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SUSTAINABLE WATERS
EMPEREST

Roadmap for advanced effluent treatment pilot investments

Tartu – Tallinn – Turku

EMPEREST – ELIMINATING MICRO-POLLUTANTS FROM EFFLUENTS FOR REUSE STRATEGIES

Tartu Waterworks Ltd, 2023

Imprint

This publication has been developed within the project **EMPEREST – Eliminating Micro-Pollutants from Effluents for Reuse Strategies,** co-financed by the Interreg Baltic Sea Region Programme 2021–2027, and helping to drive the transition to a green and resilient Baltic Sea region.

EMPEREST consortium: Union of the Baltic Cities Sustainable Cities Commission c/o City of Turku (FI), Baltic Marine Environment Protection Commission – Helsinki Commission (HELCOM) (FI), University of Tartu (EE), Berlin University of Technology (DE), Turku University of Applied Sciences (TUAS) (FI), Gdańsk Water Utilities (PL), Water and Sewage Company Ltd of Szczecin (PL), Tartu Waterworks Ltd (EE), Tallinn Water Ltd (EE), "Kaunas water" Ltd (LT), Turku Region Wastewater Treatment Plant (FI), DWA German Association for Water, Wastewater and Waste DWA Regional group North-East (DE), Environmental Centre for Administration and Technology (LT), City of Riga (LV).

The sole responsibility for the content of this publication lies with the authors. It does not necessarily reflect the opinion of the European Union.

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Title: Roadmap for advanced effluent treatment pilot investments: Tartu – Tallinn – Turku

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Authors: Taavo Tenno and Siiri Velling, University of Tartu; Markus Raudkivi, Baltic Marine Environment Protection Commission - Helsinki Commission (HELCOM); Ornella Mundi, Tartu Waterworks Ltd.

Contributors: Indrek Hiiemäe and Kaido Põhako, Tartu Waterworks Ltd; Ivar Ruubel and Jelena Valtin, Tallinn Water Ltd; Jarkko Laanti, Turku Regional Wastewater Treatment Plant; Marek Swinarski, Gdansk Water Utilities; Piia Leskinen and Riikka Vainio, Turku University of Applied Sciences; Mariia Andreeva, Agnieszka Ilola and Lotta Lehti, Union of the Baltic Cities Sustainable Cities Commission.

Layout: Laura Sarlin, City of Turku

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Project note

The EMPEREST project supports local authorities, service providers and policy-making community in finding ways to reduce PFAS (Per- and polyfluoroalkyl substances) and other organic micropollutants from the water cycle. The project has four activity strands to fulfil its aims. First, in close cooperation with HELCOM EMPEREST prepares methodological recommendations to monitor PFAS group in the aquatic environment. Second, local authorities address the subject on the city level by developing a PFAS risk assessment framework to identify and assess PFAS-related risks and propose relevant risk mitigation strategies. Third, EMPEREST supports water utilities in making informed decisions about cost-effective treatment strategies and investments for removing micropollutants from wastewater. Finally, capacity building takes place for both local authorities and public service providers to inform them about the recent developments in the field and train them with tailored materials and tools.

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1. Introduction

The Baltic Sea, given its delicate nature and the substantial economic activities within its vicinity, demands an elevated level of environmental consideration. At present, wastewater treatment plants, integral to the preservation of the Baltic Sea's ecological balance, face a noteworthy challenge in the removal of micropollutants and persistent organic pollutants (POPs), including per- and polyfluoroalkyl substances (PFAS). The EMPEREST project is designed to tackle the complexities linked to advanced wastewater treatment in the delicate Baltic Sea estuary. The implementation of more effective measures to control POPs pollution, to assure chemically and ecologically sustainable water quality of the bodies of water is aimed at Directive 2000/60/EC [1].

Current wastewater treatment plants are insufficient in removing certain chemicals originated from modern lifestyles, some of which are essential. The EMPEREST project bridges this gap by designing, constructing, and operating two pilot-scale mobile plants dedicated to the advanced treatment of water, specifically focusing on the removal of micropollutants and PFASs. These mobile pilot plants will serve as testing grounds for diverse removal technologies, providing a comprehensive assessment of their efficacy. The mobile plant described in the roadmap will be operated on three or optionally four different wastewater streams, employing diverse removal technologies to assess their effectiveness. Both inflow and outflow at each wastewater treatment plant (WWTP) will be analyzed under different operational conditions. The insights gained from this piloting processes will be invaluable for WWTPs, enabling them to make informed decisions regarding the most suitable technologies for enhanced wastewater treatment.

The data acquired from the pilot plants' operation is not merely an academic exercise. Collaboration and knowledge-sharing among stakeholders will facilitate the broader adoption of effective water treatment practices. It forms the foundation for implementing more effective pollution control measures, particularly concerning the removal of persistent organic pollutants (POP) and PFAS, on a larger scale.

For the degradation of hardly degradable organic substances, the pilot plants are equipped with various filtration technologies (pile cloth, activated carbon, ion change resin, sand filter), ozone treatment tank of wastewater, as well analyzers, sensors, and automatic control system. To study the reuse potential of the pilot plant effluent, a disinfection unit is incorporated into the technical design, to be optionally utilized as needed.

This document describes the structure and tendering process of the pilot plant built in Tartu, Estonia. After a testing phase at the WWTP in Tartu, the plant will be first transferred to the WWTP of Tallinn and then to the one in Turku, Finland. Further use after these three WWTPs will be decided later (see section 4 below).

2. Specific technological details and parameters of the investment

General technological scheme of the mobile pilot is depicted in Annex 1.

The technological process of the pilot plant is divided into five main process units 1…5. In addition, the influent pumping (Unit 00) and analysis node (Unit 10) are general units, which support the operation of the technological treatment processes.

All connections between the main process units can be connected in a flexible manner to any other process unit (CAM lock connections with flexible hoses).

2.1. Process Unit 00 – General

The task of the unit 00 is to deliver the influent water to the pilot plant. The feed pump has regulated flow 0,5...5m3/h, which can be defined from the process logic controller (PLC). Influent flow is measured and recorded.

Influent flow is subjected to the influent of Unit 01, however, it can be also directly connected with flexible hoses to any other process unit.

2.2. Process Unit 01 – Pile cloth media filter (PCMF)

Effluent concentration of suspended solids of a conventional activated sludge WWTP process ranges between 5 to 15 mg/l. The main function of pile cloth media filter is to provide solids-free water to the other processes.

Hydraulic capacity of the process is 0,5…5 m3/h. The PCMF is fully automated pilot device, which its own internal process automation.

There is an optional process of powdered activated carbon (PAC) dosage, which can be integrated with PCMF. This process has not been tendered but can be easily integrated with minor modifications at later stages. Since PAC process is very promising for cost-effective quaternary treatment, the application of this additional process may be integrated with minimal costs.

2.3. Process Unit 02 – Ozonation

Ozonation is the advanced oxidation process which can degrade unbiodegradable organic pollutants (POP). With lower ozone dosage, the POPs are partially degraded, and this usually increases the biodegradability.

The ozonation unit consists of oxygen generator (pressure swing adsorption technology), ozone generator, contact tank and destruction of excess ozone. Ozone concentration in gas and water phase helps to monitor and control the process. Ozone alarm sensor is required for work safety.

The unit is delivered as compact unit with independent process control.

The hydraulic load of the unit is 0,2…1m3/h. Contact time in the ozone tank is adjustable and can be varied within the range of 5-30 minutes.

2.4. Process Unit 03 and 04 – Filtration – DMF and GAC

Dual media filter (DMF, Unit 03), that eliminates suspended solids and provides also some biological activity is succeeded by Unit 04, which is a granulated activated carbon filter (GAC). Since a major part of PFAS molecules have anionic group, ion exchange filter can be also used for PFAS removal.

Since the principal filtration technology between those filters is very similar, three nearly identical filtration units are built. Filters can be operated simultaneously or sequentially; flow rates of process water depend on the properties of filtration unit, staying below 3 m3/h.

2.5. Process Unit 05 – UV disinfection

Before final outflow of the pilot plants, a disinfection unit will be installed. The purpose of UV (ultraviolet) treatment of water is primarily to disinfect and deactivate microorganisms present in the water. UV treatment utilizes ultraviolet light, specifically UV-C light, to disrupt the DNA or RNA of bacteria, viruses, and other pathogens, rendering them unable to reproduce and causing them to become inactive. It's important to note that while UV treatment is highly effective against microorganisms, it does not remove other contaminants like chemicals, heavy metals, or particles from the water. Therefore, it is used in conjunction with before named water treatment processes for comprehensive water purification.

2.6. Process Unit 10 – Monitoring

For efficient piloting the reliable real-time analysis of the process is essential. Since the analysers are expensive, one analyser node, consisting of pH/Redox, turbidity and UV absorbance (SAK 254) analysers. Process water can be pumped intermittently from different process units to the analysis node. The analysis package is provided with automation controller and data storage, which allows reliable monitoring of the whole pilot plant.

3. Prepared overall tender documentation for the purchase and installation of the investment

The investment for the pilot plant is performed by Tartu Waterworks Ltd (Tartu Veevärk AS) by 4 separate tenders. All procurements were carried out as public procurements and are available at the **Estonian Public Procurement Register**.

All mentioned public procurements were successful. The specifications and bids can be found in the document annexes. Here, we briefly outline the equipment and services to be procured, as well as the timeline.

3.1. Tender 1 – Pile Cloth Media Filter (Annex 2)

The procurement was published on June 8th, 2023, in Estonian Public procurement system. The successful bidder was announced on July 5th and the contract was signed on August 11th, 2023. The device has been delivered on November 16th, 2023.

Installation and startup will be performed in the frame of Tender 4.

3.2. Tender 2 – Ozonation and UV

The procurement was published on May 11th, 2023, in Estonian Public procurement system. The contract for UV was concluded on August 15th, 2023.

The UV device has been delivered and will be assembled in the frame of Tender 4.

The tendering about ozone generator failed firstly for several reasons, including insufficient diligence in checking documents, a general technical description, missing necessary documents, changed technical conditions during the procurement, and difficulties in ensuring equal evaluation of bidders. In addition, the contracting authority could not obtain necessary attachments from the bidders, making evaluation difficult as it was unclear whether the equipment fully complied with the technical description. A new, modified procurement for ozone generator with an updated technical description was published on August 22nd, the successful bidder was announced on September 11th, and the contract was signed on October 23rd, 2023. The device is in production.

3.3. Tender 3 – Package of analysers and sensors

The procurement was published on June 7th in Estonian Public procurement system. The successful bidder was announced on July 25th, and the contract was signed on August 17th, 2023.

3.4. Tender 4 – GAC filtering system and pilot assembly

The procurement was first published on July 26th under reference in Estonian Public procurement system. The successful bidder was not announced as the contracting authority could not ensure the financing of the procurement. The second time with changes, the procurement was published on August 31st, the successful bidder was announced on September 27th, and the contract was signed on October 18th, 2023.

Weekly meetings are held for the assembly of the pilot device to address possible questions.

4. General timetable of the piloting activities in each of the consequent users of the mobile pilot plant

The timeline for the testing of the mobile pilot plant for the removal of micropollutants shows that devise construction followed by commissioning and start up will be implemented by Tartu Waterworks Ltd (PP08). The 5-month pilot period in Tartu wastewater treatment plant concludes in August 2023,

after which the mobile pilot unit will be transported to the Tallinn Water Ltd (PP09). Five months, from September until January 2025, are planned for transport, reinstallation, start-up, testing and deinstallation of the equipment. Starting from February 2025 next five months (project period 5) are scheduled for the same activities in Turku Region Wastewater Treatment Plant (PP11), Finland. The last project period, P6 gives opportunity to test the mobile pilot plant in City of Riga (PP14). Although piloting period 4 is marked in both timelines of pilot plants by Tartu Waterworks Ltd and Gdansk Water Utilities Ltd, testing will be proceeded only with one pilot device. The decision regarding which device will be made during piloting period 3.

Table 1. Timeline of piloting of mobile pilot plant in Tartu Waterworks Ltd (PP08), Tallinn Water Ltd (PP09), Turku Region Wastewater Treatment Plant (PP11) and City of Riga (PP14).

Activity	**Period / Partner**	**P2: 7–12/2023**	**P3: 1–6/2024**	**P4: 7–12/2024**	**P5: 1–6/2025**	**P6: 7-12/2025**
Design and construction	PP08	7/23 – 2/24				
Commissioning and startup	PP08		3/24			
Piloting period 1	PP08		4/24 – 8/24			
Piloting period 2	PP09			9/24 –	1/25	
Piloting period 3	PP11				2/25 – 6/25	
Piloting period 4	PP14					7/25 – 11/25

5. Preliminary laboratory analysis plan with main analytes and analysis points

Laboratory analysis of wastewater samples taken from the pilot plants as well as on-line measurements of wastewater quality are crucial for assessing the efficiency of wastewater treatment processes and successful pilot tests.

In general, all piloting activities Tartu Waterworks Ltd (PP08), Tallinn Water Ltd (PP09) and Turku Region Wastewater Treatment Plant (PP11) will share a common analysis strategy, goals and analysis profile.

There are three levels of analysis plans for the monitoring of mobile pilot plant response.

I – Automation (on-line sensors)

II – Laboratory monitoring of conventional parameters

III – Laboratory monitoring of specific emerging pollutants with the focus to PFAS

5.1. Monitoring level I – Automation

The pilot plants are fully automatised and the essential parameters are measured continuously.

PILOT TARTU list of equipment:

- 00MF01 – FIR – Flow meter records the flow of the whole pilot plant

- 01MF01 – FIRCA – Flow meter of PCMF inflow
- 01MF02 – FIR – Flow meter of PCMF sludge
- 02MF01 – FIRCA – Flow meter records flow to the ozonation process
- 02MQ01(O3 GAS) – QUIR – measures ozone content in gas from ozone generator
- 02MQ02(O3 LIQ) – QUIR – measures ozone content in water effluent ozone contact tank
- 02MQ03(O3 GAS) – QUIR – measures ozone content in gas in ambient air – safety
- 03MF01 – FIRCA – Flow meter of DMF inflow
- 04MF01 – FIRCA – Flow meter of GAC filter 1 inflow
- 04MF03 – FIRCA – Flow meter of GAC filter 1 inflow
- 05MF01 – FIRCA – Flow meter of UV inflow
- 10MQ01(Red/pH) – QUIR – measures redox potential and pH from multiple process points
- 10MQ02(Turb) – QUIR – measures turbidity from multiple process points
- 10MQ03(DC, spectral) – QUIR -measures absorbance an reflects organic compounds.

The analyzers for redox/pH, turbidity and dissolved organics (10MF01…03) ca be adjusted to measure intermediately from different technological nodes.

5.2. Monitoring level I – Laboratory monitoring of conventional parameters

Daily monitoring will be performed at the environmental analysis laboratory of the water utility, where the piloting is performed. Laboratory analyses will be also used to calibrate the online measurements performed for monitoring level I.

The monitoring of process efficiency will be based on laboratory measurements, with a minimum scope covering:

- COD (chemical oxygen demand) – general parameter of organic compounds
  usual lower detection limit (LDL) 15mg/l;
- DOC (dissolved organic carbon) – general parameter of organic compounds
  usual LDL 1µg/l;
- SS (suspended solids) – parameter to evaluate the content of solids, efficiency of filters;
- N and P analyses, optionally;
- Bromide - high bromide content, ozonation can lead to the formation of brominated by-products, such as bromate, which is a known carcinogen – needs to be monitored when ozonation is used;
- pH – required to monitor process stability and efficiency.

5.3. Monitoring level I – Laboratory monitoring of PFAS and POP

5.3.1. Monitoring level IIIa – analysis of PFAS

PFAS measurement is planned on two levels: targeted analyses and analyses of total absorbable organic fluorine as a sum parameter.

Targeted analyses:

The latest targeted analysis proposed in the updated Water Framework Directive priority substance list is targeting 24 different PFAS, which are individually analysed via liquid chromatography tandem mass spectrometry (LC-MS-MS) and then summed up according to their relative potency factors (RPFs) to a perfluorooctanoic acid (PFOA) equivalent. As this is proposed to be one of the standard methods of PFAS analysis in the water matrix going further, the project aims to use it if possible. As most standard laboratories in the region are currently only offering a sum of 23 PFAS of the proposed list (excluding the new PFAS called C6O4 - perfluoro ([5-methoxy-1,3-dioxolan-4-yl]oxy) acetic acid), it will probably also be left out from project analyses due to its extra cost.

Sum parameters – AOF

As the targeted analysis of PFAS is very expensive and due to the specific PFAS substances used in society being constantly changed (until a wider restriction or ban), it might be more feasible to use a non-targeted sum parameter for stakeholders like WWTPs. Currently, absorbable organic fluorine (AOF), which can be analysed by using combustion ion chromatography (AOF-CIC) is a promising parameter, the use of which will be explored in the EMPEREST piloting phase if possible.

5.3.2. Monitoring level IIIb – analysis of other organic micropollutants

As the analysis of micropollutants is very expensive, the results of previous analyses conducted from the effluents were used for WWTPs who had them. The piloting WWTPs will tender analysis of the organic micropollutants based on the main priority classifications highlighted in Table 2 and new information gathered during the WP2. The priority classes outlined range from A to D, with class A substances expected to give the most information on the efficiency of the effluent treatment technologies and class D the least. The higher the priority class, the more often these specific substances are also proposed to be analysed, while the specific frequency will be up to the piloting WWTPs to decide in collaboration with the other project partners and based on budget availability.

A full panel of A-C or A-D priority classes is expected to be analysed by each piloting WWTP at least twice during their piloting phase, with one analysis recommended to be done from a composite effluent sample before the piloting phase begins to further validate which A-C priority class substances the specific WWTPs should focus on the most.

Table 1. Prioritisation of organic micropollutant chemical analysis for piloting WWTPs. Priority classes are based on previous effluent analysis at the WWTPs, current regulations and upcoming legislative changes.

Priority Class A[1]	Priority Class B[2]	Priority Class C[3]	Priority Class D[4]
Chloroalkanes, C10-13	Amisulprid	Diuron	Other WFD Annex X substances and potential new substances proposed to be added there
Tributyltin compounds	Carbamazepine	Isoproturon	
Polychlorinated biphenyls (PCBs)	Citalopram	Naphthalene	
Hexabromocyclododecanes (HBCDD)	Clarithromycin	Tetrachloroethylene	
Phthalates (including DEHP)	Diclofenac	Polychlorinated dibenzofurans (PCDFs)	
	Hydrochlorothiazide	Terbutryn	
	Metoprolol	Silver (Ag)[5]	
	Venlafaxine	Hexachlorobenzene	
	Benzotriazole	Benzene	
	Candesartan		
	Irbesartan		
	Mixture of 4-methylbenzotriazole and 6-methylbenzotriazole		

[1] Substances previously found in high concentrations in at least one piloting WWTP's effluent. Each piloting WWTP will focus on the relevant ones to their own facility.

[2] Substances proposed as evaluation criteria for advanced effluent treatment technologies by the new UWWTD update proposal. As the recast directive has not been approved yet, the substances under this class might change accordingly.

[3] Substances that have been detected in piloting WWTPs effluents above LOQ values, giving potential reference points and showing degradation effects.

[4] Although silver is not an organic substance, it is of increasingly high concern in wastewater.

6. Overall transfer strategy of the mobile pilot plant from one location to another

During the duration of project both pilot plants will be tested at three wastewater treatment plants. The duration of testing period including the transfer of the pilot is aimed to be 5 months.

6.1. Deinstallation (1 week)

- Efficient deinstallation of the pilot plant from the current WWTP connections.
- Careful packing and securing of movable parts to ensure safe transport.

6.2. Transport (1 week)

- Loading the container onto a HDS truck for secure transportation to the designated location.
- 1-2 compact sea containers will be transported.

6.3. Reinstallation (1 week)

- Unpacking and installation of the mobile plant at the specified site.
- To ease the reinstallation, the details for the preparation of the installation are provided and agreed prior transportation and installation.
- Operator of the pilot plant at the previous piloting site will be involved for supervision of the reinstallation.

6.4. Startup (1-3 weeks)

- Provision of comprehensive technical support during the installation and start-up phase of the plant.
- On-site assistance to address any technical issues and ensure a smooth commissioning process.
- All process units will be tested during the start-up phase.
- Operator of the pilot plant at the previous piloting site will be involved for supervision of the startup.

6.5. Test phase (up to 3 months)

The pilot plant is designed in such a way that it is possible to test various configurations of the wastewater treatment process.

The selected configuration of the process will be tested during the pilot study period.

Detailed piloting programme will be developed individually for each test phase based on previous experiences and on the technological needs of a particular WWTP, where the pilot is tested.

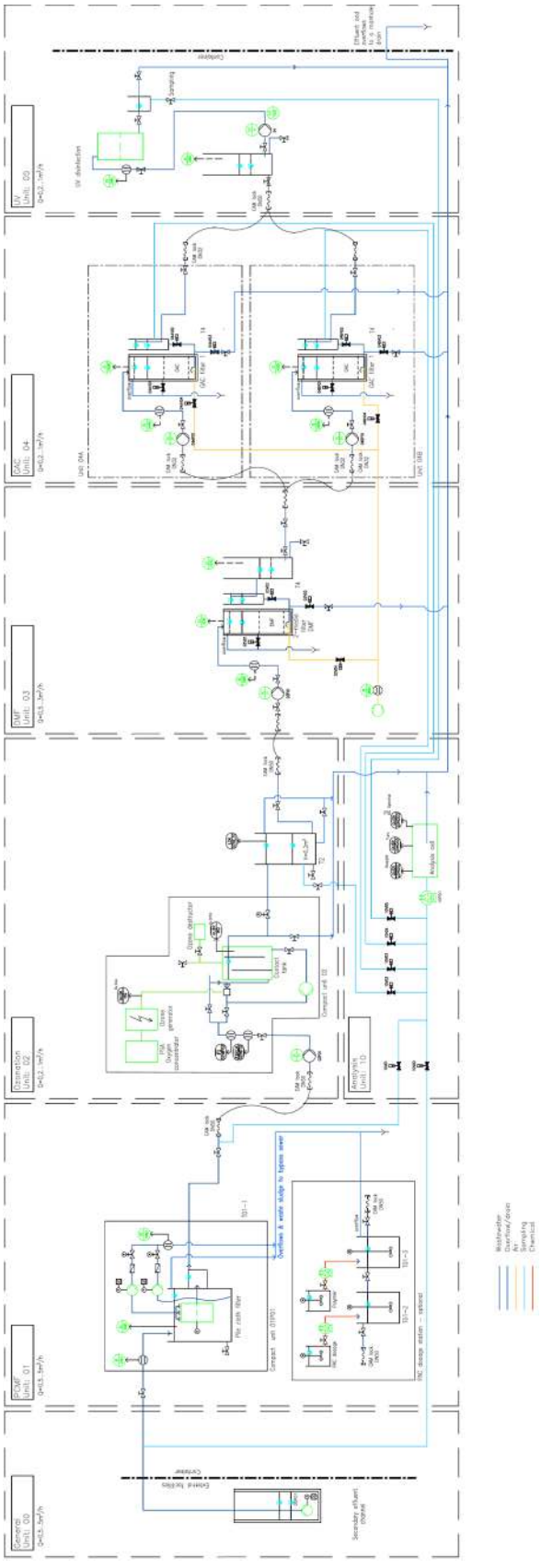
7. Reference

[1] “EUR-Lex - 32000L0060 - EN - EUR-Lex.” Accessed: Nov. 27, 2023. [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32000L0060&qid=1694525318258

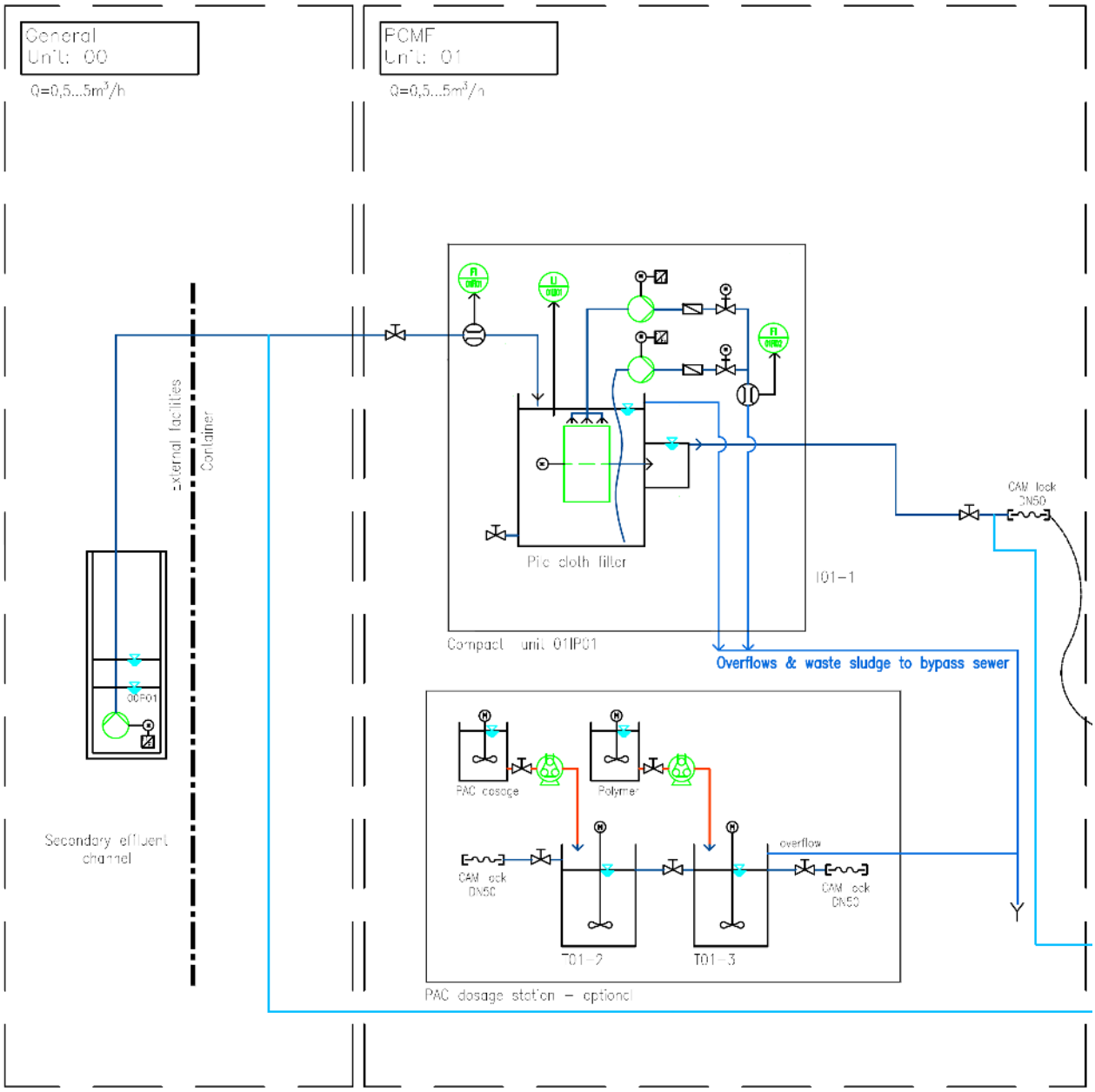
8. Annexes

8.1. Technological scheme of mobile pilot plant by Tartu Waterworks Ltd.

Below is the full technological scheme of the mobile pilot plant. On the following pages (pp. 16-19) the same scheme is shown in four consecutive parts.



Pilot Process Units 00 & 01



Wastewater

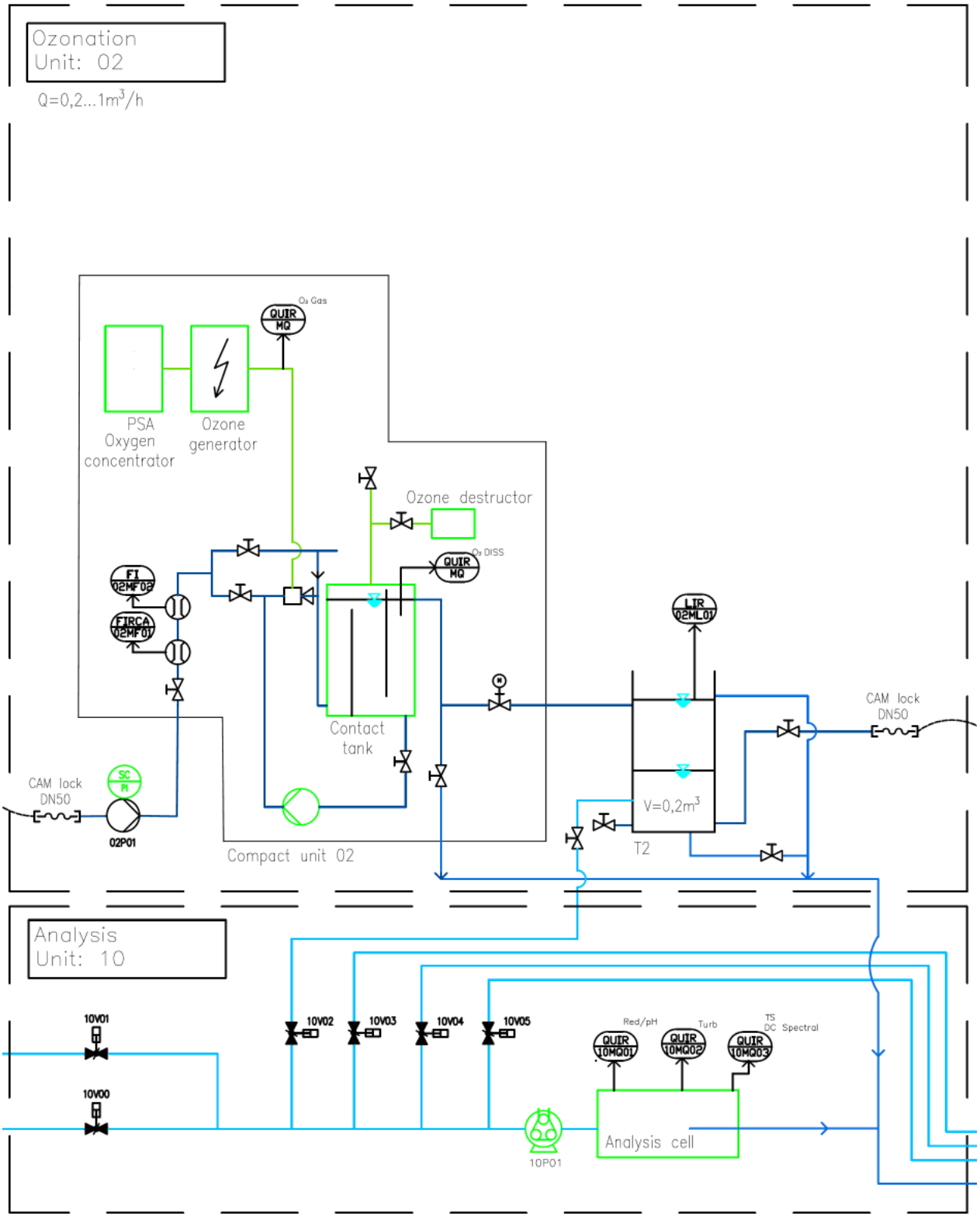
Overflow/drain

Air

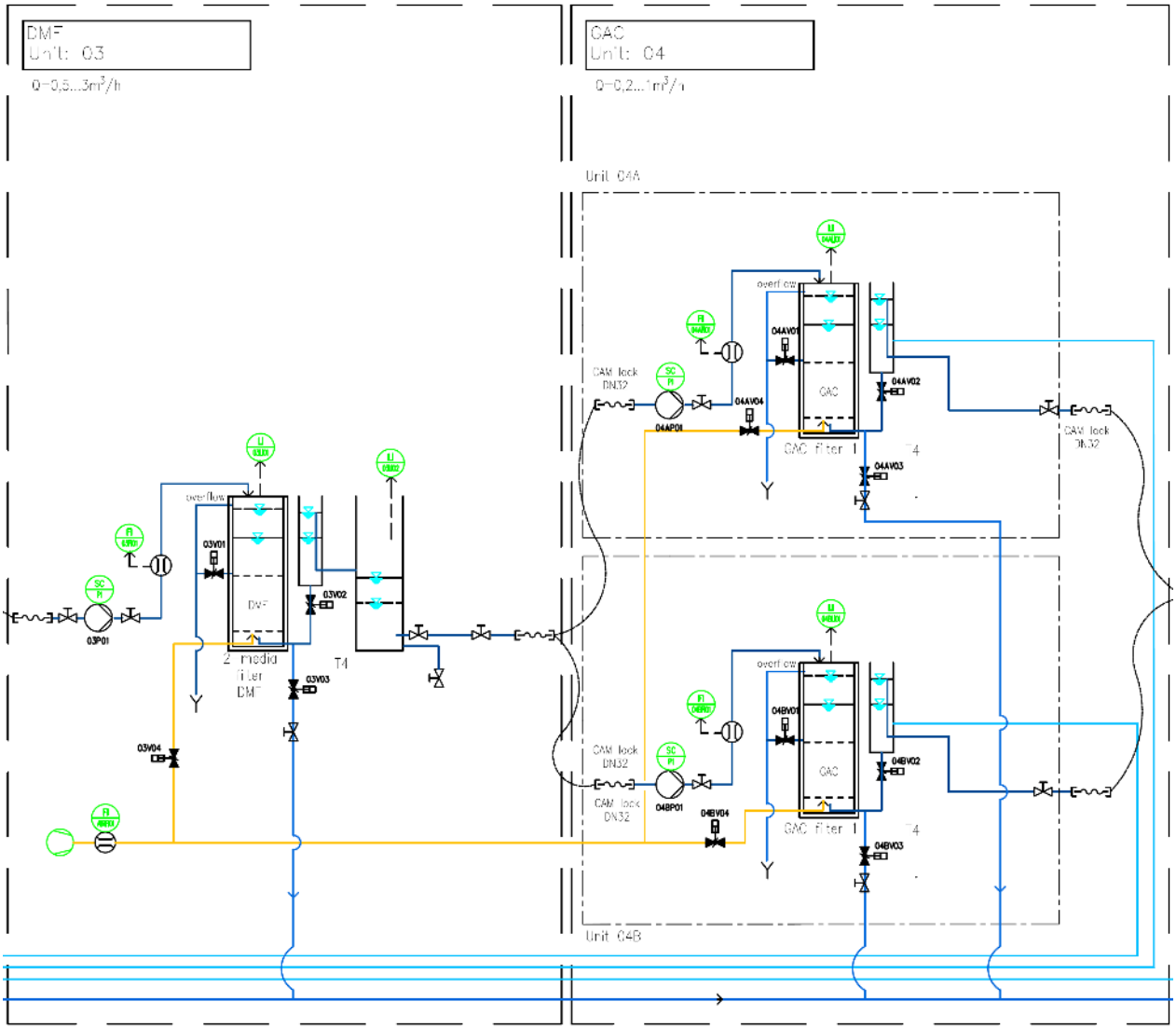
Sampling

Chemical

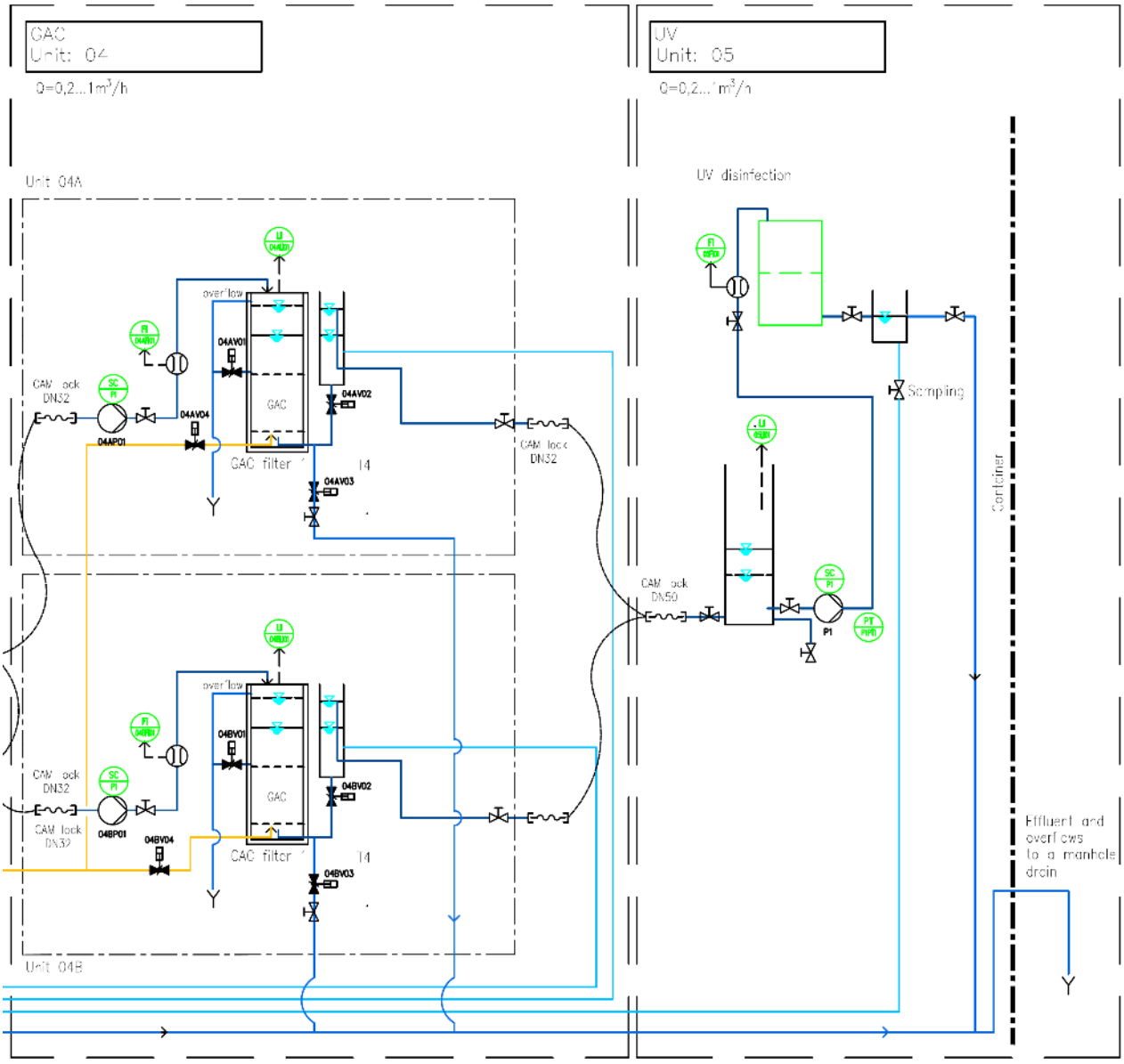
Pilot Process Units 02 & 10



Pilot Process Units 03 & 04



Pilot Process Units 04 & 05



8.2. Specific technological details and parameters of the Tender 1

Tender documents are available at Estonian Public Procurement Register.

From the procurement documentation, the technical description of the public procurement is presented in 8.2.1.

8.2.1. Technical description

Tartu Waterworks Ltd.

Technical description

Part 2

Assessing Micropollutant Removal with Pile Cloth Media Filter in Municipal Wastewater Treatment Plant of Tartu

Procurement nr: 266037

Procurement documents

May 2023

1. General terms and conditions

Contracting authority:	Tartu Waterworks Ltd
Address:	Tähe 118, 50107 Tartu
Phone:	+372 730 6200
Fax:	+372 730 6240
e-mail:	tartuvesi@tartuvesi.ee
Person responsible:	Indrek Hiiemäe

The general objective of this procurement is to ensure the transparent, efficient, and cost-effective use of the Procuring Authority's financial resources, equal treatment of tenderers, and effective use of existing competitive conditions.

During the tendering process the Procuring Authority provides explanations and responses to the questions raised by the tenderers and are considered part of the procurement documents.

2. Tender under offer

We invite you to an open tender for the procurement of pile cloth media filter for the Wastewater Treatment Plant of Tartu.
The Tenderer must submit one offer in the prescribed form. The aim of the tender is to find the most favorable offer of the Contracting Authority.

3. General overview of the order's subject

The component being ordered is intended for use in a pilot treatment wastewater system. Small-scale pilot plant in a shipping container has an aim to test the removal of organic micropollutants from municipal wastewater. While the pilot technological system incorporates multiple technologies, the focus of this particular procurement is on acquiring pile cloth media filter.

The Contractor is required to verify the adopted technical and technological solutions to ensure proper functioning of the supplied elements of the pilot plant, and any proposals for changes require approval from the Contracting Authority. Before commencing the construction of the pilot plant, the Contractor must submit a detailed design concept for approval, including the arrangement of devices, routing of pipelines, dimensions of tanks, and technical parameters of devices, pipes, and connectors.

4. Place of delivery

Tartu Wastewater Treatment Plant
Address: Tähe 118, 50107 Tartu, Estonia

5. Pile cloth media filter

5.1. Subject of the order

One of the components in pilot container is pile cloth media filter. The goal of the unit is to contribute to the elimination of organic micropollutants from **municipal wastewater**.

Technological devices

5.2. Pile cloth media filter (PCMF)

- Drum filter type TF05 Mecana or similar model

- The required filter surface is 0.5 m^2. Completely submerged filter media
- Flow through from outside to inside
- Filter cleaning process does not interrupt the filtration process
- Pile Cloth Media Filters with effective deep-pile filter cloths and not monofilament sieve fabrics
- Independently suspended suction bar that is only in contact with the pile cloth media during filter cleaning of the relevant filter surface
- Profiled suction lips to increase the effective filtration surface area
- The filter should have a drain hole in the bottom with an open/close valve
- Automatic cleaning based on a programmed difference in the tank level or time dependent
- Filter construction should be stainless steel (316L or better) and plastic resistant to the corrosive properties of municipal wastewater

5.3. Filter media: Pile Cloth media

- Pile layer material made of continuous microfiber filaments with a fiber diameter of < 7.4 µm
- The cloth backing must be made of continuous filaments
- The pile layer must be woven into the carrier fabric
- Flow-relevant pores in the Backing > 800 x 800 µm
- Knitted back constructions are not permitted
- The combination of several individual textile layers in the filtration-relevant area is not permitted

5.4. Electrical control system with data logger function and remote access

Control box, IP54 mounted on side of tank, equipped with:

- Control system: PLC with touch panel min 12" for operation and display of the operating parameters, with data logger function and remote access via LAN or GSM modem
- Main isolation switch
- Hand-0-Auto control
- Signal lamps for operation and fault
- Motor protection switch for drive motor, filter suction pump and settled sludge pump
- Frequency inverter for speed control of drive motor, filter suction pump and settled sludge pump
- Frequency inverter for speed control of feed pump
- Level control or differential pressure control for filter cleaning
- 2 pressure sensors (0-200 mbar) mounted in/on holding tank and outlet rising chamber
- Time interval control for filter cleaning and settled sludge removal pump
- Operation of all functions via touch panel (e.g. speeds of drive motor, backwash pump and settled sludge pump, manual initiation of filter cleaning cycle)
- Monitoring of the operation of filter drive motor, filter suction pump and settled sludge pump within the PLC
- Monitoring of: operating status messages, rate and totals of feed and backwash flows, level in tank and outlet rising chamber, inlet and outlet turbidity, air and water temperature, 2 analogue and 2 digital reserve channels
- Electrical documentation
- PLC two-way communication Industrial Ethernet and/or Profibus and/or Profinet (RS485), Wifi and/or GPRS

Furthermore, if the price falls within the budget, special dimensions of the filter machine or measuring equipment from the technical offer, such as data logging, backwash water, feed MID, and level sensors,

could be included in the tender as a free-form document. However, it's crucial to emphasize that during the evaluation process, we regard it **not** as a criterion, but rather as valuable and informative knowledge.

6. Warranty

The Contractor is obligated to provide a 24-month warranty for the elements of the pilot station that they have supplied.

8.3. Specific technological details and parameters of the Tender 2

Tender documents are available at Estonian Public Procurement Register.

From the procurement documentation, the technical description of the public procurement is presented in 8.3.1 and 8.3.2.

8.3.1. Technical description for UV disinfection system

Tartu Waterworks Ltd.

Technical description

Part 2

Delivery of a pilot installation for municipal wastewater treatment, an ozone oxidation and UV disinfection system

Procurement nr: 264626

Procurement documents

April 2023

1. General terms and conditions

Contracting authority:	Tartu Waterworks Ltd
Address:	Tähe 118, 50107 Tartu
Phone:	+372 730 6200
Fax:	+372 730 6240
e-mail:	tartuvesi@tartuvesi.ee
Person responsible:	Indrek Hiiemäe

The general objective of this procurement is to ensure the transparent, efficient, and cost-effective use of the Procuring Entity's financial resources, equal treatment of tenderers, and effective use of existing competitive conditions.

During the tendering process the Procuring Entity provides explanations and responses to the questions raised by the bidders and are considered part of the procurement documents.

2. Tender under offer

We invite you to an open tender for the procurement of ozone oxidation equipment, and UV disinfection system for the Wastewater Treatment Plant of Tartu.

The bidder must submit one offer in the prescribed form. The aim of the tender is to find the most favorable offer of the Contracting Authority.

3. General overview of the order's subject

The components being ordered are intended for use in a pilot treatment wastewater system. Small-scale pilot plant in a shipping container has an aim to test the removal of organic micropollutants from municipal wastewater. While the pilot technological system incorporates multiple technologies, the focus of this particular procurement is on acquiring ozone oxidation **(see PART 1 in section 5)** and UV disinfection system **(see PART 2 in section 7)**.

The Contractor is required to verify the adopted technical and technological solutions to ensure proper functioning of the supplied elements of the pilot plant, and any proposals for changes require approval from the Contracting Authority. Before commencing the construction of the pilot plant, the Contractor must submit a detailed design concept for approval, including the arrangement of devices, routing of pipelines, dimensions of tanks, and technical parameters of devices, pipes, and connectors.

4. Place of delivery

Tartu Wastewater Treatment Plant

Address: Tähe 118, 50107 Tartu

5. PART 1: ozone oxidation system

5.1. Subject of the order

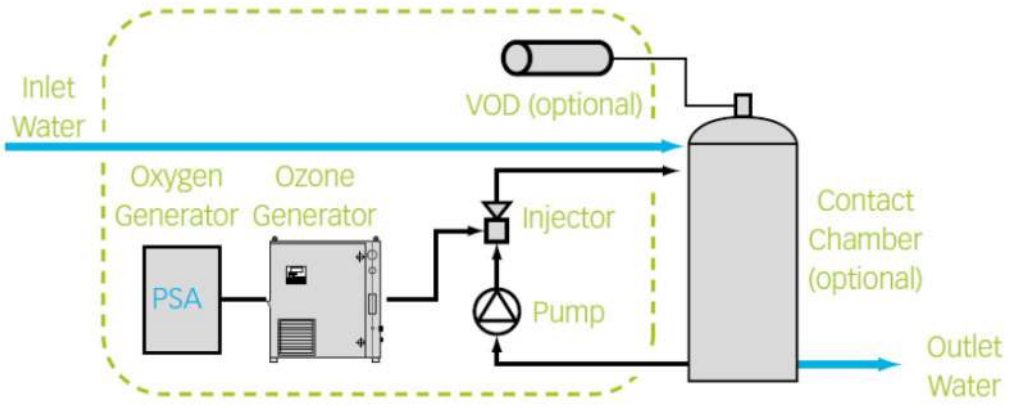
One of the components in pilot container is ozone oxidation system. The goal of the unit is to contribute to the elimination of organic micropollutants from **municipal wastewater**.

Technological devices

5.2. Ozone production and dosing system

- Complete set consisting of an oxygen generator, an ozone generator and a dosing system
- Compact type ozone generator Ozonia CFS1 or similar
- Oxygen generator based on PSA technology
- **Minimum ozone production output must be at least 20 g/h**
- Adjustable ozone production from 10% to 100% of maximum capacity
- Closed circuit water cooling system
- Pump-injector system for dosing ozone to wastewater, with necessary equipment such as a manometer
- Piping and injector made from PVC-U, ozone pipes made from PTFE
- Ozone analyzer BMT for measuring the concentration of ozone in the produced gas
- Ozone analyzer for measuring ozone concentration in wastewater
- Alarm sensor for ozone in the air inside the container
- Modbus RTU or TCP communication protocol
- Control signals and alarms for:
    - production status
    - gas valve status
    - alarm status.

Schematic diagram of the ozone oxidation system:



5.3. Ozone contact tank

- Maximum working volume of the tank: 1,000 dm^3
- The flow rate is 0.5...3 m3/h, and the retention time is adjustable with the flow rate. The contact tank must allow for a change in flow rate
- Tank dimensions are to be determined at the detailed concept design stage
- Bottom drain opening with open/close valve
- Possibility of adjusting the contact time by changing the height position of the flexible drain hose above the tank bottom
- Tank equipped with Vent Ozone Destructor (VOD) unit
- Tank material: AISI 316 stainless steel.

6. Control system for ozone oxidation system

6.1. Oxygen concentrator (PSA)

- Manual on/off switch
- Indication of the operating status - on/off, and power supply status
- Automatic switch-off when starting the filter backwash process
- Automatic switch-on after finishing the filter backwash process
- Automatic shutdown upon detecting ozone in the room

6.2. Ozone generator (OG) with dosing system

- Manual on/off control
- Indication of the operating status of the ozone generator - on/off, power supply status
- Indication of the operating status of the wastewater circulating pump - on/off, and power supply status
- Ozone detection in the room indication
- Ozone production setting from the operator panel (g/h)
- Ozone production display (g/h)
- Ozone concentration in the produced gas display (%)
- Ozone dose display (mg/l)
- Automatic switch-off when starting the filter backwash process
- Automatic switch-on after finishing the filter backwash process
- Automatic shutdown upon detecting ozone in the room
- Operation parameter readings using Modbus communication.

6.3. Ozone destructor (VOD)

- Manual on/off switch
- Indication of the operating status of the ozone generator - on/off, and power supply status.

PART 2: UV disinfection system

6.4. Subject of the order

One of the components in pilot container is UV disinfection system. The goal of the unit is to contribute to the elimination of organic micropollutants from **municipal wastewater**.

Technological devices

6.5. UV lamp for wastewater disinfection (option 1)

- Low-pressure UV lamp
- UV lamp power adjusted for wastewater flow rates in the range of 0.150 - 0.700 m^3/h
- Wastewater transmittance measurement
- Radiation intensity measurement
- System for adjusting the radiation power of the UV lamps
- Reactor material: AISI 316L steel
- Radiation dose of 400 J/m^2 at UV transmittance T 1 cm 60%
- UV radiation monitoring system to ensure proper operation of the device
- Cleaning system to ensure the maximum amount of UV light enters the wastewater

- Drain valve for evacuation of solids after mechanical cleaning.
- Wavelength 254 nm

6.6. UV lamp for wastewater disinfection (option 2)

All the parameters remain the same as they are in option 1 (section 7.2). Only difference in between option 1 and option 2 is that option 2 requires **manual cleaning** instead of automatic one.

The particular option provides a chance for tenderers to propose smaller unit systems while considering the fact that smaller devices may lack an automatic backwash feature.

When offering UV disinfection system then the Tenderer should mention whether equipment has automatic backwash or manual cleaning system.

7. Control system for UV disinfection

7.1. UV lamp (UV)

- Indication of the operating status - on/off, and power supply status
- Indication of UV intensity measurement
- Indication of wastewater transmittance measurement
- Indication of the current lamp power
- Regulation of lamp power depending on the wastewater flow rate
- Automatic cleaning system activated either by measuring the UV radiation sensor or by a timer (option 1) **OR** manual cleaning system (option 2)
- Backwash wastewater flow rate (m/h)
- UV radiation intensity (W/m^2)
- Transmittance of wastewater (%)
- Current power of UV lamp (W).

8. Warranty

The Contractor is obligated to provide a 24-month warranty for the elements of the pilot station that they have supplied.

8.3.2. Technical description for ozone oxidation system

Tartu Waterworks Ltd.

Technical description

Part 2

Assessing Micropollutant Removal with an Ozone Oxidation System in Municipal Wastewater Treatment Plant of Tartu

Procurement nr: 268931

Procurement documents

August 2023

1. General terms and conditions

Contracting authority:	Tartu Waterworks Ltd
Address:	Tähe 118, 50107 Tartu
Phone:	+372 730 6200
Fax:	+372 730 6240
e-mail:	tartuvesi@tartuvesi.ee
Person responsible:	Indrek Hiiemäe

The general objective of this procurement is to ensure the transparent, efficient, and cost-effective use of the Procuring Entity's financial resources, equal treatment of tenderers, and effective use of existing competitive conditions.

During the tendering process the Contracting Authority provides explanations and responses to the questions raised by the tenderers and are considered part of the procurement documents.

2. Tender under offer

We invite you to an open tender for the procurement of ozone oxidation equipment for the Wastewater Treatment Plant of Tartu.

The tenderer must submit one offer in the prescribed form. The aim of the tender is to find the most favorable offer of the Contracting Authority.

3. General overview of the order's subject

The components being ordered are intended for use in a pilot treatment wastewater system. Small-scale pilot plant in a shipping container has an aim to test the removal of organic micropollutants from municipal wastewater. While the pilot technological system incorporates multiple technologies, the focus of this particular procurement is on acquiring ozone oxidation system.

The Contractor is required to verify the adopted technical and technological solutions to ensure proper functioning of the supplied elements of the pilot plant, and any proposals for changes require approval from the Contracting Authority. Before commencing the construction of the pilot plant, the Contractor must submit a detailed design concept for approval, including the arrangement of devices, routing of pipelines, dimensions of tanks, and technical parameters of devices, pipes, and connectors.

4. Place of delivery

Tartu Wastewater Treatment Plant

Address: Tähe 118, 50107 Tartu

5. Ozone oxidation system

5.1. Subject of the order

One of the components in pilot container is ozone oxidation system. The goal of the unit is to contribute to the elimination of organic micropollutants from **municipal wastewater**.

Technological devices

5.2. Ozone production and dosing system

- Complete set consisting of an oxygen generator, an ozone generator and a dosing system
- Compact type ozone generator OtriKS.WASTE.40 or similar
- Oxygen generator based on PSA technology
- Minimum ozone production output must be at least 20 g/h
- Adjustable ozone production from 10% to 100% of maximum capacity
- Closed circuit water cooling system
- Pump-injector system for dosing ozone to wastewater, with necessary equipment such as a manometer
- Piping and injector made from PVC-U, ozone pipes made from PTFE
- Ozone analyzer BMT for measuring the concentration of ozone in the produced gas
- Ozone analyzer for measuring ozone concentration in wastewater
- Alarm sensor for ozone in the air inside the container
- Modbus RTU or TCP communication protocol
- Control signals and alarms for:
    - production status
    - gas valve status
    - alarm status.

Unit 02 in the P&ID diagram schematically illustrates an ozone oxidation system (see annex 1).

5.3. Ozone contact tank

- Maximum working volume of the tank: 1,000 dm^3
- The flow rate is 0.2...1 m3/h (see Annex 1, unit 02 on the scheme), and the retention time is adjustable with the flow rate. The contact tank must allow for a change in flow rate
- Tank dimensions are to be determined at the detailed concept design stage
- Bottom drain opening with open/close valve
- Possibility of adjusting the contact time by changing the height position of the flexible drain hose above the tank bottom
- Tank equipped with Vent Ozone Destructor (VOD) unit
- Tank material: AISI 316 stainless steel.

6. Control system for ozone oxidation system

6.1. Oxygen concentrator (PSA)

- Manual on/off switch
- Indication of the operating status - on/off, and power supply status
- Automatic switch-off when starting the filter backwash process
- Automatic switch-on after finishing the filter backwash process
- Automatic shutdown upon detecting ozone in the room

6.2. Ozone generator (OG) with dosing system

- Manual on/off control
- Indication of the operating status of the ozone generator - on/off, power supply status
- Indication of the operating status of the wastewater circulating pump - on/off, and power supply status

- Ozone detection in the room indication
- Ozone production setting from the operator panel (g/h)
- Ozone production display (g/h)
- Ozone concentration in the produced gas display (%)
- Ozone dose display (mg/l)
- Automatic switch-off when starting the filter backwash process
- Automatic switch-on after finishing the filter backwash process
- Automatic shutdown upon detecting ozone in the room
- Operation parameter readings using Modbus communication.

6.3. Ozone destructor (VOD)

- Manual on/off switch
- Indication of the operating status of the ozone generator - on/off, and power supply status.

7. Warranty

The Contractor is obligated to provide a 24-month warranty for the elements of the pilot station that they have supplied.

8. Annexes

Annex 1- P & ID of the whole pilot container (See ozonation unit 02 on the scheme).

8.4. Specific technological details and parameters of the Tender 3

Tender documents are available at Estonian Public Procurement Register.

From the procurement documentation, the technical description of the public procurement is presented in 8.4.1.

8.4.1. Technical description

Tartu Waterworks Ltd.

Technical description

Part 2

Complex analyzer for multi-parameter measurements

Procurement nr: 265972

Procurement documents

May 2023

1. General terms and conditions

Contracting authority:	Tartu Waterworks Ltd
Address:	Tähe 118, 50107 Tartu
Phone:	+372 730 6200
Fax:	+372 730 6240
e-mail:	tartuvesi@tartuvesi.ee
Person responsible:	Indrek Hiiemäe

The general objective of this procurement is to ensure the transparent, efficient, and cost-effective use of the Procuring Entity's financial resources, equal treatment of tenderers, and effective use of existing competitive conditions.

During the tendering process the Procuring Entity provides explanations and responses to the questions raised by the tenderers and are considered part of the procurement documents.

2. Tender under offer

We invite you to an open tender for the acquisition of an advanced analytical instrument capable of measuring turbidity, pH levels, conductivity, temperature, and SAC at a precise wavelength of 254 nm. **This instrument represents a unified solution integrating multiple measuring devices into a single device.** The device is intended for use at the Wastewater Treatment Plant of Tartu.

The tenderer must submit one offer in the prescribed form. The aim of the tender is to find the most favorable offer of the Contracting Authority.

3. General overview of the order's subject

The components being ordered are intended for use in a pilot treatment wastewater system. Small-scale pilot plant in a shipping container has an aim to test the removal of organic micropollutants from municipal wastewater. While the pilot technological system incorporates multiple technologies, **the focus of this particular procurement is on acquiring a single analyzing device that is capable of measuring the following parameters: turbidity, pH, conductivity, temperature, and SAC 254 nm.**

The Contractor is required to verify the adopted technical and technological solutions to ensure proper functioning of the supplied elements of the pilot plant, and any proposals for changes require approval from the Contracting Authority. Before commencing the construction of the pilot plant, the Contractor must submit a detailed design concept for approval, including the arrangement of devices, routing of pipelines, dimensions of tanks, and technical parameters of devices, pipes, and connectors.

4. Place of delivery

Tartu Wastewater Treatment Plant

Address: Tähe 118, 50107 Tartu, Estonia

5. Analyser

5.1. Subject of the order

One of the components in pilot container is **a single complex analyzer with multi-parameter measurements** for turbidity, pH, conductivity, temperature and SAC 254 nm. The objective of the unit is to assess beforementioned factors with the aim of evaluating the effectiveness of various equipment in removing organic micropollutants from municipal wastewater.

5.2. Operator unit

The multi-operator unit for easy operation of several devices up to a maximum of 8 measuring channels

- Display VGA with touchscreen resolution minimum 320 x 240 pixels with 3.5" diagonal
- Protection class IP 66
- Outputs 4 x 0/4 .. 20mA, 7 x digital outputs, freely configurable
- Inputs 5 x digital inputs, freely configurable
- Operating voltage 9 .. 30 VDC
- Dimensions: 160 x 157 x 60 mm
- Options: Modules:

  Profibus DP, 4x 0/4 .. 20mA output, input
- Digital interfaces: Ethernet, microSD card (for logging, software update, diagnostics), Modbus TCP

5.3. Power Box for Operator unit

Power Box for the electrical Connection of the 6 electromagnetic Sampling valves

5.3.1. Multiple valve unit for measuring 6 measuring points with 6 valves controlled by the operator unit

The multi-valve unit allows the measurement of 6 measuring points, the measuring cycles are freely adjustable on the operator control unit. All measured values are permanently displayed and cyclically updated

- Protection class IP 66
- Operating pressure 10 bar
- Stainless steel
- G1/2“

5.3.2. Turbiditymeter

AquaScatS (1 pc) or analogue, 90° scattered light measurement at 880 nm according to EN ISO 7027 including:

- Range 0…4000FNU
- Resolution 0.001 FNU
- Comparison with secondary turbidity standard
- Measurement installed in bypass cell
- Pressure up to 6 bar at 20°C
- LED 860nm
- 8 freely programmable measuring ranges
- Connection directly to the control system via mA 1x and digital signals 2x

- Protection class IP 68
- Sample temperature 0°C – 60°C
- Stainless steel housing 1.4571
- Sensor head with integrated absorber to eliminate interfering light
- WLAN IEEE 802.11b/g/n access with web server (optional)
- Process connection: Bypass Flowcell

5.3.3. Operator panel connection box for digital communication (1 pc)

Active distribution box for 8 sensors.

- 100... 240 VAC, 47 .. 63 Hz or 9 .. 30 VDC (DC voltage depending on the connected sensors)
- Protection class IP 66

5.3.4. Measured pH

Polylite Plus ARC 120 or analogue (1 ps).

- Highly reproducible measurements due to long-term stable POLISOLVE PLUS (or analogue) reference electrolyte
- Reference system: Everef-L
- 2 SINGLE PORE Diaphragma
- "H" glass
- Blue inner buffer with indicator function
- Integrated data processing, no transmitter required
- Digital interface: ModBus RTU
- 2 analog interfaces: 4-20 mA, configurable
- Quality indicator
- Warning and fault contacts according to Namur NE43
- Measured variables: pH: pH, mV; Temperature: °C, K, °F
- Measuring range: pH 0... 14
- Working temperature: 0... 100 °C
- Pressure range: 0... 16 bar (100 °C)
- Min. conductivity: 2µS/cm
- Temperature sensor: NTC 22 kOhm

5.3.5. Conductivity Sensors (1 pc)

Conducell 4USF ARC PG 120 or analogue 4-pole conductivity sensor

- 4-pole Conductivity sensor
- Integrated data processing, no transmitter required
- Digital interface: ModBus RTU
- 2 analog interfaces: 4-20 mA, configurable
- Quality indicator
- Warning and fault contacts according to Namur NE43

- Conductivity: µS/cm, mS/cm; Temperature: °C, °F, K
- Uncompensated and compensated measurement possible
- Measuring range: 1 µS/cm to 300 mS/cm
- Accuracy minimum: ± 3 % at 1 µS/cm... 100 mS/cm, ± 5 % at 100... 300 mS/cm
- Cell constant: 0.36/cm
- Working temperature min: 0.. 110 °C
- Pressure range: 0… 20 bar (110 °C)
- Temperature sensor: NTC 22 kOhm

5.3.6. 3-fold measuring cell for the installation of up to three probes (pH, conductivity, etc) (1 pc).

5.3.7. Measuring panel made of plastic with pre-assembled measuring sensors (turbidity, SAC 254, pH, conductivity) wired and tubed ready for operation.

6. Warranty

The Contractor is obligated to provide a 24-month warranty for the elements of the pilot station that they have supplied.

8.5. Specific technological details and parameters of the Tender 4

Tender documents are available at Estonian Public Procurement Register.

From the procurement documentation, the technical description of the public procurement is presented in 8.5.1.

8.5.1. Technical description

Tehniline kirjeldus
Osa 2

Reoveepuhastuse neljanda astme pilootseadme kokkupanek
Hanke nr: 269443

Hanke alusdokumendid

August 2023

Üldised tingimused

Tellija:	AS Tartu Veevärk
Aadress:	Tähe 118, 50107 Tartu
Telefon:	+372 7 306203
Faks:	+372 7 306240
Vastutav isik:	Indrek Hiiemäe

Käesoleva hanke üldeesmärgiks on tagada Hankija rahaliste vahendite läbipaistev, otstarbekas ja säästlik kasutamine, pakkujate võrdne kohtlemine ning olemasolevate konkurentsitingimuste efektiivne ärakasutamine.

Hankija poolt pakkumismenetluse käigus antavad selgitused ja vastused Pakkujate küsimustele kuuluvad hankedokumentide hulka.

Pakkumisele kuuluv hange

Kutsume Teid avatud pakkumisele, mille objektiks on reovee puhastamise piloot katseseadme valmistamine. Katseseade hõlmab:

1. *Aktiivsöefiltrite valmistamine (2tk);*
2. *Tellija poolt üle antavate seadmete paigaldamine vastavalt tehnoloogilisele skeemile (P&ID):*
    a. *„Mecana" filter*
    b. *Osoonimisse seade koos osooni generaatoriga*
    c. *Liivafilter*
    d. *UV seade*
    e. *Proovivõtuseade „Sigrist";*
3. *Tellijale olemasoleva liivafiltri ümberehitus;*
4. *Pumbad, andurite, vahemahutite, torud, õhupuhur jne valmistamine või hange;*
5. *Katseseadmete kokkupanek, paigaldamine, installeerimine jne vastavalt ette antud P&ID-le..*
6. *Elektri ja automaatikatööd;*
7. *Katseseadmed paigaldatakse ühte või kahte 6m merekonteinersisse (soojutatud ja ümber ehitatud). Üks või kaks konteinerit, selgub projekteerimistööde käigus.*

Pakkuja peab esitama ühe pakkumise ettenähtud vormis. Pakkumise eesmärk on leida hankija jaoks soodsaim pakkumine.

Pakkujal peab olema ISO 3834 sertifikaat, mis kinnitab tema kvalifikatsiooni keevitustööde valdkonnas.

Üldine ülevaade tellimusest

Tellitavad komponendid on ette nähtud kasutamiseks reovee pilootpuhastussüsteemis. Väikesemahulise pilootkatse eesmärgiks on katsetada orgaaniliste mikrosaasteainete eemaldamist reoveest. Pilootkatses katsetatakse erinevaid tehnoloogiaid nagu osoon, UV, aktiivsüsi, liivafilter jne. Käesoleva hanke põhirõhk on suunatud aktiivsöefiltri soetamisele ja kogu pilootseadme kokkupanekule.

Töövõtja on kohustatud kontrollima vastuvõetud tehnilisi ja tehnoloogilisi lahendusi, et tagada katseseadme tarnitud elementide nõuetekohane toimimise. Muudatusettepanekud ei ole keelatud, kuid vajavad Tellija heakskiitu. Enne piloot katseseadme ehitamise alustamist peab töövõtja esitama heakskiitmiseks üksikasjaliku projektikontseptsiooni, mis sisaldab seadmete paigutust, torustike marsruute, mahutite mõõtmeid ning seadmete, torude ja liitmike tehnilisi parameetreid jne.

Tarnekoht

Tartu Veevärk AS

Aadress: Tähe 118, 50107 Tartu, Eesti

Üldist

Hankimisele kuuluvate komponentide kirjeldamiseks on lisatud pilootseadme P&ID joonis (vt Lisa 1) P&ID joonisel on katseseadmed jagatud eraldi kogumiteks (Unit), toodud välja vooluhulgad ning täiendavaid tehnilist täpsustusi.

Kõikidele Tellija poolt üleantavatel seadmetele antakse kaasa kogu olemasolev dokumentatsiooni (skeemid, elekter, automaatika jne).

OSA 1: Merekonteiner

Kõik EMPERESTI projekti raames hangitavad seadmed paigaldatakse merekonteinerisse. Seadmetega varustatud konteiner täidab pilootseadme rolli, mille eesmärk on katsetada erinevaid tehnoloogiaid mikrosaasteainete eemaldamiseks reoveest. Merekonteiner aitab kaitsta seadmeid välismõjude eest ja võimaldab pilootseadet transportida erinevate sihtkohtade vahel. Konteiner peab olema uus.

ISO 1CCC High Cube ladustamis- kontorikonteiner

Kõik katseseadme elemendid paigaldatakse ISO 1CCC High Cube - 20ft HC konteinerisse, kõrgusega 2,655m.

Hinnapakkumises on konteinereid kaks tükki, kuna seadmete, mahutite, torustike mõõtmed on täpsustamisel. Kahte 20 ft konteinerit vajatakse juhul kui kõik seadmed ühte konteinerisse ära ei mahu. Eelistatakse siiski ühte konteinerit.

Vajadusel võib konteineri lakke teha avad, et võimaldada üle 2,5 meetri kõrguste seadmete paigaldamist. Transpordiasendis ei tohi konteiner ületada liikluseeskirjadega määratud mõõte.

Konteiner peab olema ilmastikukindel ja soojusisolatsiooniga, soojusmaterjal kinnise pooriga (näiteks EPS, PUR vms). Seinad, katus minimaalselt 50mm, põrand minimaalselt 25mm soojustusmaterjaliga, maksimaalselt soojusjuhtivustegu 0,04 W/(m·K).

Konteineri sisevooder peab olema valmistatud veekindlast vineerist, minimaalse paksusega 12mm või roostevabast (minimaalselt AISI 302) plekist minimaalse paksusega 0,8 mm.

Konteineri uksed:

1. Ühe konteineri kasutamisel tuleb lisaks standardsetele otsaustele lisada üks sissekäigu uks minimaalse laiusega 850 mm (ukseleht). Asukoht valitakse projekteerimise käigus.
2. Kahe konteineri kasutamisel tuleb standardsed otsauksed asendada tõsteustega ja lisada üks sissekäigu uks minimaalse laiusega 850 mm (ukseleht). Asukoht valitakse projekteerimise käigus. Kaks konteinerit paigaldatakse kokku, tõsteuksed vastamisi, tekitades ühe suure ruumi. Konteinerite liitmiskohad (tõsteuksega otsad) peavad olema tihendatud (soojustatud) nii, et võimaldavad mitmekordset paigaldamist (konteinerite liitmist ja lahutamist).

Kiirühendused, mis võimaldavad lihtsat ühendamist ilma tööriistu kasutamata, tuleb paigaldada konteineri seinte välisküljele:

- Elektrienergia
- Joogivesi (paindlik voolik)
- Reoveepumba väljutusvoolik on valmistatud painduvast sünteetilisest materjalist, mis on vastupidav reovee söövitavale toimele;
- Reovee ja sette väljutusvoolik protsesside äravoolust (kangasfiltri ja aktiivsöefiltrite tagasipesust, UV-lambi puhastusest ning protsessipaakide ülevooludest), valmistatud painduvast sünteetilisest materjalist, mis on vastupidav reovee söövitavale mõjule.

Konteinerile ei ole vaja eraldi rajada põranda trappe. Põrandale sattunud vesi valgub konteinerist välja üle ukse pakkude. Palun seda arvestada uste paigaldamisel.

Eeldatavalt ei ole vaja arvestada käigusildadega vms liikumiseks või protsessi jälgimiseks. Kui selline katseseadme valmimisel selgub, et üle torustike liikumiseks on vaja käigusildasi vms, siis need tellitakse eraldi.

Konteineri varustuse hulka kuuluvad:

Kätepesu valamu

- Statsionaarne valamuroostevabast terasest AISI 304
- Segisti ühendamiseks läbimõõduga ¾ või ½ tolli, joogiveeühendus
- Kuuma vee boiler min 10 l
- Äravool – reovee väljavoolu.

Seadmete pesuks ja hoolduseks joogivesi

- Kiirühendus joogiveel
- Kiirkinnitus
- 10 meetri pikkune painduv voolik kiirühendusega ½-tollise läbimõõduga
- Vooliku kandur või rull.

Ventilatsioon

- Ühe konteineri kohta kaks tükki
- Väljatõmbeventilaator
- Pinge: 230V AC
- Õhu vooluhulk min 400 m^3/h, reguleeritav
- Roostevabast terasest korpus ja rootor
- Ventilaatorite töö konteineri siseruumis on juhitav termostaatide abil
- Ventilaatorite käsitsi käivitamine konteineri sees asuvate elektriliste lülitite abil
- Varustatud ruloodega või katetega, mis takistavad ilmanähtuste, nagu sademete sattumist konteineri siseruumi.

Valgustus

- Konteineri(te)s minimaalne valgustuse intensiivsus 300 lx;
- LED valgusallikad;
- Kõik valgustid minimaalsaelt IP44.

Pistikupesad

- Konteineri kohta min 3 vaba pistikupesa pingega 230V AC
- 1 kolmefaasiline pistikupesa pingega 400V AC, 16A
- Kõik pistikupesad minimaalsaelt IP44.

Küte

- Elektrilised kütteseadmed, millel on termostaat igas selleks ettenähtud konteineri osas;
- Kütteseadme võimsus valitakse vastavalt ruumi(de) vajadus(t)ele;
- Konstruktsioonimaterjal: valitud vastavalt söövitavale keskkonnale C3;
- Kõik kütteseadmed minimaalsaelt IP44.

OSA 2: Protsesside juurde kuuluvad seadmed

Aktiivsöefiltrid (GAC)

Aktiivsöefiltrite eesmärgiks on hinnata efektiivsust mikrosaasteainete eemaldamisel reoveest. Tellija aitab koostada aktiivsöefiltrite tehnoloogilist-tehnilist projekti. Kaks ühesugust filtrisüsteemi;

- Filtri põhikorpuse läbimõõt ~300 mm;
- Filtrikolonni kogukõrgus soovitavalt mitte rohkem kui 2,3 m;
- Toetuskruusa kõrgus ~0,10 m;
- Filtreerimiskihi kõrgus ~0,5 … 1,50 m;
- Alumine väljavoolukamber ~0,10 m;
- Reovesi juhitakse filtritesse surveliselt (pumbatakse);
- Filtreeritud reovesi suunatakse (võimalusel) isevoolselt puhvermahutisse;
- Filtreerimise ja pesu protsesse juhitakse läbi filtri ja puhvermahuti tasapinna jälgimise (ette antud, ühtlase pealevoolu tingimusel).
- Filter töö ja pesuprotsess filterelemendis peab olema survevaba. St filtri pesuprotsess toimub läbiülevoolu;
- Filtreerimiskolonnid tuleb ehitada ja paigaldada nii, et filtrikihti oleks võimalik hõlpsasti ja ohutult vahetada;
- Filtreerimiskolonnide sööbitav materjal on pleksiklaas (protsessi visuaalselt jälgimiseks). Võib kasutada ja roostevaba AISI 304 kesta millel vaateaken;
- Filtrite põhimaterjal roostevaba teras AISI 304;
- Filtri varustuse hulka kuuluvad:
    - Elektri-automaatikaga ja käsitsi juhitav sulgarmatuur (kogu süsteem, filtreerimine, pesu, õhk jne);
    - Vooluhulgamõõturid automaatika väljundiga ja rotameeter visuaalseks jälgimiseks
    - Filtri pesu pump (puhastatud reoveega puhvermahutist);
- Filtreerimiskihi tüüp: granuleeritud aktiivsüsi, mis on sobivalt valitud mikrosaasteainete eemaldamiseks reoveest Hydraffin Donau Carbonilt või samaväärne.

Vahemahutid

Vahe-puhvermahutid on mõeldud igast protsessiosast tuleva reovee kogumiseks, et sealt omakorda võtta automaatseid proove. Protsessiosa läbinud vesi juhitakse järgnevasse puhastusüksusesse. Lisaks sellele varustab vahemahuti protsessiosa mahutit tagasipesuveega kui tagasipesu tsükkel käivitub. (Tagasipesuvesi

suunatakse reoveekanalisatsiooni). Iga protsessiosa järel on üks vahemahuti. Võib kasutada eraldi mahutit igale seadmele või ühte mitme sektsiooniga mahutit (ühise ülevooluga).

Vahemahutitele seatud tingimused

- Vahemahutid on P&ID-l järgnevad: T01-1, T01-2, T01-3, T2, T3, T4 A ja B.
- Mahutite ruumalad on arvestatud vooluhulkade (m3/h) vähenemise järgi ning mahuti mahud on 0,3 m^3 kuni 1,0 m^3-ni. Täpsem info vt Lisa 1 P&ID joonis.
- Mahutid võivad olla paigutatud, kas:
    a) Eraldi iga protsessiosa taha. Kui vahemahutid on paigutatud eraldi iga protsessiosa taha, siis mahuti maksimaalsed mõõtmed on järgmised: pikkus 500 mm, laius 500 mm, kõrgus 1000 mm.
    või
    b) Ühiselt, mitme sektsiooniga mahuti näol. Sellisel juhul tuleb arvestada töömahu ja ülevoolu kõrgusega.
- Merekonteineris tuleb mahutite mõõtmete valiku puhul arvestada optimaalse ruumi kasutamisega, nii, et mahutid saaksid sobivalt paigutatud konteinerisse, võimaldades samal ajal kõndimisruumi nende kõrval.
- Vahemahutitel on ülevool liigse reovee eemaldamiseks ning alumine äravool koos avatava/suletava kuulventiiliga.
- Vahe-puhvermahutid väljavool järgmisse protsessi etappi (Unit) toimub pumba abil (automaatikaga juhitav);
- Mahutite materjal: Plast PE, PVC(U) või AISI 304 (roostevabast teras);
- Igast vahemahutist võetakse automaatsed reovee proovid vastavateks analüüsideks. Analüüsid hõlmavad erinevate parameetrite mõõtmisi: hägusus, pH, elektrijuhtivus, temperatuur, UV absorptsioon lainepikkusel 254 nm jm.
- Igasse mahutisse tuleb lisada tasemeandur(id) vastavalt P&ID-l märgitule.

Pulbrilise aktiivsöe doseerimise sõlm (PAC dosage station)

Pakkuja peab arvestama konteineri(te)s seadmete paigutamisel pulbrilise aktiivsöe doseerimise sõlme asendiga. Pulbrilise aktiivsöe doseerimise sõlme koostamine-valmistamine ei kuulu käesoleva hanke mahtu. Tellija hangib seadme eraldi või lisatööna pakkujalt vajadusel hiljem.

OSA 3: Protsessipumbad

Sissetuleva reovee pump (00P01)

- Portatiivne sukelpump, jalgadel ja riputatav
- Vastupidav, sagedase käivituse ja pideva töörežiimi jaoks mõeldud pump
- tõstekõrgus minimaalselt 10 meetrit (h=10m)
- Pumba valimisel tuleb arvestada vähemalt 6 kuni 10,0 meetri geomeetrilise tõstekõrguse ja 60 m väljavoolutoru pikkusega
- Pumba tootlikus koos sagedusmuunduriga peab olema vahemikus 0,5 m^3/h kuni 5,0 m^3/h;
- Toitepinge: 230/400 V AC
- Pumba käitab sagedusmuundur, mis on paigaldatud konteinerisse
- Pumba materjal – vastavalt reovee käitluseks sobiv
- Pumba elektriühendus konteineriga ja võimalikud kontrollahelad on ühendatud pistikuga
- Pumba kaabel varjestatud (sagedusmuunduri poolt tekitavate signaalide vältimiseks), pikkusus 30m.
- Kuivkaitse funktsiooni saab lahendada ka paakides olevate nivooanduritega
- Ühendus-väljavoolutoru:
    - pikkus: 30m;
    - sünteetiline materjal, olmereoveele sobiv, painduv;
    - kiirühendus konteineriga ühendamiseks.

Protsesside vahelised pumbad

- Tingimused pumpadele on samad kui eelnevalt kirjeldatud „sissetuleva reovee pumba“ osas;
- Protsessivaheliste pumpade all on mõeldud pumpasid enne iga uue protsessi algust. Täpsem info P&ID jooniselt;
- NB! Järgnevad parameetrid käivad protsessivaheliste pumpade, mitte sissetuleva reovee pumba kohta:
- Pumpade tootlikkus koos sagedusmuunduriga on märgitud P&ID joonisel iga tehnoloogilise üksuse kohale, jäädes vahemikku 0,2-5,0 m^3/h;

Õhukompressor (04BLR01)

Õhukompressorit kasutatakse aktiivsöefiltrite tagasipesu ajal, kus õhk surutakse läbi filtersüsteemide vastassuunas. Selline tagasipesu protsess aitab taastada filtersüsteemi efektiivsuse, eemaldades samal ajal saasteaineid.

- Õhukompressori nimiväärtus: 100 L/min
- Õlivaba kompressor
- Kompressor, mis on varustatud õhupaagi ja rõhu reguleerimissüsteemiga
- Toiteallikas: 230/400 V AC.

OSA 4: Andurid

Vooluhulgamõõtjad

Vooluhulgamõõtjate peamine eesmärk on mõõta kas vedeliku või gaasi (õhk) vooluhulka.

Reoveele:

- Vooluhulgamõõtjad on valitud järgmiste reovee vooluhulkade jaoks:
    - sissevool katsejaama (kangasfiltrisse) (Q.1): 0,5… 5 m3/h;

    - sissevool osoonikontaktmahutisse (Q.2): 0,2… 1 m3/h;
    - sissevool aktiivsöefiltritesse (Q.3): 0,2… 1 m3/h;
    - sissevool UV desinfitseerimisse: 0,2… 1 m3/h;
- Soovitavalt palun kasutada Siemens, Krohne, Endress+Hauser vooluhulga arvesteid.
- Mõõtmismeetod: elektromagnetiline – induktsioon või ultraheli;
- Mõõtmise täpsus: mitte üle 0,4%;
- Tühja toru tuvastamine;
- Kaitseklass IP67;
- Varustatud 4-20mA, Modbus RTU (RS485), Profinet või Profibus kommunikatsioonivõimalusega;
- Konverter paigaldatakse võimalusel eraldi (konteineri seinale või elektri-automaatika kilpi).

GAC on kaks vooluhulga arvestit: elektrooniline (automaatika juhtimine) ja rotameeter (visuaalne kontroll).

- Vastus: vooluhulgaarvesti ja rotameeter, sama ka enne osooni generaatorit

Õhu vooluhulga arvesti (söefiltri loputamiseks 04MF03)

- Termiline massivoolumõõtur
- Õhuvoolumõõtur, mis on õigesti valitud mõõtepunktis oleva õhuvoolu vahemikuks 50 kuni 100 dm3/min;
- Analoogvooluväljund 4-20 mA või
- Modbus RTU või Profibus kommunikatsioonitugi.

Tasemeandurid

- Hüdrostaatiline nivooandur;
- Õlivaba keraamilise membraaniga mahtuvuslik andur;
- Mõõtepiirkond 0..1m H_2O (0..2m H_2O vajadusel);
- Täpsus 0,2%;
- Väljund 4..20mA (PLC-sse) või
- Modbus RTU või Profibus kommunikatsioonitugi;
- Anduri läbimõõt 42mm uputatav või keermega ¾ ’... 1 ½’;
- Kaabel 10m või vastavalt vajadusele;
- Mõõdetava keskkonna temperatuur 0..70°C.

OSA 5: Elekter - Automaatika

Pakkuja peab koostama elektri ja automaatika projektid vähemalt põhiprojekti tasemel.

Automaatika kontrolleri ja HMI andmeside lahendada interneti ühenduse võimalusega ehk RJ45 liidesega. Kasutaja - Tellija peab saama ise valida millist interneti ühendust kasutad (näiteks Elisa Eesti – Soome SIM ruuter, kohtvõtk vms.)

Automaatika kontroller PLC peab olemas Siemens S7 seeria. Seadmed, andurid, arvestid jne võib ühenda 4…20mA, Modbus RTU (RS485), Profinet või Profibus.

Automaatika üldise tööülesande koostamine koostab Pakkuja, kuid detailsemad seadmete ja üksuste tööülesanded koostab Tellija koostöös Pakkujaga.

Tegemist on testseadmetega, kus automaatika põhiülesanneteks on:

- Üksikute seadmete ja eraldi automaatikat omavate seadmete, andurite, pumpade, arvestite jne juhtimine;
- Seadmete, andurite, pumpade, arvestite jne andmete kogumine reaalajas.

Kogu testseadet juhib ja kontrollib keskne kontroller. Kesksesse kontrollerisse ühendatakse:

1. Kompleksseadmed
    a. Filterseadme kontroller
    b. Osoonigeneraatori kontroller
    c. Liivafiltri kontroller

    d. UV seadme kontroller
    e. Analüsaatori kontroller
2. Kõik üksikud seadmed, mis on vajalikud söefiltri GAC tööks, juhtimine, pesudeks jne
3. Kõik üksikud seadmed, mis asetsevad kompleksseadmete ees, vahel ja järel ning tagavad üksikute ja komplekssete seadmete ühtse toimimise tervikuna. Need seadmed on tähistatud P&ID skeemil üksustega 00 kuni 05.
    a. Vooluhulga arvestid;
    b. Sulgeseadmed (solenoid või muud);
    c. Nivoo-taseme andurid;
    d. Sagedusmuundurid (kõikidel pumpadel);
    e. jne
4. Andmebaasi kandja – kõvaketas (SSD), pilvteenus vms

Keskse kontrolleri programmeerimisel tuleb arvestada, et üksikuid kompleksseadmeid peab olema võimalik vahelt välja võtta või järjekorda muuta. Kui põhiskeem on Unit 00> Unit 01> Unit 02> Unit 03> Unit 04> Unit 05, siis peab olema võimalus ka näiteks nii: Unit 00> Unit 03> Unit 05 või Unit 00> Unit 01> Unit 05> Unit 04> Unit 03> Unit 02.

Testseadme testi tulemite hea kvaliteedi tagab eri üksustele võimalikult ühtlase vooluhulga tagamine. Selleks on ette nähtud puhvrina vahemahutid iga kompleksseadme järel. Vastavalt testseadmete järjekorrale alati väheneb vooluhulk (vahemahutitel ülevoolud sisse-välja vahe kompenseerimiseks). Kõik pumbad peavad seega omama sagedusmuundurit ja tagama võimalikult ühtlase hetke toodangu. Pulseeriv vooluhulga pumpasid võib kasutada ainult eraldi kokkuleppel Tellijaga.

Testseadme andmete kogumine

Pärast katsetuste läbiviimist on vajalik uurida kuidas katsetused toimusid. Sellepärast on ülimalt oluline, et kõikide seamete töö andmed oleks kogutud andmebaasidesse.

Seadmete tööolukordade andmed kogutakse kellaajaliste tsüklite kaupa. Tsükli pikkus määratakse eelnevalt (10sek, 30sek; 01min, 2min, 5min, vms) operaatori poolt. Tsükli pikkuse määrab osaliselt proovivõtu süsteemini oma tsüklite pikkus.

Andmetest moodustuv tabel peab olema hõlpsasti hiljem töödeldav ehk andmebaas (SQL), Excel vms. Kogunevad andmed tuleb kohe dubleerida üksteisest sõltumatutele andmekandjatele, ehk süsteemi sisemine andmekandja ja lisa backup (andmekandja) seade, nn pilve dubleerimine. Vähemalt ühele andmebaasile peab olema juurdepääs reaalajas.

MHI (Human Machine Interface)

Keskse kontroller visualisatsioon ehk HMI peab võimaldama juhtida kõiki seadmeid ja kompleksseadmeid läbi nende oma kontrollerite (kui on olemas). Samuti peab HMI võimaldama testseadme tööskeemi muuta (näiteks: Unit 00> Unit 03> Unit 05 jne).

Näidata kõiki seadmeid, seadmete juhtimise ja kompleksseadmete veateateid.

Kaughaldus

Katseseadme olek, töö, parameetrid jne peavad olema mingil viisil (näiteks üle interneti) kaug- hallatavad ja/või visualiseeritud. Juhtimine ei ole vajalik aga võimalusel võib olla.

Katseseadme kiireloomulised ehk avariiteated peavad kaughalduses operaatorile jõudma mingil viisil alarmiga (e-posti või SMS sõnumeid ei pea täiendavalt alarmiga varustama).

Kiireloomulised teated:

- Üldised veateated, testprotsessi põhinäitajatest kõrvalekaldumine jne (võimalusel HMI-lt valitav)
- Oma HMI-d (Kangasfilter Mecana, O_3 seade, UV, Liivafilter) omavate seadmete veateated;
- Side, elektri puudumine;
- Vms.

Elektri ja automaatika tööd, lisa nr 2 „Üldised tehnilised tingimused Tartu Veevärgi elektripaigaldiste projekteerimiseks ning ehitamiseks“ ei ole kohustuslikult nõutavad, kuid võimalusel palun juhinduda Pakkujal on võimalus lihtsamalt ja rahalisalt odavamalt, samas samaväärselt, funktsionaalselt, töökindlalt ja turvaliselt lahendada elektri ja automaatika osa siis aktsepteeritav.

OSA 6: Kokkupanek

Gravitatsiooni- ja survekanalisatsioonitorustik

Reoveetorud (isevoolsed- ja survetorud) peavad olema valmistatud materjalidest, mis on vastupidavad reovee, osooniga töödeldud reovee või osooni söövitavale toimele. Lubatud on kasutada selliseid materjale nagu PE, PVC, roostevaba teras AISI 304, mis on asjakohaselt valitud transporditava meediumi jaoks. Seadmed ühendatakse ja seademete vahelised ühendused tuleb teha kiirliitmikega (näiteks Camlock vms). Ülevoolud seadmetest ja mahutitest võivad olla statsionaarsed, kuid ikkagi vajadusel tööriistadega avatavad.

Garantii

Töövõtja on kohustatud andma 24-kuulise garantii tema tarnitud pilootkatse seadmetele/ elementidele.

Lisad

Lisa 1. Pilootseadme P&ID skeem

Lisa 2. Tartu Veevärk elektri ja automaatika tingimused

Lisa 3. Kangasfilter Mecana

Lisa 4. Osoonigeneraator, samalaadne näidisele

Lisa 5. Liivafilter

Lisa 6. UV seade