

System performance:

Object location – Dergachi city, Kharkov region (MSW landfill); Flow of: 170 m³/day

Climatic modification U1 (Moderate climate -40 ... + 40 ° C)

Estimated seismicity of the construction object in points of the scale MSK-64 is 5 points

Snow load 160kg / m²

Wind load 43kg / m²

No	Name	Data
1	Capacity	170 m ³ /day
2	Power	70 kW-400V/50Hz
3	Space Requirement	40 ft. Container
4	Feed	170 m ³ /day
5	Reject	67 m ³ /day
6	Filtrate	103 m ³ /day
7	Recovery	75%

The treatment plant is based on the reverse osmosis process with a capacity of up to 170 m³/day. The task is to remove excess organic and mineral substances (heavy metals, chlorides, sulphates and other dissolved salts), as well as partial disinfection of wastewater. The module is supplied in container version - ISO 40 ft. (12x2.5x2.5), fully automated (based on SIEMENS controllers), and equipped with lighting, air conditioning, adapted to weather conditions in Ukraine.

The estimated electrical conductivity for raw/untreated wastewater is about 15,000 µS/cm (at 25°C).

The estimated degree of leachate treatment is about 75%.

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Advantages over other membrane plants:

- Create a circular flow on the surface of each membrane. The permeate passes into the common central channel while the concentrate flow as a result falls on the next membrane in turn, etc;
- Can be used at pressures up to 140 bar, which allows wastewater treating with a high percentage;
- Have a self-generation system, which ensures a long and effective service life for membranes;
- Has a modular layout that simplifies maintenance, repair and replacement of membrane modules;
- Has a low-pressure drop across the membranes, so the operating flow is lower than that of competing systems.

Typically, energy savings is of 5-8 kW per m³ of liquid;

- Specially designed for landfill leachate and high quality permeate.

The developed facility of membrane reactors consists of the following elements:

- Installation of reverse osmosis;
- Drain/leachate tank;
- Degasser of permeate;
- Antiscalant dosing station;
- Alkaline cleaning dosing station;

- Acid-cleaning dosing station;
- Monitoring system based on the Siemens controller.
- Installation of reverse osmosis of the second stage.

The proposed technology will allow to treat leachate to the normative requirements of wastewater quality before discharging it into the city wastewater system in Kharkov or to use it for technical purposes (irrigation of the landfill in arid months, technical water for the needs of the Complex).

When wastewater treatment (MSW leachate), two wastewater flows are formed:

- Permeate - conditionally clean wastewater,
- Concentrate - a solution of suspended contaminants.

Influent concentration for design:

Parameter	Value	Unit	Remark
Temperature	5-20	C ⁰	
Calcium, Ca	170	mg/dm ³	1
Magnesium, Mg	40	mg/dm ³	
Sodium, Na	3700	mg/dm ³	1
Bicarbonate HCO ₃	1700	mg/dm ³	1
pH	8,0	(unit)	
CCO	14000	mg/dm ³	
BOD ₅	6000	mg/dm ³	
Ammonium nitrogen	1500	mg/dm ³	
Nitrite	3,9	mg/dm ³	
Nitrates	50	mg/dm ³	
Phosphates	111	mg/dm ³	
Chlorides	3500	mg/dm ³	
Sulphates	500	mg/dm ³	
Total iron	70	mg/dm ³	2
Copper	1,4	mg/dm ³	
Chrome ³⁺	3,0	mg/dm ³	
Synthetic surfactants	5,7	mg/dm ³	
Phenol	5,2	mg/dm ³	
Oil	7,0	mg/dm ³	3
Zinc	4,0	mg/dm ³	
Nickel	1,5	mg/dm ³	
Dry residue	15000	mg/dm ³	

Remarks:

- 1- Pretreatment has to reduce Ca/Mg content to make sure that cleaning frequencies are not too high.
- 2- Pretreatment has to reduce iron content. The original iron potential produces a lot of cleaning frequencies.
- 3- Pretreatment has to reduce oil content. For prevent to blockages of RO membrane

Requirement of filtrate quality:

Parameter	Value	Unit
pH	6.5÷9	pH units
COD	≤ 2.5 BOD5	mgO ₂ / dm ³
BOD5	300	mgO ₂ / dm ³
Suspended solids	300	mg/dm ³
Oil and oil products	5,0	mg/dm ³
Fats	6,0	mg/dm ³
Ammonium nitrogen	40,0	mg/dm ³
Nitrites	3,3	mg/dm ³
Nitrates	45,0	mg/dm ³
Sulphate	400	mg/dm ³
Chlorides	350	mg/dm ³
Phosphates	6,0	mg/dm ³
Sulphides	1,0	mg/dm ³
Synthetic surface active	0,5	mg/dm ³
Phenol	0,039	mg/dm ³
Total Iron	2,0	mg/dm ³
Copper	1,0	mg/dm ³
Chrome3+	0,13	mg/dm ³
Chrome6+	0,13	mg/dm ³
Zinc	0,5	mg/dm ³
Nickel	0,2	mg/dm ³

Electricity Balance Sheet

№	Name of the facility	Q-ty of working equipment	Installed power [kW]	Total power [kW]
1	Wash Pump - Flow rate 30 m ³ /hour - Operation pressure 4,0 bar	1	5,5	5,0
2	Feed Pump - Flow rate 10 m ³ /hour - Operation pressure 5,0 bar	1	3,0	3,0
3	Agitator feed tank -RPM 70	1	1,5	1,5
4	RO1 High pressure pump with frequency control including - Flow rate 7,5 m ³ /h - Operation pressure 70-80 bar	1	22	22
5	RO1 Circulation Pumps - Flow rate 45 m ³ /h - Operation pressure 5 bar	1	9,5	9,5
6	RO2 High pressure pump with frequency control including - Flow rate 7,5 m ³ /h - Operation pressure 70-80 bar	1	22	22
7	Dosing station	3	0,06	0,18
8	Air condition	1	4	4
9	Lightining	1	0,5	0,5
Total Installed Energy				69,7
Total Operating Energy				40,2

Estimation of the treatment cost for leachate landfill capacity 170 m³/day

Basic Data

Time of work in year – 7880 hour

Capacity of feed – 7,1 m³/hour (59 948 m³/year)

Capacity of permeate – 4,3 m³/hour (33 884 m³/year)

№	Name	Consumption per year	Price unit, Euro	Cost year, Euro	Cost permeate Euro/m ³	Cost feed Euro/m ³
1	Power	287 388	0,05	14 369	0,42	0,26
2	H2SO4 (44%), kg (IEX-123)	26 700	0,69	18 423	0,54	0,33
3	NaOH (40%), kg (AB-007)	12 800	1,2	15 360	0,45	0,27
4	Antiscaling (100%), kg (PS-890)	560	4,0	2 238	0,07	0,04
5	Cleaner A010 (acid), kg (ROH-014)	2 200	3,0	6 600	0,19	0,12
6	Cleaner S010 (alkaline), kg (ROE-021)	2 200	3,0	6 600	0,19	0,12
	Total 1-6			63 592	1,88	1,14
7	Cartridge filter, pcs	1200	8,4	10 080	0,30	0,18
8	Bag filter, pcs	110	11,5	1 265	0,04	0,02
9	First stage RO membranes	18	1500	27 000	0,8	0,48
	Total 7-9			38 345	1,13	0,69
	TOTAL			101 937	3,01	1,82

List of man equipment:

Position	Pieces	Description
1	1	Aggregate Container - ISO 40 ft. Container (12x2,5x2,5) floor coated special polymer - Walls are lined with HDPE plates - Insolation - Air Condition - Ventilation - Lighting
2	1	Raw Water Tank - Volume 5.000 L - Level Control System - Pipework for pH adjustment - Air valve - Material: Polypropylene
3	1	Filtered Water Tank & Membrane Cleaning Unit - Volume 3.000 L - Level Control System - Pipework for pH adjustment - Air valve - Heater 18 kW - Material: Polypropylene
4	1	Rack for Aggregates – Skid frame Material : Stainless Steel 304
5	2	Sand filter system - Tank material GFK; PN 10 - Size 36x72 inch - Special Filter material - Differential pressure switch - Pipe work, PVC - hydraulically and electrically integrated - Fabr. Wave Cyber 36x72
6	1	Wash Pump - Flow rate 30 m3/hour - Operation pressure 4,0 bar - Power – 5,5 kW - Material AISI: 316 - Fabr. GRUNDFOS CRN 10-8
7	1	Feed Pump - Flow rate 10 m3/hour - Operation pressure 5,0 bar - Power – 3,0 kW - Material: AISI 316 - Fabr. GRUNDFOS CRN 32-3
8	1	Agitator of feed tank -RPM 70 - Power – 1,5 kW - Material: AISI 316 - Fabr. ETATRON AGR-V

9	1	<p>Cartridge filter</p> <ul style="list-style-type: none"> -Water flow rate : 25 m³/h -Size 5x40 inch -Filter fineness : 5 Micron -Material : PVC
10	1	<p>Bag Filter</p> <ul style="list-style-type: none"> -Water flow rate : 8 m³/h -Size 2 inch -Filter fineness : 20 Micron -Material : PVC
11	1	<p>Dosing Station for</p> <ul style="list-style-type: none"> - Antiscaling/Antifouling - Dosing Pump 1,0 L/h-5,0 bar - Dosing Tank 100 L - Level control system - Fabr. ETATRON DLX-MA
12	1	<p>Dosing Station for Acid</p> <ul style="list-style-type: none"> - Dosing Pump 12,0 L/h-6 bar - Dosing Tank 1000 L - Level control system - Automatic pH control - Fabr. ETATRON DLX-MA
13	1	<p>Dosing Station for -Caustic</p> <ul style="list-style-type: none"> - Dosing Pump 2,0 L/h-6,0 bar - Dosing Tank 200 L - Level control system - Fabr. ETATRON DLX-MA
14	1	<p>RO1 High pressure pump with frequency control including</p> <ul style="list-style-type: none"> - Flow rate 7,5 m³/h - Check valve - Operation pressure 70-80 bar - Power connection 22 KW 400V/50Hz - Material: Duplex - Fabr. Danfoss APP 10.1
15	1	<p>RO1 Circulation Pumps</p> <ul style="list-style-type: none"> - Flow rate 45 m³/h - Operation pressure 5 bar - Max. OP pressure 70 bar - Power connection 9,5 KW 400V/50Hz - Material: AISI 316 - Fabr. Grundfos BM 46-6N
16	1	<p>RO2 High pressure pump with frequency control including</p> <ul style="list-style-type: none"> - Flow rate 7,0 m³/h - Check valve - Operation pressure 60-70 bar - Power connection 22 KW 400V/50Hz -Material: Duplex -Fabr. Danfoss APP 10.1

17	18	<p>RO1 Membranes</p> <ul style="list-style-type: none"> - Type INDUSTRIAL RO3 (SC 8040) - Special for wastewater streams - Fouling-resistant membrane surface - Membrane area 24,5 m² - Max. pressure 80 bar
18	6	<p>RO2 Membranes</p> <ul style="list-style-type: none"> - Type AE HR 440 - High Rejection Low Energy Seawater - Membrane area 32 m² - Max. pressure 80 bar
19	4	<p>RO Pressure Vessels</p> <ul style="list-style-type: none"> -Max. Working Pressure 84 bar -Material GFK - RO 8040 – 6 pcs - Fabr. Knappe
19	1	<p>RO1/RO2 Pipework</p> <ul style="list-style-type: none"> - Stainless steel 1.4571 /AISI 316Ti – high pressure section PN 100 - Plastic PVC – low pressure section PN16 - Feed DN 50 - Permeate DN 50 - Recirculation DN 90 - Brine DN 25
20	2	<p>Sets of Electrical Equipment</p> <p>Qty. Specification Supplier</p> <ul style="list-style-type: none"> 1 Conductivity Feed FIP 2 Conductivity Permeate FIP 2 Pressure Transmitter 0-60/100 bar WIKA 1 pH Transmitter FIP 2 Permeate Capacity FIP 2 Concentrate Capacity FIP 2 Level system Dosing Tanks 1 Level system CIP Tank 1 Pressure Switch WIKA
21	1	<p>CONTROL PANEL</p> <p>According VDE/VDI 0110/0113 CE</p> <ul style="list-style-type: none"> - Housing Supplier. RITTAL - Main Switch, Fuses, Relays, Clamps, Lamps - Frequency Converter - PLC Fabr. SIEMENS - Operator Panel -Ethernet Connection ready for external SCADA

RO-1 Membrane:

industrial RO series

industrial high pressure brackish water RO elements

The S-Series proprietary thin-film reverse osmosis membrane is used in the Industrial RO3 elements. It is characterized by high sodium chloride rejection and a smooth, fouling-resistant membrane surface.

The A-Series proprietary thin-film reverse osmosis membrane is used in the Industrial RO5 and RO6 elements. It is characterized by high sodium chloride rejection and a high permeability.

Industrial RO Brackish Water Elements are used for concentration of wastewater streams with a high osmotic pressure or a high level of solids. They can also be used to concentrate diluted acids.

These elements feature a 35mil or 50mil spacer in a high pressure compatible element assembly.

Table 1: Element Specification

Membrane	S-Series, Thin-film membrane (TFM*) A-Series, Thin-film membrane (TFM*)
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Model	Average permeate flow gpd (m ³ /day) ^{1,2}	Average NaCl rejection ^{1,2}	Minimum NaCl rejection ^{1,2}
INDUSTRIAL RO3 4040F35	1,900 (7.2)	99.0%	98.5%
INDUSTRIAL RO3 4040F50	1,450 (5.5)	99.0%	98.5%
INDUSTRIAL RO3 8040F35	7,800 (29.5)	99.0%	98.5%
INDUSTRIAL RO3 8040F50	6,500 (24.6)	99.0%	98.5%
INDUSTRIAL RO5 4040F35	2,200 (8.3)	99.5%	99.0%
INDUSTRIAL RO5 8040F35	9,200 (34.8)	99.5%	99.0%
INDUSTRIAL RO5 8040F50	7,400 (28.0)	99.5%	99.0%
INDUSTRIAL RO6 4040F35	2,200 (8.3)	99.0%	98.0%
INDUSTRIAL RO6 8040F35	9,200 (34.8)	99.0%	98.0%

¹Average salt rejection after 24h operation. Individual flow rate may vary ±25%.

² Testing conditions:

INDUSTRIAL RO3: 2,000ppm NaCl solution at 425psi (2,930kPa) operating pressure, 77°F, pH 7.5 and 15% recovery.

INDUSTRIAL RO5: 2,000 ppm NaCl solution at 225psi (1,550kPa) operating pressure, 77°F, pH 7.5 and 15% recovery.

INDUSTRIAL RO6: 500 ppm NaCl solution at 115psi (793kPa), operating pressure, 77°F, pH 7.5 and 15% recovery.

Model	Spacer mil (mm)	Active area ft ² (m ²)	Outer wrap	Part number
INDUSTRIAL RO3 4040F35	35 (0.89)	75 (7.0)	Fiberglass	3050577
INDUSTRIAL RO3 4040F50	50 (1.27)	61 (5.7)	Fiberglass	3049999
INDUSTRIAL RO3 8040F35	35 (0.89)	330 (30.7)	Fiberglass	1207451
INDUSTRIAL RO3 8040F50	50 (1.27)	269 (25.0)	Fiberglass	1207450
INDUSTRIAL RO5 4040F35	35 (0.89)	75 (7.0)	Fiberglass	3050576
INDUSTRIAL RO5 8040F35	35 (0.89)	330 (30.7)	Fiberglass	3144696
INDUSTRIAL RO5 8040F50	50 (1.27)	269 (25.0)	Fiberglass	3097294
INDUSTRIAL RO6 4040F35	35 (0.89)	75 (7.0)	Fiberglass	3144699
INDUSTRIAL RO6 8040F35	35 (0.89)	330 (30.7)	Fiberglass	3144697

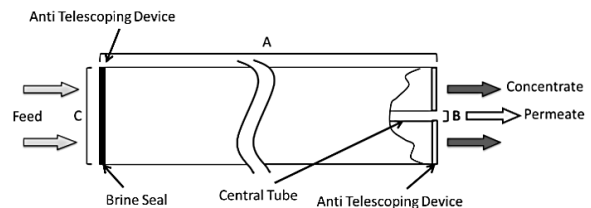


Figure 1a : Element Dimensions Diagram (Female) – 8040

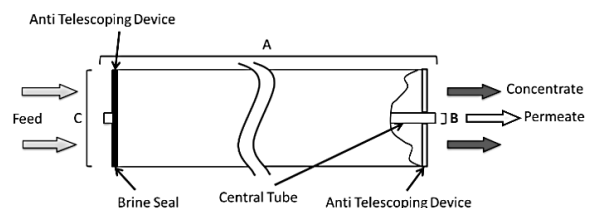


Figure 1b: Element Dimensions Diagram (Male) – 4040

AE HR Series

High Rejection Low Energy Seawater RO Elements

The AE HR series of proprietary thin film reverse osmosis membrane elements are characterized by an excellent sodium chloride rejection. AE HR series is selected when high quality permeate is demanded from seawater that is relatively high in TDS.

AE HR series new membrane chemistry provides excellent rejection characteristics when operated at seawater operating conditions (pressures exceeding 800psi (5,516kPa).

Table 1: Element Specification

Membrane	Thin-film membrane (TFM*)			
Model	Average permeate flow gpd (m3/day) ^{1,2}	Average NaCl rejection ^{1,2}	Minimum NaCl rejection ^{1,2}	Minimum Boron Rejection ²
AE-90	2000 (7.6)	99.8%	99.3%	90.0%
AE-400, 34	9000 (34.1)	99.8%	99.3%	90.0%
AE-440	9900 (37.5)	99.8%	99.3%	90.0%

¹ Average salt rejection after 24 hours operation. Individual flow rate may vary +25%/-15%.
² Testing conditions: 32,000mg/l NaCl & 5mg/l Boron solution at 800psi (5,516kPa) operating pressure, 77°F (25°C), pH 8.0 and 10% recovery.

Model	Active area ft² (m²)	Outer wrap	Part number
AE-90	90 (8.4)	Fiberglass	3056660
AE-400, 34	400 (37.2)	Fiberglass	3056662
AE-440	440 (40.9)	Fiberglass	3056663

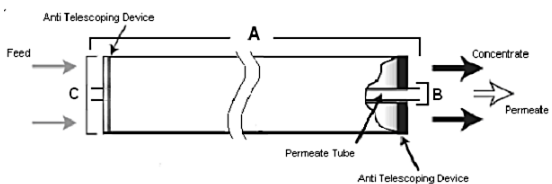


Figure 1a: Element Dimensions Diagram - Male

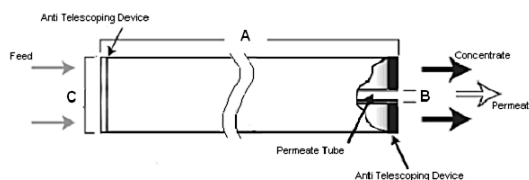


Figure 1b: Element Dimensions Diagram - Female

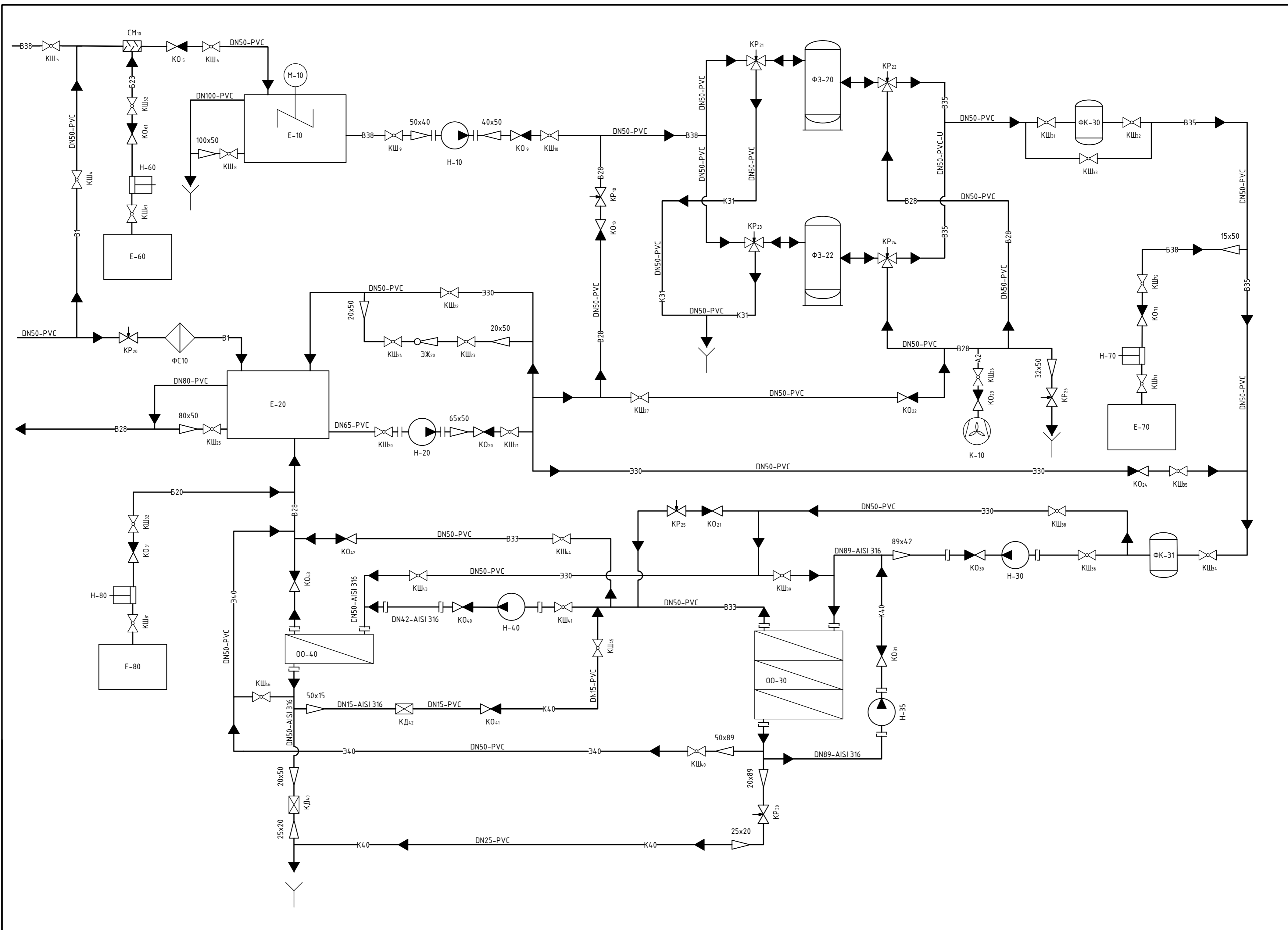
Table 2: Operating and CIP parameters

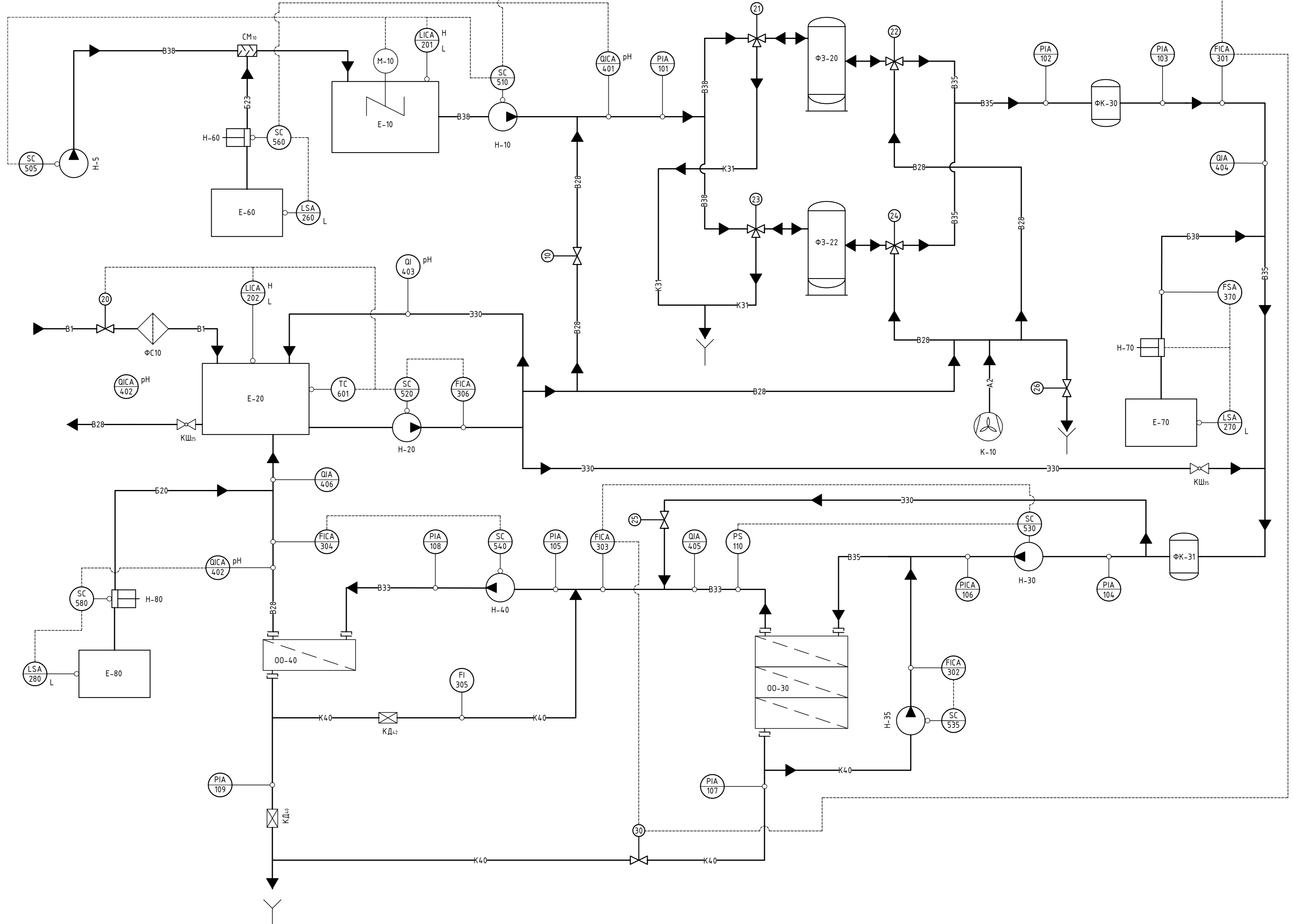
Typical Operating Pressure	800psi (5,516kPa)
Typical Operating Flux	7-11GFD (12-19LMH)
Maximum Operating Pressure	1,200psi (8,274kPa)
Maximum Temperature	Continuous operation: 122°F (50°C) Clean-In-Place (CIP): 122°F (50°C)
pH range	Optimum rejection pH: 7.0-7.5, Continuous operation: 4.0-11.0, Clean-In-Place (CIP): 2.0-11.5
Maximum Pressure Drop	Over an element: 12 psi (83 kPa) Per housing: 50 psi (345 kPa)
Chlorine Tolerance	1,000+ ppm-hours, dechlorination recommended
Feedwater³	NTU < 1 SDI < 5

³SDI is measured on a non-linear scale using a 0.45 micron filter paper. Additionally, finer colloids, particulates and microorganisms that pass through the filter paper and not measured in the SDI test, will potentially foul the RO element. For performance consistency and project warranty, please use Winflows projection software and consult your Filters with Membranes representative.

Table 3: Dimensions and Weights

Model ¹	Type	Dimensions, inches (cm)			Boxed Weight lbs (kg)
		A	B ²	C	
AE-90	Male	40.0 (101.6)	0.75 (1.90)	3.9 (9.9)	9 (4)
AE-400, 34	Female	40.0 (101.6)	1.125 (2.86)	7.9 (20.1)	35 (16)
AE-440	Female	40.0 (101.6)	1.125 (2.86)	7.9 (20.1)	35 (16)

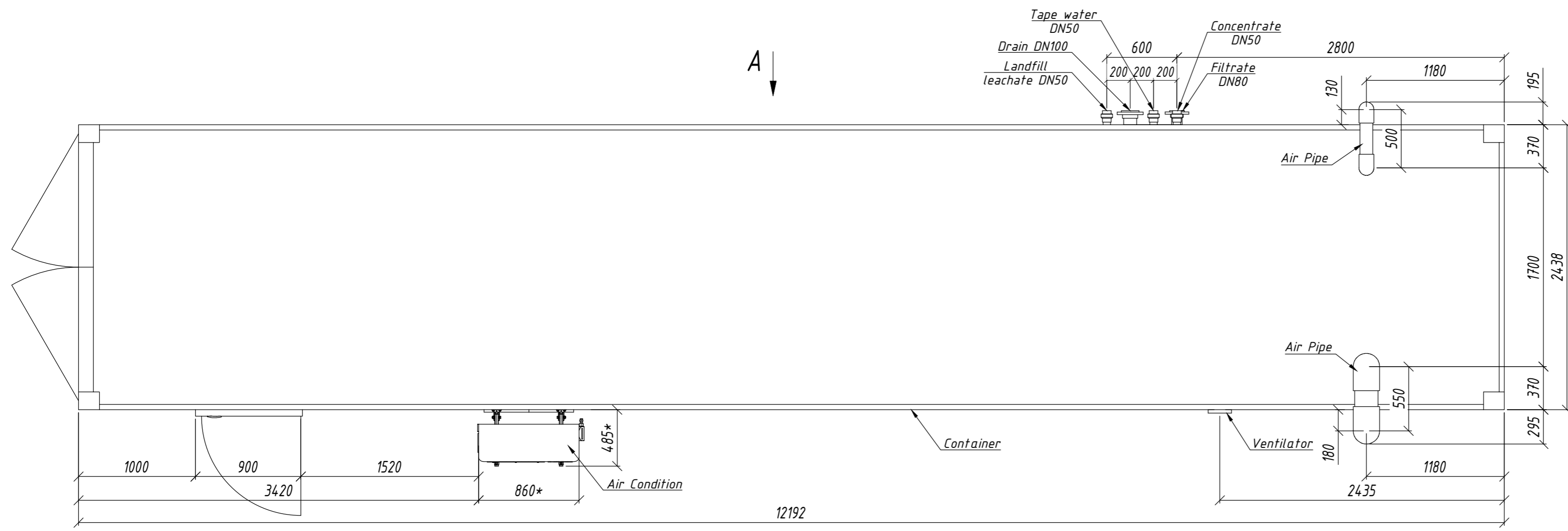
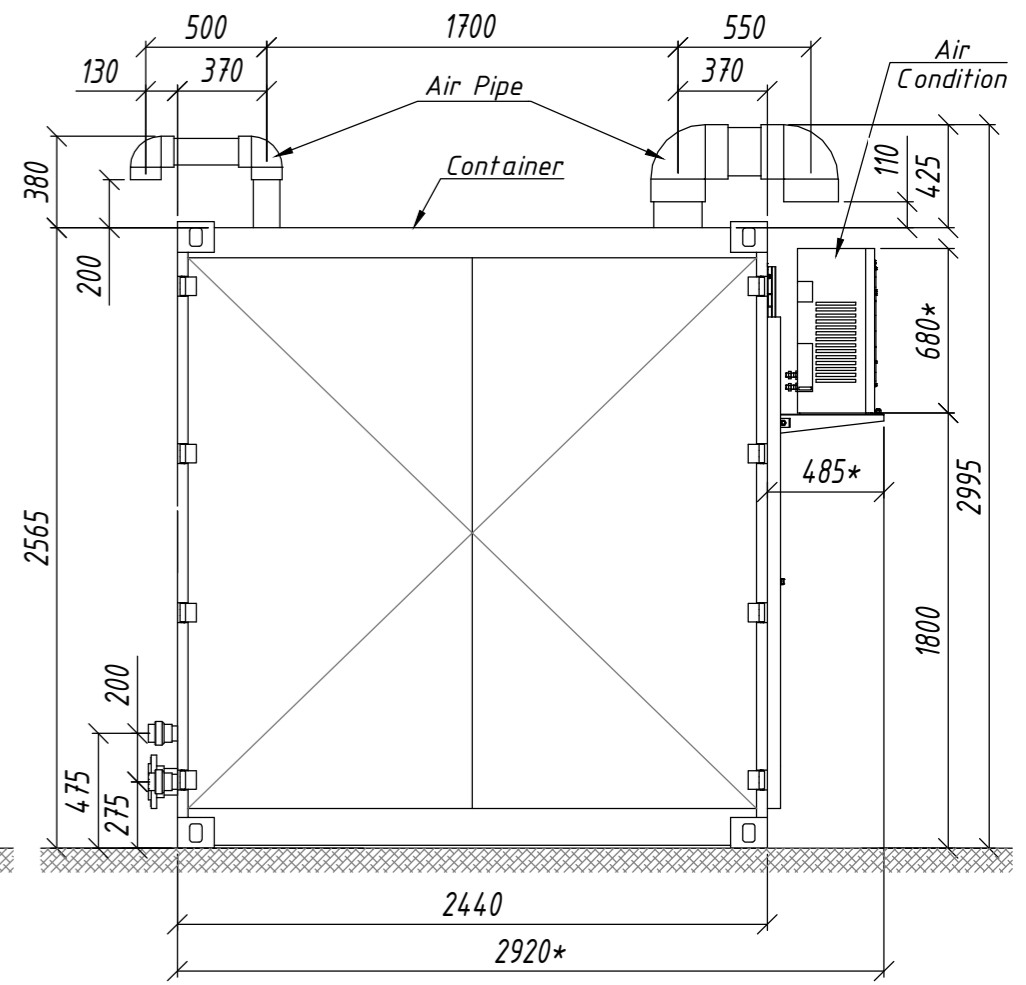
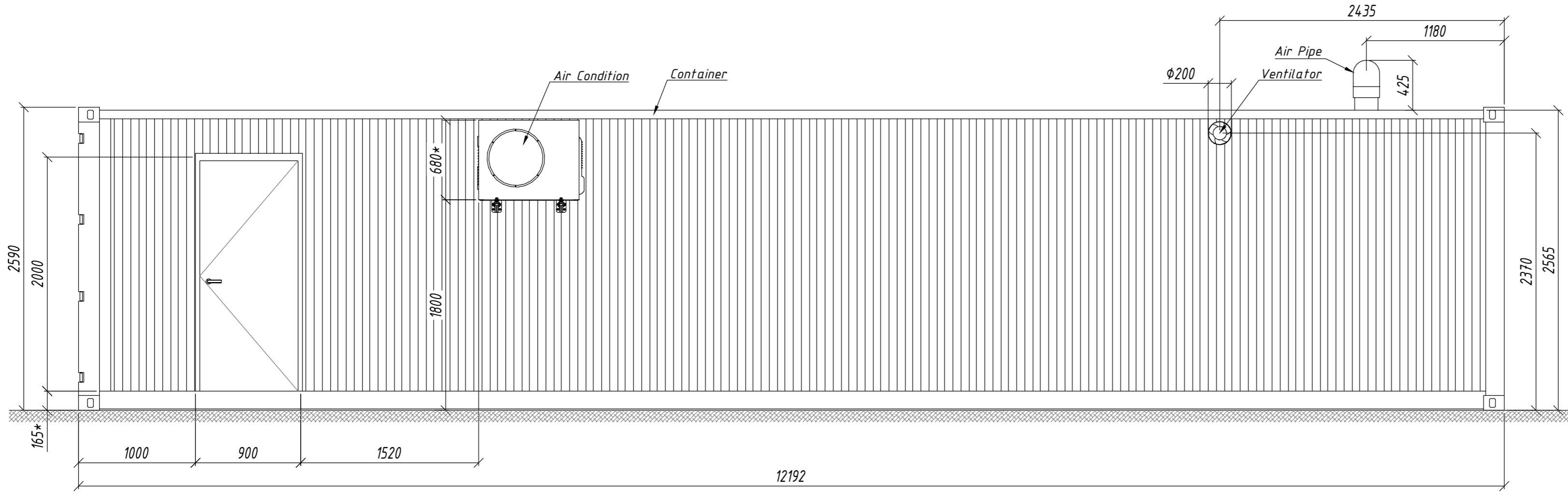




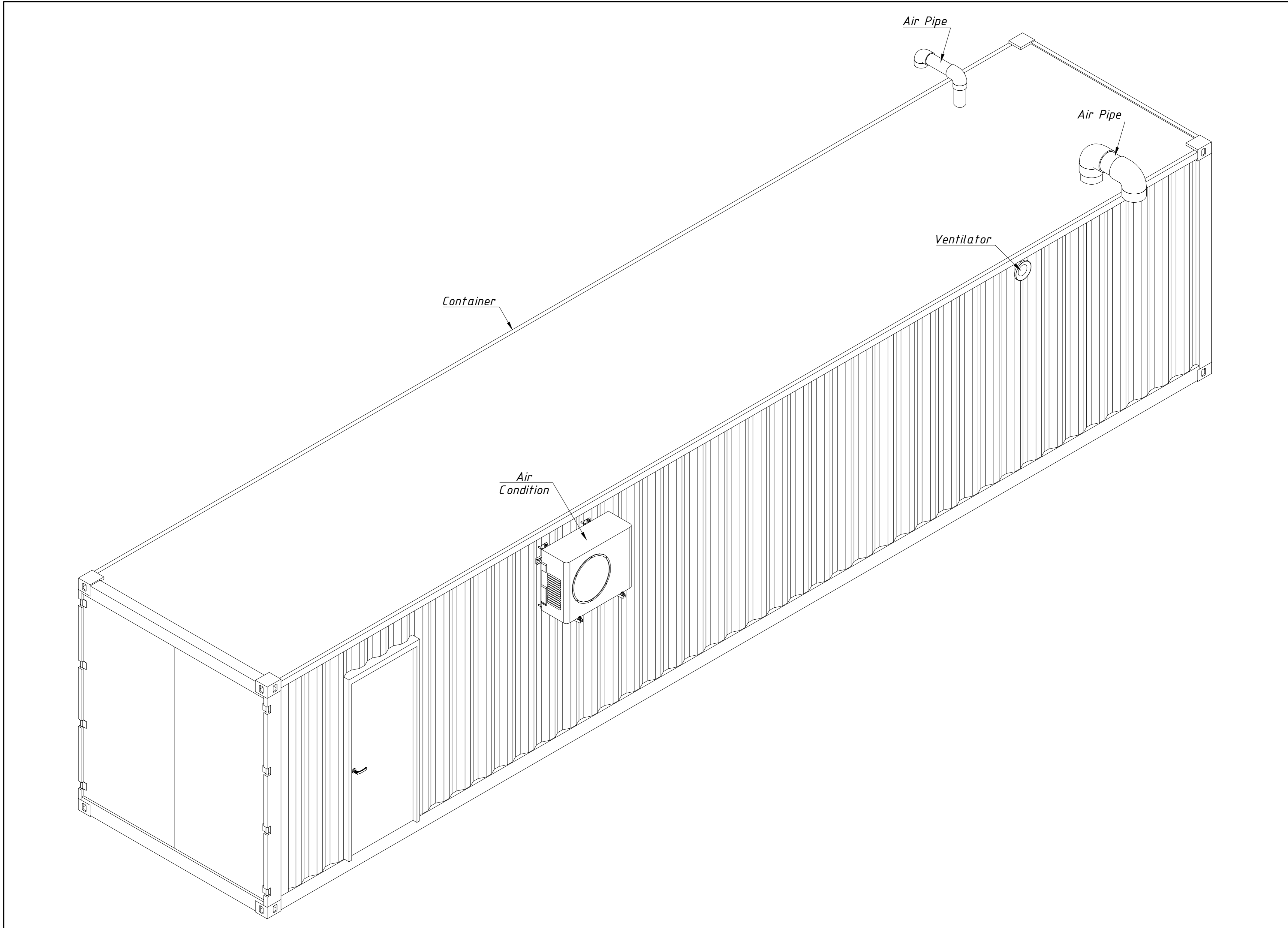
Specification

Pos.	Description	Qty.	Note
PIA-101/105	Pressure Transmitter, 0-10 bar	5	Danfoss
PIA-106/109	Pressure Transmitter, 0-80 bar	4	Danfoss
PS-110	Pressure Switch, 0-12 bar	1	Danfoss
LICA-201/1202	Ultrasonic Level Transmitter, 0-2,0 m	2	DInel
LSA-260/280	Level Switch	3	ETATRON
FICA-301,303,304	Flow Magnetic Transmitter, 0-10 m3/hour	3	FIP
FICA-302	Flow Transmitter, 0-50 m3/hour	1	FIP
FI-305	Flow Meter , 0-6,0 m3/hour	1	FIP
FICA-306	Flow Magnetic Transmitter, 0-30 m3/hour	1	FIP
FI-305	Flow Switch	1	ETATRON
QICA-401/402	pH Transmitter, 0-14 pH	2	FIP
QI-403	pH Transmitter, 0-14 pH	1	FIP
QIA-404	Conductivity Transmitter, 10-25 000 ppm	1	FIP
QIA-405	Conductivity Transmitter, 10-10 000 ppm	1	FIP
QIA-406	Conductivity Transmitter, 10-2 000 ppm	1	FIP
SC-505	Frequency Converter, N-2,2 kW	1	DANFOSS
SC-510	Frequency Converter, N-3 kW	1	DANFOSS
SC-520	Frequency Converter, N-5,5 kW	1	DANFOSS
SC-530,540	Frequency Converter, N-22 kW	2	DANFOSS
SC-535	Frequency Converter, N-9,5 kW	1	DANFOSS
SC-560,580	Frequency Converter	2	ETATRON
TC-601	Heater, N-18 kW	1	

Symbol		Name of Pipe
	Picture	
	—A2—————A2—	Compressed Air
	—B20—————B20—	Caustic 40%
	—B23—————B23—	Sulphuric Acid 44%
	—B38—————B38—	Антискайлант
	—B1—————B1—	Вода технична
	—B28—————B28—	Фільтрат
	—B33—————B33—	Фільтрат першої ступені осмосу
	—B35—————B35—	Попередньо очищенні стоки ТПВ
	—B38—————B38—	Стоки ТПВ
	—K31—————K31—	Промивні води засипних фільтрів
	—K40—————K40—	Концентрат зворотного осмосу
	—Z30—————Z30—	Розчин для промивки мембран
	—Z40—————Z40—	Розчин після промивки мембран



A ↓



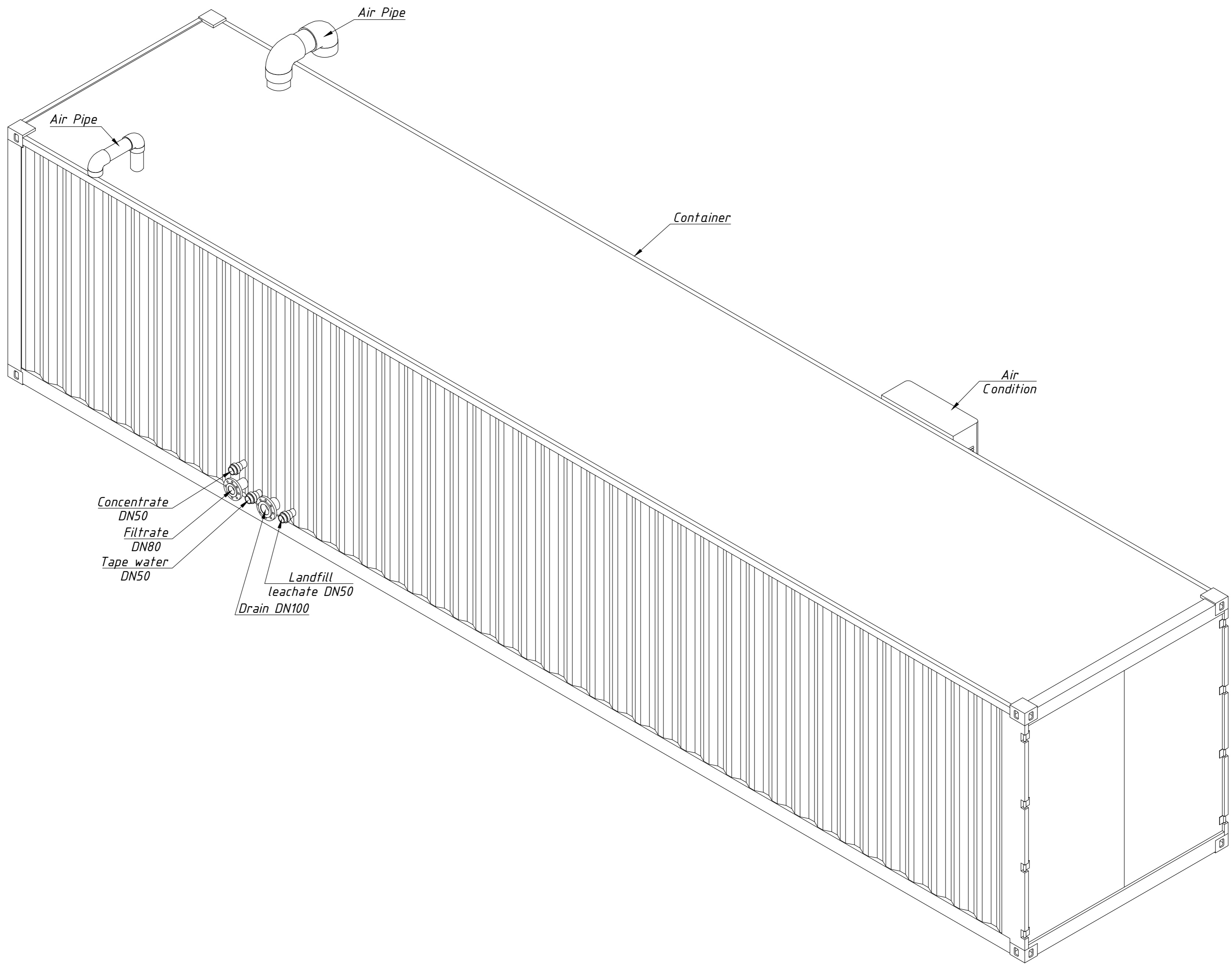
Air Pipe

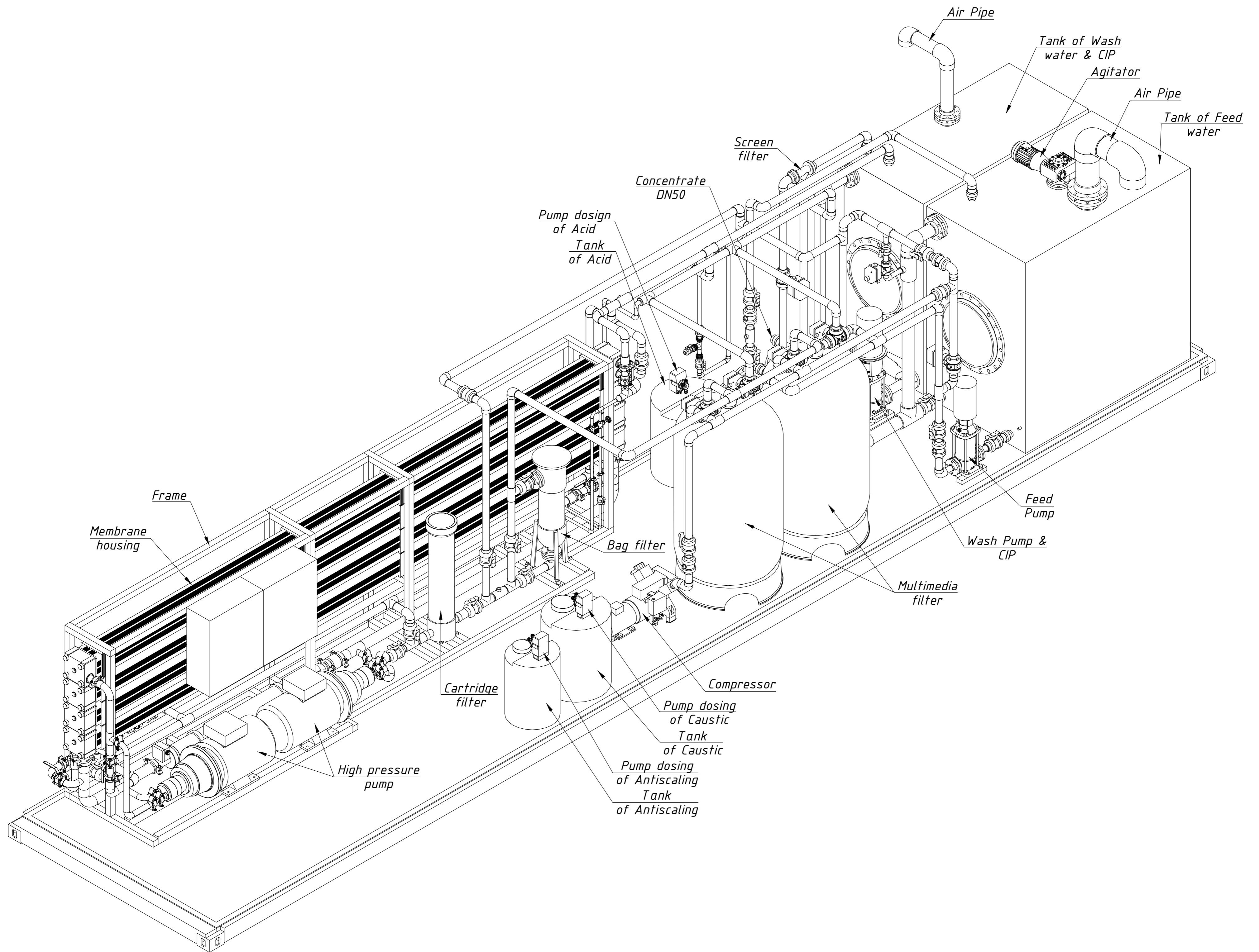
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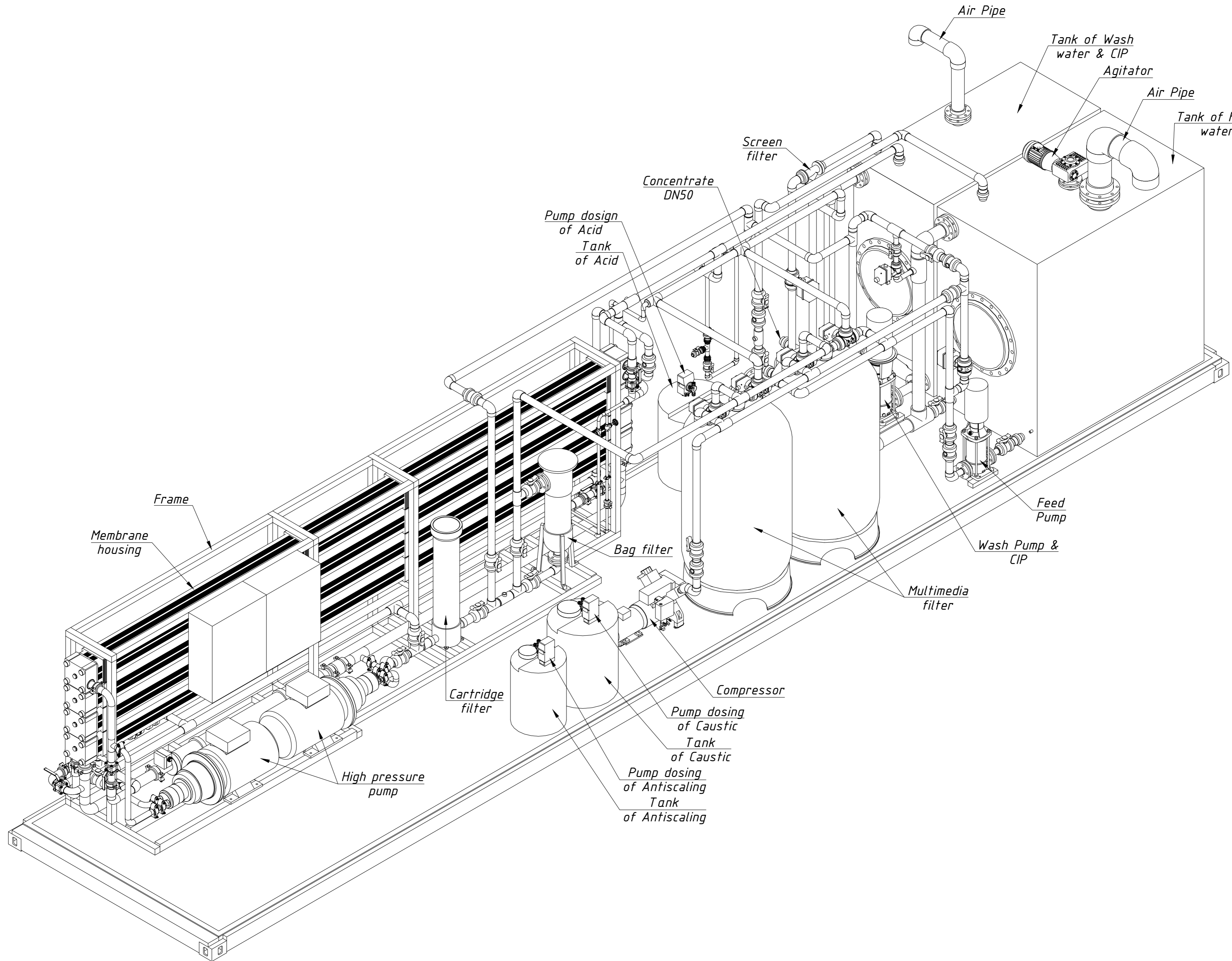
Ventilator

Container

*Air
Condition*







Air Pipe

Tank of Wash water & CIP

Agitator

Air Pipe

Tank of Feed water

Screen filter

Concentrate DN50

Pump dosing of Acid Tank of Acid

Frame

Membrane housing

Feed Pump

Wash Pump & CIP

Bag filter

Multimedia filter

Cartridge filter

Compressor

Pump dosing of Caustic Tank of Caustic

Pump dosing of Antiscaling Tank of Antiscaling

High pressure pump