entity holding a relevant emission measurement authorisation.
Upon successful completion of all tests, the Contractor will issue a final report (or a protocol on the results of the commissioning tests), which will be submitted to the Engineer for approval. The Engineer's approval of the final report on the completion of the commissioning tests is a prerequisite for the start of the trial operation.

8.3.4 Trial operation (running-in and process proving)

Once the pre-commissioning and commissioning tests have been completed to the satisfaction of the Engineer, the Contractor shall operate and maintain the sludge management plant in accordance with the draft operation and maintenance manuals for a trial period of one year. During this period the Engineer shall have the opportunity to witness all operation and maintenance activities, the objectives of which are to optimise the function and operation of the entire plant.
Before starting the trial operation the Contractor shall, at his own cost, ensure that all tanks etc. are filled with consumables. Further consumables during the trial operation will be paid by the Employer.

During the one-year operation, the Employer will ensure sampling and analyses in a scope listed in Table 12. The results of the analyses will be submitted by the Engineer to the Contractor within one week.

Table No. 12 sampling points and types during the trial operation.

	Parameter	Primarry sludge - thickener output	Surplus sludge – thickening input	Surplus sludge – thickening output	Surplus sludge - THP	Mixed sludge	Digested sludge – digester output	Dewatered digested sludge-input	Dewatered sludge- input	Sludge drier- output	Biogas	Water for steam generator	Service water for drier cooling
Sludge	VSS %	X		X	X		X	X	X	X			
	SS (mg/l)	on line metering	X										
	Suspended solids volatile matter (VSS) %												
	Volatile matter (VM) %	X				X	X						
	DS (mg/l)											X	
	Nt (mg/l)						X		X				
Supernatant/condensate	Supernatant/condensate m3/d	X		X					X	X			
	SSA (mg/l)	X	X	X					X	X			
	Supernatant/ Nt (mg/l)	X		X					X	X			
Flocculant	Consumption in m3/d			X				X					
	Consumption in kg/d			X				X					

Comments on sampling:
– *Sludge and supernatant samples will be taken daily from sampling points permanently established by the Contractor, 24h composite samples from 4 grab samples.*
- Flocculant: on-line measurement – taken from a permanently installed flowmeter set by the Contractor - SCADA reading.
– *Sludge and supernatant flow rate taken from the permanently installed flowmeter set by the Contractor - SCADA reading.*
– *In the event of a request by the Contractor for a larger range of sampling or analyses, the requirement will be discussed between the Contractor and the Engineer.*

During the one-year trial operation, the DS content in the dried sludge must not be less than 90%, the sludge temperature in the digesters must be in the range of 36 to 40 °C, and the nitrogen content in the sludge produced by the Works must not exceed the Nt value of 1,114 kg/d.

Trial operation in the period shall be under automatic and manual control as directed by the Engineer to prove the functionality and reliability of the control systems.
In order to demonstrate that the constructed sludge management plant conforms to the Employer's Requirements and the performance guarantees provided by the Contractor as a part of the contract, the Contractor shall carry out performance tests in accordance with the requirements specified in Section 8.5.
During the trial operation the Employer shall conduct two load tests in line with and on conditions set out in Section 8.6.
The Contractor shall be responsible for setting up a system for completing the necessary performance tests and reporting the results indicating whether or not compliance with the Employer's Requirements has been achieved.
The test results will be formulated in such a way that for each guaranteed value the difference between the guaranteed value given in the Letter of Tender in the Form List of Guaranteed Parameters (further also "guaranteed value") and the actual measured value will be obvious.

Odour
Air samples shall be taken out for the determination of the hydrogen sulphide expressed in mg/m3 at four site boundary locations and at eight other locations within the works to be determined by the Engineer.

Noise
The noise level at the site boundary shall be measured at four locations during the trial operation period. The Engineer shall determine the time and location of measurement.
Acceptance of the completed works relating to acceptable noise levels at the site boundaries by the Engineer shall be based on the system demonstrating that it performs in accordance with the requirements.
The noise level at 1 m distance from all noise producing equipment shall be measured once during the trial operation period at a time to be determined by the Engineer.

8.4 Employer's taking over

Once the Contractor is satisfied that the necessary performance tests, to demonstrate compliance with the Employer's Requirements and performance guarantees, have been completed he shall submit a final test report to the Engineer summarizing the test results. This report shall be accompanied by:

- A statement from the Contractor that, in his opinion, the works have passed the tests on completion; and
- An application for a taking-over certificate.

The taking-over certificate will be issued by the Employer once the Works have been completed in line with the contract and the terms and conditions listed under Chapter 3.5 Requirements for the Completion of the Works have been met.

8.5 Process Performance Guarantees

The process performance tests shall be conducted during the trial operation to demonstrate that the plant and the individual equipment meets the process performance guarantees given by the Contractor in the Letter of Tender in the Form List of Guaranteed Parameters (further also "List of guaranteed parametres").

All equipment to be tested shall be operated in accordance with the manufacturer's operating instructions. Performance tests can commenced no earlier than after 30 days of continuous trouble-free operation.
The Contractor shall carry out the process performance tests with the Engineer present.
An Inspection and Test Plan shall be prepared for the Process Performance Test prior to the commencement of the test and within the required timing as set out in Section 8.1.
The plan shall include:

- Test Program;

- Test Standards;
- Description of instrumentation to be used;
- Method of data recording.

Process Performance Test Reports shall be prepared on the completion of the test, outlining the results of all testing and including:

- Preparation for the tests
- Progress of the tests
- Tables, graphs and calculations necessary for interpretation of the results;
- Comparison of the test results with value given in the Letter of Tender in the List of Guaranteed Parameters;
- SCADA printouts detailing any alarms and reliability of the equipment/plant;
- Discussion on overall performance of equipment/plant.

8.5.1 Process Performance Guarantee for steam consumption for THP

Steam consumption for THP

Objective:

The Contractor guarantees that during a performance test conducted as herein provided the specific steam consumption per a ton of dry solids (DS) in a waste activated sludge will be lower or equal as the value provided in the Letter of Tender in the List of guaranteed parameters.

Procedure:

Pre-conditions for test run start-up:

The digesters have run at full capacity during a stable operating period over a minimum of 1 month.
Input sludge concentration will be lower than 6 % DS.

Test period:

During the test period the THP will be loaded continuously for the minimum period of three days with the surplus sludge load of minimum of 30 t/day.

Measurement of steam consumption:

During the test period the sludge volume (m³/den), content of dry solids (% DS) and steam consumption (kg/t sušiny) are measured. Furthermore, the total THP output and electrical energy kWh/day and steam in kg/day will be measured.

Sampling of sludge:

Sludge samples are taken during test period every hour from the effluent.
Duration of samplings: 3x8 consecutive hours to be chosen between 6 h. and 20 h.
Frequency of samplings: 1 sample per hour.
Minimum volume of a sampling: 1 litres.

Sludge analysis:

Input and output sludge ssamples will be analysed for DS content (total solids) (mg/l).

Presentation of the results:

The Contractor will submit the report on the progress and results of the test.

Remedial action:

In case of compliance failure, the Contractor shall execute the improvement as quickly as technically possible with reasonable consideration to all occurrences. The work must be completed within maximum 1 months. A new test can be carried out after 2 weeks of stable and continuous operation of the tested equipment. If results show that the control requirements are not met, the above procedure must be repeated once.

Discount for failure to attain the guaranteed maximum steam consumption for THP.

If the results indicate that the guaranteed steam consumption value for THP per ton of DS in waste activated sludge cannot be achieved, the Contractor will be liable to provide a discount related to this failure of his obligation. Discount will be established based on the formula:

RMKH = annual volume of sludge to be hydrolysed = 30 t DS/day x 365 days/year = 10 950 t DS/year
GSP = guaranteed steam consumption (kg/t DS)
NSP = measured steam consumption (kg/t DS)
NP = cost for 1 kg of steam = 1,0 CZK/kg
T = 10 years

$$\text{Discount for increased steam demand (CZK)} = \text{RMKH} \times (\text{NSP} - \text{GSP}) \times \text{NP} \times \text{T}$$

Maximum compensation for failure to attain the guaranteed maximum steam consumption for THP is set to **10 mil. CZK.**

8.5.2 Process performance guarantee for electrical energy consumption for THP

Electrical energy consumption for THP

Objective:

The Contractor guarantees that during a performance test conducted as herein provided the specific electrical energy consumption per a ton of dry solids in a waste activated sludge will be lower or equal as the value provided in the Letter of Tender in the List of guaranteed parameters.

Procedure:

Pre-conditions for test run start-up:

The digesters have run at full capacity during a stable operating period over a minimum of 1 month.
Input sludge concentration will be lower than 6 % DS

Test period:

During the test period the THP will be loaded continuously for the minimum period of three days with the surplus sludge load of minimum of 30 t/day.

Measurement of electrical energy consumption:

During the test period the sludge volume (m³/den), content of dry solids (% DS) and steam consumption (kg/t sušiny) are measured. Furthermore, the total THP output and electrical energy consumption kWh/day and steam in kg/day will be measured.

Sampling of sludge:

Sludge samples are taken during test period every hour from the effluent.
Duration of samplings: 3x8 consecutive hours to be chosen between 6 h. and 20 h.
Frequency of samplings: 1 sample per hour.
Minimum volume of a sampling: 1 litres.

Sludge analysis:

Input and output sludge samples will be analysed for DS content (total solids) (mg/l).

Presentation of the results:

The Contractor will submit the report on the progress and results of the test.

Remedial action:

In case of compliance failure, the Contractor shall execute the improvement as quickly as technically possible with reasonable consideration to all occurrences. The work must be completed within maximum 1 months. A new test can be carried out after 2 weeks of stable and continuous operation of the tested equipment. If results show that the control requirements are not met, the above procedure must be repeated once.

Discount for failure to attain the guaranteed maximum electrical energy consumption for THP:

If the results indicate that the guaranteed electrical energy consumption value per ton of DS in waste activated sludge cannot be achieved, the Contractor will be liable to provide a discount related to this failure of his obligation. Discount will be established based on the formula:

RMKH = annual volume of sludge to be hydrolysed = 30 t DS/day x 365 days/year= 10 950 t DS/year
GSEE = guaranteed consumption of electrical energy (kWh/t DS)
NSEE = measured consumption of electrical energy (kWh/t DS)
NEE = cost of 1 kWh of electrical energy = 1,25 CZK/kWh
T = 10 years

$$\text{Discount for increased electrical energy demand (CZK)} = \text{RMKH} \times (\text{NSEE} - \text{GSEE}) \times \text{NEE} \times \text{T}$$

Maximum compensation for failure to attain the guaranteed maximum consumption of electrical energy for THP is set to **2 mil. CZK.**

8.5.3 Process performance guarantee for power consumption for mixing of digesters

Power consumption for mixing of digesters

Objective:

The Contractor guarantees that during a performance test conducted as herein provided the electric input value of the sludge agitator in the digesters will be lower or equal to the value provided in the Letter of Tender in the List of guaranteed parameters. The concentration of suspended solids should not differ by more than 10 % at any point inside the digesters.

Procedure:

Pre-conditions for test run start-up:

The digesters have run at full capacity during a stable operating period over a minimum of 1 month.
The sludge content in the inlet sludge shall not be less than 6 % DS.

Test period:

Test period for measurement of power consumption is 30 days with normal operation. Period for continuous operation for measurement of variation in suspended solids is 8 hours.

Measurement of electrical power consumption:

During the testing period, the power consumption in kW of the installation is read at the low voltage box. The total power consumption in kWh is also read.

Sampling of sludge:

Sludge samples for suspended solids are taken every hour during test period from the recirculation sludge flow through the sludge heat exchangers. The sludge flow shall be taken both from the bottom and from the top of the digesters by changing the outtake point from the digesters. In addition, a third sample must be taken from the heat exchanger.

Duration of samplings: 8 consecutive hours to be chosen between 6 h and 20 h.
Frequency of samplings: 1 sample per hour from top, bottom and heat exchanger.
Minimum volume of a sampling: 1 litres.

Sludge analysis:

The samples from top, bottom and heat exchanger are analysed for the dry solids (total solids) (mg/l) parameters.

Presentation of the results:

The Contractor will submit the report on the progress and results of the test.

Remedial action:

In case of compliance failure, the Contractor shall execute the improvement as quickly as technically possible with reasonable consideration to all occurrences. The work must be completed within maximum 1 months. A new test can be carried out after 2 weeks of stable and continuous operation of the tested equipment. If results show that the control requirements are not met, the above procedure must be repeated once.

Discount for failure to attain the guaranteed maximum power consumption for mixing of digesters:

If the results indicate that the guaranteed power consumption for mixing of digesters cannot be achieved, the Contractor will be liable to provide a discount related to this failure of his obligation. Discount will be established based on the formula:

PHR = Operation hours per year = 24 h/d * 365 days/year=8,760 hours/year)
OVN = Volume of digesters, total =13,500 m³
GEP = Guaranteed power consumption for mixing of digesters - in W/m3
NEP = Measured power consumption for mixing of digesters - in W/m3
N = Cost for 1 kWh of electrical power = 1,25 CZK/kWh
T = 10 years

$$\text{Discount (CZK)} = \text{OVN} \times \frac{(\text{NEP} - \text{GEP})}{1000} \times \text{PHR} \times \text{N} \times \text{T}$$

Maximum compensation for failure to attain the guaranteed maximum power consumption for mixing of digesters is set to **8 mil. CZK.**

8.5.4 Process performance guarantee for specific biogas production

Specific biogas production

Objective:

The Contractor guarantees that during a performance test conducted as herein provided the guaranteed biogas production value (i.e. biogas production per ton of VSS expressed in MLSS fed to the digesters) is equal or higher than the value in the Letter of Tender in the List of guaranteed parameters.

Procedure:

Pre-conditions for test run start-up:

The biogas production value will be measured once the entire biogas production system has been operated in stable operation at full capacity for minimum of 1 month. The test duration will be a minimum of 30 days. The organic matter will be analysed at least once a day over the test duration, i .e. 30 days. At the same time the COD value in the biomass will be determined.

Test period:

30 days during normal operation.

Measurement of specific biogas production:

During the testing period, the biogas production of the plant is measured at the gas flow meter.

Sampling of sludge:

Sludge samples during the performance tests will be taken every day from the homogenisation tanks upstream and downstream the digestion system. The input sludge sample will be taken from the mixing tank upstream the digestion so as to obtain representative sample of the primary and secondary sludge mixture before digestion. The output sample will be taken from the homogenization storage tank downstream the digestion.

Frequency of samplings: 2 x 4 grab samples a day.

Minimum volume of a sampling: 1 litres.

4 grab samples are poured together into a composite sample per 1 sampling point, which means the following samples:

i. one (1) inlet sludge sample (primary and secondary homogenized) per day.
ii. one (1) digested sludge sample per day.

Sludge analysis (Analysis shall be performed by an authorised laboratory using appropriate standards.)

The composite samples for mixed primary and biological sludge and for digested sludge are analysed for the following parameters: - Volatile Suspended Solids (VSS) (mg/l).

- Dry solids (total solids) (mg/l).

Presentation of the results:

The Contractor will submit the report on the progress and results of the test.

Remedial action:

In case of compliance failure, the Contractor shall execute the improvement as quickly as technically possible with reasonable consideration to all occurrences. The work must be completed within maximum 1 months. A new test can be carried out after 2 weeks of stable and continuous operation of the tested equipment. If results show that the control requirements are not met, the above procedure must be repeated once.

Discount for failure to attain the guaranteed biogas production value:

If the results indicate that the guaranteed specific biogas production cannot be achieved, the Contractor will be liable to provide a discount related to this failure of his obligation. Discount will be established based on the formula:

RMNL = annual volume of suspended solids (loss on ignition) in sludge before digestion = 35 t/day x 365 days = 12 775 t/year

GSPB = guaranteed specific biogas production (Nm3/kg org. DS)

DSPB = attained specific production of biogas (Nm3/kg org. DS)

F = conversion factor biogas to natural gas = 0,7

N = 11,50 CZK/Nm3

T = 10 years

$$\text{Discount (CZK)} = (\text{GSPB} - \text{DSPB}) \times \text{RMNL} \times 1000 \times \text{F} \times \text{N} \times \text{T}$$

Maximum compensation for failure to attain the guaranteed value of biogas production is set to **30 mil. CZK.**

8.5.5 Process performance guarantee for sludge dryer heat demand

Sludge dryer heat demand

Objective:

The Contractor guarantees that during a performance test conducted as herein provided the guaranteed sludge dryer heat demand value will be equal or lower than the value in the Letter of Tender in the List of guaranteed parameters. Guaranteed value for Sludge dryer heat demand means heat demand in the form of hot water on 1 kg of evaporated water including the loss from the sludge dryer, on condition that the minimum content of dry solids in the sludge at the sludge dryer output is in the amount at least of 90%, and the maximum consumption of process water for cooling system is 100 litres/second.

Procedure:

Pre-conditions for test run start-up:

The sludge drying units have run at full capacity during a stable operating period over a minimum of 1 month.
The sludge content in the inlet sludge shall not be less than 23 % DS.

Test period:

During testing, the processes will be loaded continuously over a min. period of three days using mixed sludge in the ratio of: 30 t of primary sludge, 20 t of secondary sludge.
This test can only be carried out in the spring or autumn.
The aforementioned testing will be verified outside the verification operation – see section 8.6.

Measurement of the heat, energy and water consumption:

During the testing period, the power consumption and the heat consumption in kW and of the installation is read. The total power and heat consumption in kWh is also read. Furthermore the water consumption in m³ is measured.

Sampling of sludge:

Sludge samples are taken during test period every hour from the effluent.
Duration of samplings: 3x8 consecutive hours to be chosen between 6 h. and 20 h.
Frequency of samplings: 1 sample per hour.
Minimum volume of a sampling: 1 litres.

Sludge analysis:

Input and output sludge samples will be analysed for DS content (total solids) (mg/l).

Presentation of the results:

The Contractor will submit the report on the progress and results of the test.

Remedial action:

In case of compliance failure, the Contractor shall execute the improvement as quickly as technically possible with reasonable consideration to all occurrences. The work must be completed within maximum 1 months. A new test can be carried out after 2 weeks of stable and continuous operation of the tested equipment. If results show that the control requirements are not met, the above procedure must be repeated once.

Discount for failure to attain the guaranteed sludge dryer heat demand value:

If the results indicate that the guaranteed sludge dryer heat demand value cannot be achieved, the Contractor will be liable to provide a discount related to this failure of his obligation. Discount will be established based on the formula:
RMN = annual volume of sludge to be dryed = 106 m3/day x 365 days/year = 38 690 m3/year
RMOV = annual volume of water, which will be evaporated (28 % DS at input) =
= 38 690 m3/year x 72 % water = 27 860 m3/year
GPTE = guaranteed heat demand (kWh/kg evaporated water)
NPTE = measured heat demand (kWh/kg evaporated water)
GSEE = guaranteed consumption of el.energy (kWh/kg evaporated water)
NSEE = measured consumption of el.energy (kWh/kg evaporated water)
NTE = cost of 1 kWh heat energy = 1,10 CZK/kWh
NEE = cost of 1 kWh el.energy = 1,25 CZK/kWh
T = 10 years

$$\text{Discount for increased sludge dryer heat demand (CZK)} = \text{RMOV} \times 1000 \times (\text{NPTE} - \text{GPTE}) \times \text{NTE} \times \text{T}$$

Maximum compensation for failure to attain the guaranteed value of maximum sludge dryer heat demand is set to **20 mil. CZK.**

8.5.6 Process performance guarantee for sludge dryer electrical energy consumption

Sludge dryer electrical energy consumption

Objective:

The Contractor guarantees that during a performance test conducted as herein provided the guaranteed sludge dryer electrical energy consumption value will be equal or lower than the value in the Letter of Tender in the List of guaranteed parameters. Guaranteed value of sludge dryer electrical energy consumption means electrical energy consumption on 1 kg of evaporated water including the loss from the sludge dryer, on condition that the minimum content of dry solids in the sludge at the sludge dryer output is in the amount at least of 90%, and the maximum consumption of process water for cooling system is 100 litres/second.

Procedure:

Pre-conditions for test run start-up:
The sludge drying units have run at full capacity during a stable operating period over a minimum of 1 month.
The sludge content in the inlet sludge shall not be less than 23 % DS.

Test period:
During testing, the processes will be loaded continuously over a min. period of three days using mixed sludge in the ratio of: 30 t of primary sludge, 20 t of secondary sludge.
This test can only be carried out in the spring or autumn.
The aforementioned testing will be verified outside the verification operation – see section 8.6.

Measurement of the heat, energy and water consumption:
During the testing period, the power consumption and the heat consumption in kW and of the installation is read. The total power and heat consumption in kWh is also read. Furthermore the water consumption in m³ is measured.

Sampling of sludge:
Sludge samples are taken during test period every hour from the effluent.
Duration of samplings: 3x8 consecutive hours to be chosen between 6 h. and 20 h.
Frequency of samplings: 1 sample per hour.
Minimum volume of a sampling: 1 litres.

Sludge analysis:
Input and output sludge samples will be analysed for DS content (total solids) (mg/l).

Presentation of the results: The Contractor will submit the report on the progress and results of the test.

Remedial action:

In case of compliance failure, the Contractor shall execute the improvement as quickly as technically possible with reasonable consideration to all occurrences. The work must be completed within maximum 1 months. A new test can be carried out after 2 weeks of stable and continuous operation of the tested equipment. If results show that the control requirements are not met, the above procedure must be repeated once.

Discount for failure to attain the guaranteed values of sludge dryer electrical energy consumption:

If the results indicate that the guaranteed values of sludge dryer electrical energy demand cannot be achieved, the Contractor will be liable to provide a discount related to this failure of his obligation. Discount will be established based on the formula:
RMN = annual volume of sludge to be dryed = 106 m3/day x 365 days/year = 38 690 m3/year
RMOV = annual volume of water, which will be evaporated (28 % DS at input) =
= 38 690 m3/year x 72 % water = 27 860 m3/year
GPTE = guaranteed heat energy demand (kWh/kg evaporated water)
NPTE = measured heat energy demand (kWh/kg evaporated water)
GSEE = guaranteed electrical energy consumption (kWh/kg evaporated water)
NSEE = measured electrical energy consumption (kWh/kg evaporated water)
NTE = cost of 1 kWh heat energy = 1,10 CZK/kWh
NEE = cost of 1 kWh electrical energy = 1,25 CZK/kWh
T = 10 years

$$\text{Discount for increased sludge dryer electrical energy demand (CZK)} = \text{RMOV} \times 1000 \times (\text{NSEE} - \text{GSEE}) \times \text{NEE} \times \text{T}$$

Maximum compensation for failure to attain the guaranteed value of sludge dryer electrical energy consumption is set to **20 mil. CZK.**

8.5.7 Process performance guarantee for polymer consumption for waste activated sludge thickening

Polymer consumption for waste activated sludge thickening

Objective:

The Contractor guarantees that during a performance test conducted as herein provided the guaranteed value of Polymer consumption for waste activated sludge thickening will be equal or lower than the value in the Letter of Tender in the List of guaranteed parameters. The guaranteed value of polymer consumption is related to the minimum content of DS (i.e. total solids or DS) in the thickened sludge min. 16% DS at maximum dose of polymer 12 kg/ton DS.

Procedure:

Pre-conditions for test run start-up:

The sludge content in the inlet sludge shall not be llower than 1 % DS.

The test run shall only be performed with sludge from the storage for biological sludge and shall be performed at 100% unit capacity.

Test period:

One day with 8 hours with continuous operation.

Measurement of sludge flow:

The sludge flow is measured by the magnetic flow meters placed on the influent pipe to each of the units. The total thickening capacity in m^3/h is calculated as the summarised average flow entering each thickening unit.

Sampling of sludge:

Sludge samples are taken every hour during test period from the inlet and outlet sampling points at each of the thickening units.

Duration of samplings: - 8 consecutive hours to be chosen between 6 h and 20 h.

Frequency of samplings: - 1 sample per hour.

Minimum volume of a sampling: - 1 litres.

Each sample of 1 litres (minimum) will be taken as spot samples from the sampling points for influent and effluent sludge at each sludge thickening unit. The 8 spot samples shall be mixed to one composite sample per sampling point constituting the following samples:

- One (1) influent sludge sample per thickening unit.
- One (1) effluent sludge sample per thickening unit.

Sludge analysis:

The composite samples from in- and effluent of each thickening unit is analysed for the following parameters:

- Dry solids (total solids) (mg/l).

Analysis shall be performed by an authorised laboratory using appropriate standards.

Presentation of the results:

The Contractor will submit the report on the progress and results of the test.

Remedial action:

In case of compliance failure, the Contractor shall execute the improvement as quickly as technically possible with reasonable consideration to all occurrences. The work must be completed within maximum 1 months. A new test can be carried out after 2 weeks of stable and continuous operation of the tested equipment. If results show that the control requirements are not met, the above procedure must be repeated once.

Discount for failure to attain the guaranteed polymer consumption for WAS thickening:

If the results indicate that the guaranteed values of polymer consumption for WAS thickening demand cannot be achieved, the Contractor will be liable to provide a discount related to this failure of his obligation. Discount will be established based on the formula:

RMBK = Annually amount of biological sludge for thickening = 25 t/day x 365 days/year = 9 125 t/year

RNSP = Annually over-consumption of polymer (kg/year)

GSP = guaranteed polymer cons. (kg/t DS)

N = 100 CZK/kg

T = 10 years

$$\mathrm{RNSP} = \left(\frac{\mathrm{DSP}}{\mathrm{GSP}} - 1\right) \times \mathrm{RMBK} \times \mathrm{GSP}$$

$$\mathrm{Discount\ (CZK)} = \mathrm{RNSP} \times \mathrm{N} \times \mathrm{T}$$

Maximum Compensation for failure to attain the guaranteed maximum polymer consumption for WAS thickening is set to **10 mil. CZK**

8.5.8 Process performance guarantee for polymer consumption for sludge dewatering

Polymer consumption for sludge dewatering

Objective:

The Contractor guarantees that during a performance test conducted as herein provided the guaranteed value of Polymer consumption for sludge dewatering will be equal or lower than the value in the Letter of Tender in the List of guaranteed parameters. Dry solids (i.e. total solids or DS) content in the dewatered sludge will be of min. 28 % DS. and the content in the reject water is maximum 1.500 mg SS/l.

Procedure:

Pre-conditions for test run start-up:

The sludge content in the inlet sludge shall not be less than 4 % DS. The test run shall only be performed with sludge pumped from the digested sludge storage tanks, and shall be performed at 100% unit capacity.

Test period: One day with 8 hours with continuous operation.

Measurement of sludge flow:

The sludge flow is measured by the magnetic flow meters placed on the influent pipe to each of the units. The total dewatering capacity in m^3/h is calculated as the summarised average flow entering each final dewatering unit.

Measurement of dry solids (DS) of the influent sludge

The dry solids (total solids) of the influent sludge are measured continuously by the DS-meter over the test period. The measured meter values are only used for identification of the fluctuation of DS over the test period. The average value of each meter readings shall be higher than 4.0 % DS.

Sampling of sludge

Sludge samples are taken every hour during test period from the inlet, outlet and reject water sampling points at each of the final dewatering units.

Duration of samplings: - 8 consecutive hours to be chosen between 6 h and 20 h.

Frequency of samplings: - 1 sample per hour.

Minimum volume of a sampling: - 1 litres.

Each sample of 1 litres (minimum) will be taken as spot samples from the sampling points for influent, effluent sludge and for the reject water at each sludge dewatering unit. The 8 spot samples shall be mixed to one composite sample per sampling point constituting the following samples:

- One (1) influent sludge sample per final dewatering unit;
- One (1) effluent sludge sample per final dewatering unit;
- One (1) reject water sample per final dewatering unit.

Sludge analysis:

The composite samples from in- and effluent of each final dewatering unit is analysed for the Dry solids (total solids) (mg/l). The composite samples from reject water of each final dewatering unit is analysed for the Suspended solids (SS) (mg/l). Analysis shall be performed by an authorised laboratory using appropriate standards.

Measurement of sludge flow, water and polymer consumption

The following information is recorded at the time of each sampling:

- The sludge flow measured by the influent flow meter of the plant.
- The consumption of polymer.

During the tests, the quantity of consumed water and polymer shall be noted and the consumption per treated quantity (cubic metre of sludge flow or quantity of DS) are calculated and compared with the required values.

Presentation of the results: The Contractor will submit the report on the progress and results of the test.

Remedial action:

In case of compliance failure, the Contractor shall execute the improvement as quickly as technically possible with reasonable consideration to all occurrences. The work must be completed within maximum 1 months. A new test can be carried out after 2 weeks of stable and continuous operation of the tested equipment. If results show that the control requirements are not met, the above procedure must be repeated once.

Discount for failure to attain the guaranteed polymer consumption for sludge dewatering:

If the results indicate that the guaranteed values of polymer consumption for sludge dewatering cannot be achieved, the Contractor will be liable to provide a discount related to this failure of his obligation. Discount will be established based on the formula:

RMOK = Annually amount of dewatered sludge = 50 t/day x 365 days/year = 18 250 t/year
RNSP = Annually over-consumption of polymer (kg/year)
DSP = attained polymer cons.(kg/t DS)
GSP = guaranteed polymer cons. (kg/t DS)
N = 100 CZK/kg
T = 10 years

$$\mathrm{RNSP} = \left(\frac{\mathrm{DSP}}{\mathrm{GSP}} - 1\right) \times \mathrm{RMOK} \times \mathrm{GSP}$$

$$\mathrm{Discount\ (CZK)} = \mathrm{RNSP} \times \mathrm{N} \times \mathrm{T}$$

Maximum compensation for failure to attain the guaranteed maximum polymer consumption for sludge dewatering is set to **25 mil. CZK.**

8.6 Load tests

8.6.1 Generally

The Contractor will perform verification tests during the one-year trial operation. The purpose of the verification tests is to confirm the fulfillment of the Employer's requirements at the maximum load of the sludge line and extraordinary operating conditions as follows:

a) maximum sludge load during normal operation - all process units are in full operation - at least 2 x 3 days
b) extraordinary operating mode - one digester out of operation - 3 weeks
c) extraordinary operating mode - one sludge drying line out of operation - 1 week
d) extraordinary operating mode - newly installed CHP out of service - 3 days
e) extraordinary operating mode - all CHPs out of service (for testing the capacity of steam generators, hot-water boilers and for defining the maximum consumption of electricity from the grid) - 8 hours from 7:00 to 15:00
f) extraordinary operating mode - THP out of operation - 20 days

During the verification tests, all equipment must be in continuous automatic mode without any malfunction of the automatic control or other necessary modifications.

The verification test plan will be prepared by the Contractor for approval by the Engineer 21 days prior to the expected start of the verification test or for all verification tests (for each separately) 21 days prior to the expected start of the first test. This plan will include:

- Verification test programme;
- Sampling and monitoring plan during the conduct of the test, including measuring points,
- Description of the instruments used;
- Data Recording Method.

Upon completion of each verification test, the Contractor shall provide the Engineer with the verification test report. Submitting the report after all verification tests have been completed is not allowed.

The test report will include:

- Tables, graphs and calculations needed to interpret the results;
- Comparison of the results with Employer requirements;
- SCADA records with details of all alarms and reliability of the equipment,
- Assessment the overall performance of the equipment.

The results and conclusions of the verification tests will be incorporated into the updated operational rules for emergency operations..

8.6.2 Requirements for verification tests

In the event that the plant is not operated continuously during the verification tests or further modifications are required during this period, the Contractor will re-initiate the verification test to ensure this continuous and trouble-free operation.

8.6.2.1 Extraordinary sludge line load during standard operation

The aim of the test is to verify the maximum load of the sludge management. system.

Course and duration:

All process units will be in operation during the test, during the tests the following operating modes will be tested:

a) Primary sludge load at the limit of 30 t SS day, total mixed sludge load 50 t SS / day, test duration at least 3 days;

b) Load with excess sludge at the limit of 30 t NL / day, total mixed sludge load 50 t NL / day, duration at least 3 days.

To ensure the required sludge volume for the test, the test date must be agreed with the Engineer sufficiently in advance, for part (b) the summer holidays period is expected. The verification test can be performed either at the same time, i.e. part (a) with a transition to part (b) or separately in different periods, i.e. part (a) and, after interruption, part (b).

8.6.2.2 Extraordinary operating mode – one digester out of service – 3 weeks

The aim of the test is to verify the capacity of the sludge line to process the required amount of mixed sludge (with a minimum amount of sludge of 50 t for a minimum of 3 days), with at least the following parameters being observed:

- Max.consumption of active polymer for mechanical digested sludge thickening up to 12 kg/t DS
- SS content in reject water from digested sludge dewatering max. 6,000 mg SS /l

8.6.2.3 Extraordinary operating mode – one sludge drying line out of service- 1 week

The purpose of the test is to verify the maximum capacity of one sludge dryer line. During the test, the Contractor shall demonstrate the ability to achieve the following:

- Min. capacity of one sludge drying line 87 m³/day

8.6.2.4 Extraordinary operating mode all CHP out of service – 1 day (Mon – Fri)

The aim of the test is to verify the capacity of steam generators, hot-water boilers as heat sources for the operation of heat-dependent technologies (THP, sludge dryer) at their maximum capacity.

- THP output 30 t/d of surplus sludge

8.6.2.5 Extraordinary operating mode - THP out of service - 20 days

The objective of the test is to validate the ability of the digester heat management system to achieve the required temperature in the digesters, observe the DS guaranteed parameters in dried sludge while proving observance of at least the following parameters:

- Min. temperature in digesters 36^0 C
- Dried sludge DS content 90%

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