DRINK WATER TREATMENT - ULTRAFILTRATION CONTAINERIZED UNIT
Capacity – 17 500 m^3/day

1. Design Basis

Proposal suggests treatment of the incoming water utilizing ultrafiltration (UF) membrane technology to obtain potable water quality product per tender requirements.

Equipment proposed herein is based on the information that raw surface water quality complies with the given data in the documentation with regards to the organic/microbiological content and general understanding of the fresh surface water quality.

Filter elements that require periodic replacement are not used in the technological process. All filtration stages have an automatic backwash to restore filtering capabilities.

Containerized drink water station is delivered completely ready for use.

The productivity of the stations is 17 500 m^3/day and consists of 5 pcs 40-foot containers and one 20-foot container.

The containers are insulated and have a special «winter-summer» cooling-heating system.

2. Stages of the technological process

2.1 **Prefiltration** – filtering of large parts and fibrous (algae) inclusions on automatic disc filters up to 200 microns in size.

2.2 **Ultrafiltration –** membrane technology of deep water purification on ultrafiltration membranes. The degree of filtration is 0.02 microns. At this stage, the final purification of water from organic compounds, clarification of water, removal of microorganisms, bacteria and viruses.

At the same time, the mineral composition of the source water not change.

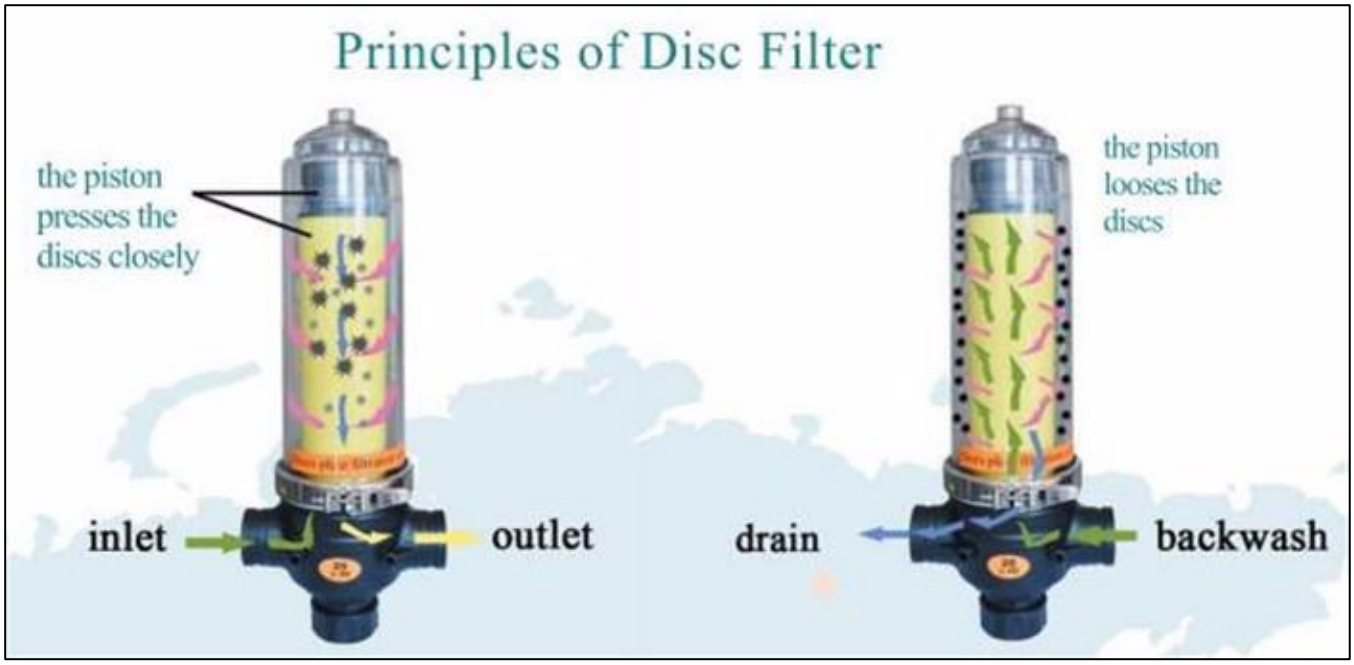
3. Technology and process description

Feed water in the pressurized pipeline to the newly built process building, where it's being treated by the following technological steps:

- Prefiltration;
- Ultrafiltration;

During Prefiltration stage on the automatic disc filter 200 micron and bigger particles rejected to protect membrane surface from sharp solid particles. This step immediately followed by the Ultrafiltration. All three technology phases synchronized in fully automated system that control the process to get the most from system operation.

Feed water enters disc filters, which are made from polymers. Outside surface of the filter element appears in cylinder shape after disc compression. On each disc surface grooves are inflicted of the certain depth and width to achieve volumetric net structure, which is an actual filtration tool for smaller particles. During filtration phase discs are compressed by utilization of the spring. Compressed discs are creating the uniformed filtration structure. During backwash (BW) stage, which starts after reception of the signal from the outside, pistons change direction of the water stream through the filter. Thus, disc packet expands. Under the skew stream that is created by special nozzles, discs start rotation and all particles from the surface are quickly and efficiently washed out into the drain under BW stream. At the end of the BW mode filters are rinsed by clean water



After Prefiltration water entering Ultrafiltration, under pressure of 2-3 bar.
Main advantage of the UF system is to achieve high level of product quality without any change of high permeate (product) quality. UF handling high turbidity not using additional steps of treatment and chemicals. For UF operation only 0.5-1 bar of the working pressure needed, therefore energy consumption of the process is low.

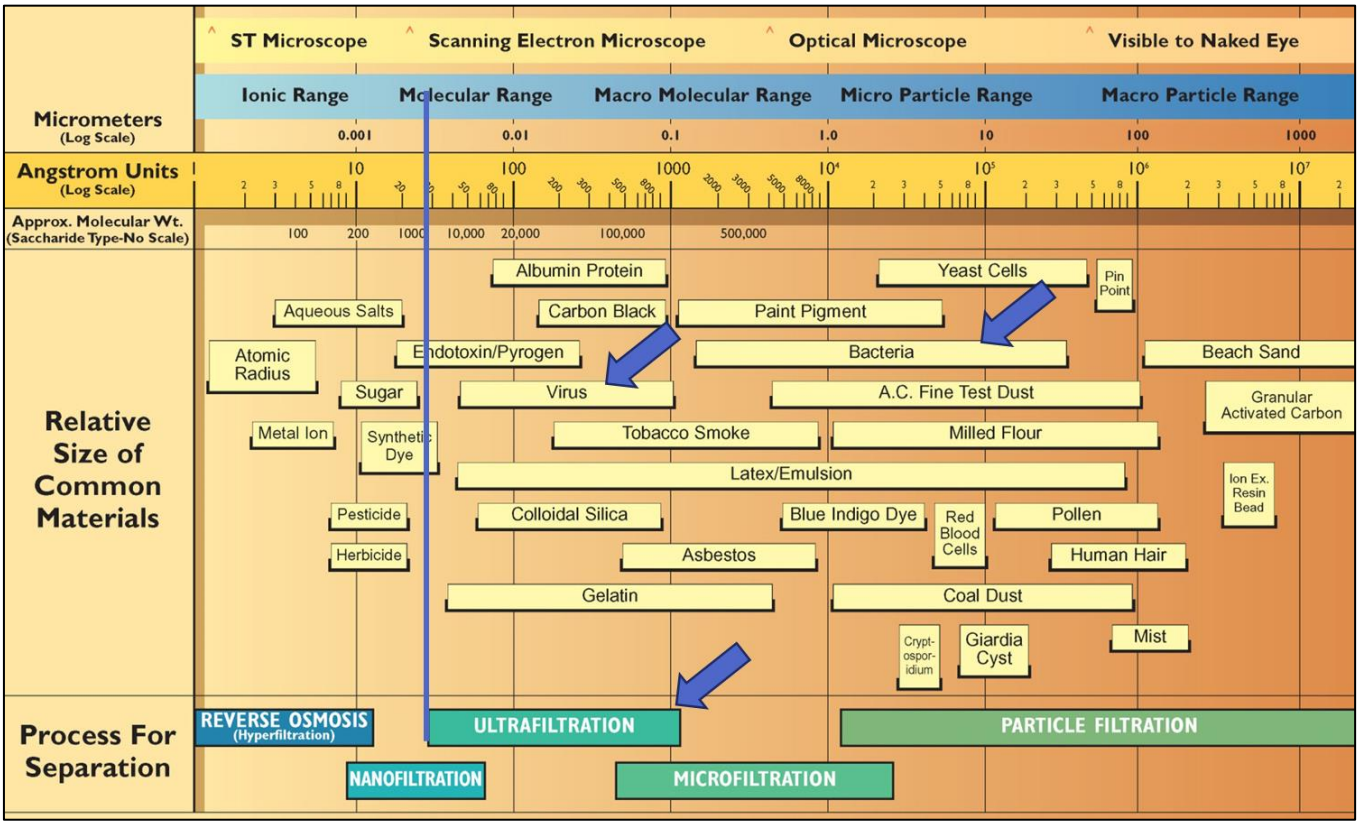
Ultrafiltration reliably removes particles, bacteria, germs and viruses from the water independent of the feed water quality.

In order to be able to guarantee a complete elimination of any harmful substances, disruptions and leakages within the membrane must be totally avoided. In addition to a high chemical and biological resistance, the membrane must additionally be of a high mechanical stability so that it will also sustain high-pressure water hammers which may be caused by valve circuits.

The inner diameter of each capillary of fiber is 0.9 mm. This is larger than usual and offers a number of advantages. In first place it provides a greater tolerance against higher solids loads (more than 50 mg/l suspended solids is possible). The larger diameter reduces the pressure drop along the fiber significantly in comparison to smaller capillaries. This results in a more even water distribution along the fiber and consequentially in a more evenly distributed fouling layer. Thus, the removal of the debris by backwashes is more efficient and usually results in savings on necessary membrane area.

The membrane is highly tolerant against chlorination allowing approx. 200,000 ppm/hours of free chlorine. In addition, it has a wide pH tolerance (pH 1-13) in cleaning mode which is a precondition for efficient cleanings. The multibore fibers are operated in in-out mode which means that in filtration mode the feed water enters the inside of the capillaries and is filtered to the outside whereas during backwash mode the water passes through the fiber from the outside to the inside.

FILTRATION SPECTRUM



The UF modules are mounted vertically in racks usually comprising the frame, interconnecting piping, valves, local instrumentation and the modules. This allows a very simple modular design which can be easily up- or downscaled as necessary.

Further advantages are:

- racks can be pre-assembled in the workshops saving expensive labor at site
- small footprint, low height
- easy access to individual modules simplifying maintenance
- no additional devices such as cranes, tanks, cleaning areas and driers necessary

Permeate from UF membranes enters common pipe followed by a product tank. To clean membrane surface from absorbed contamination designed Back Wash process by clean product water.

Back Wash implemented by specially consigned pump. BW process designed to bring water in opposite to a filtration mode direction – "out-in". BW volume usually make up 3-5% of the feed water volume.

Time duration – 30 secs, every 40-70 min.

To clean membrane even further, every 24 hours or so, Chemical Enhanced Backwash (CEB) is held. During CEB chemicals (normally acid and caustic) are used. Both BW and CEB are conducted in automatic mode.

All main equipment has automatic reserve. Ultrafiltration modules working in parallel. During back wash half UF modules stay working and produced clean water.

All technological process fully automated. Not need constant presence personal for working process, only for periodical services (add chemical).

3.1 Table of comparative characteristics of ultrafiltration and multimedia (sand) filters.

№	Technological parameters	Ultrafiltration	Sand Filters
1.	The size of filtrated solids	All impurities larger than 0.02 μm in size. Retains colloidal parts	Solids up to 50 μm in size. Does not retain colloidal parts
2.	Removal of bacteria and viruses	**YES** Bacteria and viruses are retained by ultrafiltration membranes	**NO** Bacteria and viruses are not retained by Sand Filter Need a lot of more dosing of active chlorine are required for disinfection. The danger of creating toxic organochlorine compounds in the clean water.

3	Dependence of the quality of the filtrate on the amount of impurities in the incoming water	**INDEPENDENT** The quality of the filtrate does not change when the amount of impurities in the incoming water changes.	**IT DEPENDS** When the quality of the incoming water deteriorates, the quality of the filtrate also deteriorates.
4.	Design features	Compact, block-modular construction Does not require lifting mechanisms The quality and properties of the membranes do not change for a long time.	Bulky design. Requires additional lifting mechanisms for installation and maintenance. They have an internal filling of filter material - it needs periodic filling and replacement.

4.1 Розрахунок витрат електроенергії технологічного процесу ультрафільтрації продуктивністю 17 500 м3 на добу.

The main consumers of electricity of the technological process are:

- feed water pumps – work constantly;
- back wash pumps work periodically;
- dosing pumps work periodically.

Variable Frequency drives (VFD) used for every pump, which helps to manage the process more effectively, reacting to requested flow and water temperature changes regardless of the nominal power of the pump

Power Consumption, while Producing Maximum Output, 17 500 m^3/Day

Найменування	Working time per day, hour	Power consumption per hour, kW	Power consumption per day, kW	kW per $м^3$ produced
Feed to UF	24	117	2808	0,16
Back Wash UF	1,2	115	147	0,008
Dosing pumps	24	0,4	9,7	0,001
Chemical Wash UF	0,02	75	1,6	0,0001
			Total:	**0,17**

4.2 Chemical Usage

For CEB process we are using acid and caustic.

Caustic (NaOH 40%) – used to achieve high pH (12-12.5) for effective cleaning from organics and microbiological fouling. It will be done few times a week and depends on how quickly pressure UF skid high drop appears. It will be done more often during the summer and less often during winter time.

Sulphuric Acid (H2SO4 44%) – used to achieve low pH (2-2.5) for effective cleaning from inorganic fouling. Acid CEB likely to be performed once in 36 hours or so.

CEB performed by dosing chemical by means of dosing pump directly into the pipeline, while UF permeate for the BW tank pumped into the skid. After completion of the CEB cleaning, which may also include several minutes soaking step skid is rinsing by clean permeate water before bringing back to

service. Water with chemicals is pumped out from the skid and after neutralization with either acid or caustic to neutral pH will be dumped into the sewage system.

Our technology suggests usage of Sulphuric Acid (44%), which is within the requirements of using it without any restriction.

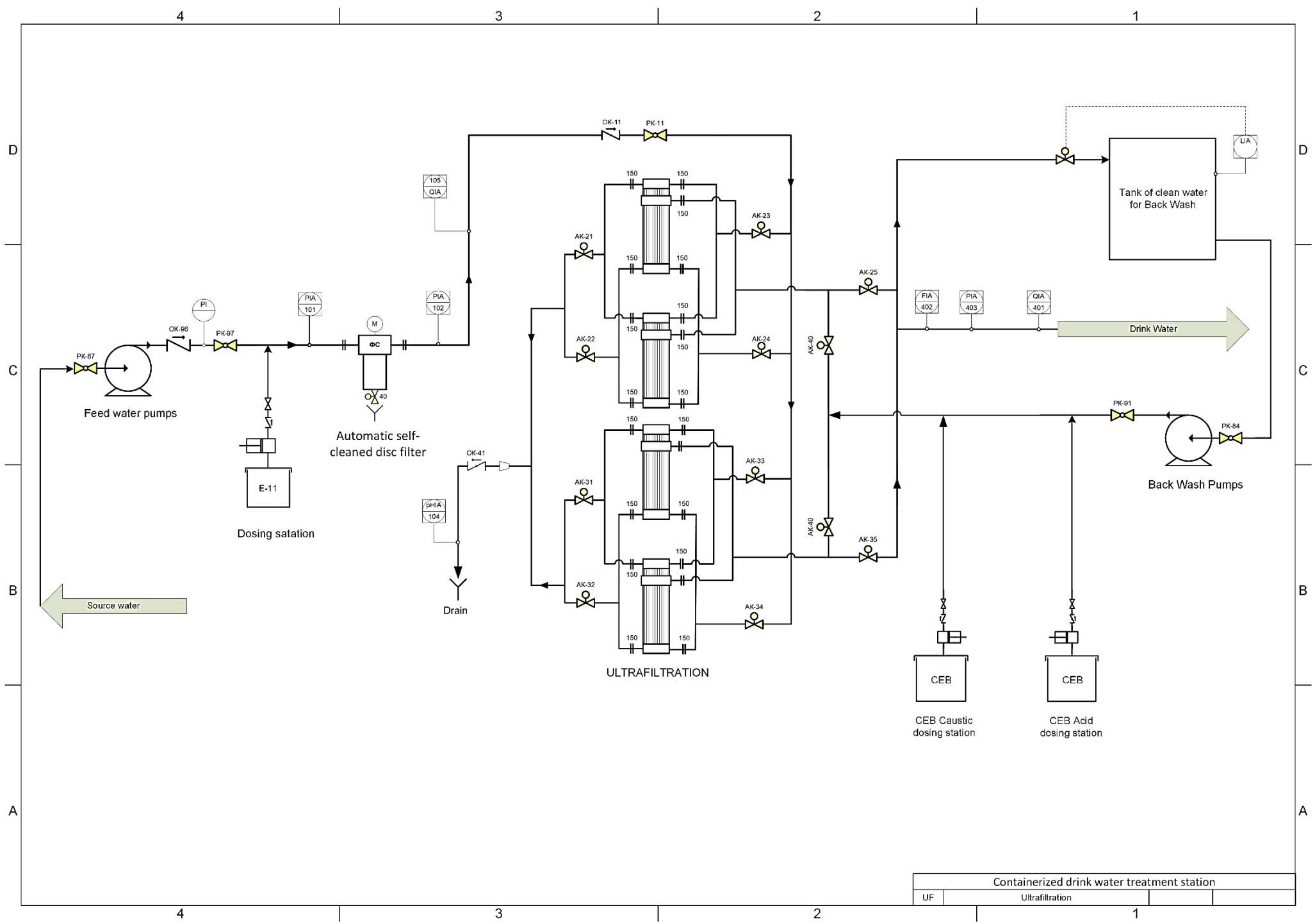
Chemicals Usage, while Producing Maximum Output – 17 500 m^3/Day

Chemical	Day Usage, kg	Usage per year, kg	Usage per 1 m^3 product produced	Note
Caustic, 40%	50	18 250	0,003	
Sulphuric acid, 44%	27	9 860	0,002	
Coagulant	9.5	855	0,001	*dosing 90 days per year*

5. Specification of main equipment

№	Name	Description	Producer	Q-ty
1	Feed pumps	Q-840 m^3/hour, H-50v, N -132 kW	Grundfos or equivalent	2
2	Frequency converter	N-132 kW	Danfoss or equivalent	2
3	Motor cabinet for Pumps	N-132 kW	Schneider or equivalent	2
4	Dosing station of coagulant	Q-5 L/hour, H-50v, N-0,3 kW	Etatron or equivalent	2
5	Tank of coagulant	V-1000 L.		1
6	Automatic self-cleaned disc filter	Q-840 m^3/hour 2” Spin Klin, 200	Amiad	1
7	Ultrafiltration	XL-4-0,9 - 80	Inge Ag	180
8	Automatic valves with electrical gearbox	Dn-150,200	Ebro or equivalent	36
9	Manifold of ultrafiltration (pipes, valves, frame)	PVC, Stainless steel	FIP or equivalent	kit
10	Automatic pressure sensors	0-10 bar	Danfoss or equivalent	4

11	Flow transmitter	0-500 m^3/hour	GF or equivalent	4
12	Turbidity transmitter	0-10 NTU	Rosemount or equivalent	3
13	Back wash pumps	Q-1100 m^3/hour, H-30 m, N -132 kW	Grundfos or equivalent	2
14	Frequency converter	N-132 kW	Danfoss or equivalent	2
15	Motor cabinet for Pumps	N-132 kW	Schneider or equivalent	2
16	Tank for Back Wash UF	PP V-10,0 m^3		1
17	Acid dosing station	Q-400 L/hour, H-50m, N-0,6 kW	Etatron or equivalent	2
18	Caustic dosing station	Q-400 L/hour, H-50m, N-0,6 kW	Etatron or equivalent	2
19	CIP (Clean in Place) station	Q-570 m^3/hour, H-30 m, N -55 kW	Grundfos or equivalent	1
20	PLC station		Siemens	4
21	Container insulated	40 foot HQ		5
22	Container insulated	20 foot		1
23	Climatic cooling/heating system of container equipment		Daikin or equivalent	6
24	Control panel of container		Schneider or equivalent	6


Feed water pumps
Automatic self-cleaned disc filter
Dosing satation
E-11
Source water
Drain
ULTRAFILTRATION
Tank of clean water for Back Wash
Drink Water
Back Wash Pumps
CEB
CEB Caustic dosing station
CEB Acid dosing station
Containerized drink water treatment station
UF
Ultrafiltration


24.88 NTU
0.018 NTU
SIEMENS
SIMATIC HMI