LG Chem

LG Water Solutions

Technical Service Bulletin

QuantumPure™

Pressurized UF Membranes

LG Water Solutions

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Technical Service Bulletin

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Receipt of Modules, Short-Term Storage, and Disposal of Used Module

Receiving Inspection

After a shipment arrives, conduct a visual inspection of all packages to confirm that:

1. Shipment arrived without damage to the packaging or its contents.
2. All packages listed on the packing list arrived in good order.

⚠ **CAUTION: To avoid damage to the UF module, the UF module should not be subjected to impact, drops and excessive vibration.**

⚠ **CAUTION: Take caution when opening the shipping container. Do not damage the membrane with the tools used to open the box.**

⚠ **CAUTION: Two people are recommended to lift the UF module at all times**

UF membrane modules are shipped in wooden crates with Styrofoam end protectors. LG Chem strongly recommends inspecting the product for any visible damage or defects immediately upon receipt. If any issues are encountered, please contact an LG Chem Customer Service representative before accepting the delivery to ensure that your rights are protected. In such cases, LG Chem will promptly identify possible causes of the damage and determine whether it occurred during transit.

Please notify your carrier or freight forwarder and a LG Chem Customer Service Representative IMMEDIATELY of any damaged merchandise or product shortages.

Storage

Before use, the module(s) should be stored, in their original packing, in an area between 5-40˚C (41-104˚F), with good ventilation, no direct sunlight, and no corrosive substances.

Allowing the module to freeze by reaching temperatures below 0˚C (32˚F), may cause serious damage to the membrane.

After factory performance testing, membranes are preserved in a protective solution. This prevents damage to the membrane, along with bacterial growth. Do not discharge the protective solution until you are ready to install the module.

LG Chem UF modules should NOT be stored in areas exposed to direct sunlight.

LG Chem UF modules should NOT be stored in areas where damage can occur from moving equipment such as forklifts and pallet jacks.

For long-term storage (greater than 60 days), periodically re-inspect the shipping containers to ensure that there is no physical damage or leakage. Any leakage may indicate a loss of integrity of the membrane preservative.

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Receipt of Modules, Short-Term Storage, and Disposal of Used Module

Disposal of Used Module

Used LG Chem UF membrane modules should be disposed of in accordance with all local and federal regulations. Used module can be disposed of as municipal waste provided that no preservation solution or other hazardous liquids remaining within the module and no deposition of hazardous substances on the membranes at concentrations exceeding regulatory standards.

If the user wants to recycle the module, the material components by %age weight of a new module can be found below:

Material	% by Weight[1)]
Nitrile Rubber	0
ABS (Acrylonitrile-Butadiene-Styrene)	0.5–30
UPVC (Unplasticized Polyvinyl Chloride)	20–65
PVDF (Polyvinylidene Fluoride)	20–40
Epoxy (2Part)	2–6
Polyurethane	2–6
Silica Gel	0
Stainless Steel	4–8
EPDM (ethylene propylene diene monomer) Rubber	0.1– 0.5

[1)] Refers to weight of a new module

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UF System Start-Up Consideration and Checklist

Successful UF system performance, both short term and long term, depends on handling, operation, and maintenance in accordance with all published guidelines and limits. Specific guidelines and limits can be found in:

- Performance Projection Software
- Product Data sheet
- Standard and Custom Warranties
- Technical Service Bulletins

Please refer to all appropriate documents to become familiar with the guidelines and limits for a specific project. As an UF module supplier, LG Chem's scope of supply and liability is limited. The considerations and items presented below are intended as a general reference and are not to be considered all-inclusive for any specific project.

Feedwater Source

- Ensure the feed water quality is satisfactory & within design expectations.
- Intake or well flows are able to provide continuous design feed flow to all UF units.
- Chemical tanks are filled with proper chemicals.
- Chemical injection points are properly located.
- Chemical suction and discharged piping are installed as designed.
- Provisions exist for proper chemical mixing and draw-down measurement.

Instrumentation, Sampling, and Monitoring

Each UF train requiring monitoring and performance tracking contains, as a minimum, provision for reporting:

- Feed water flow rate (m^3/h) (gpm).
- Feed water pressure (kPa) (psi)
- Feed water temperature (°C) (°F)
- Filtrate pressure (kPa) (psi)
- Filtrate flow rate (m^3/h) (gpm)
- Feed water turbidity (NTU)
- Product water turbidity (NTU)

Ensure that:

- Instruments are properly located and installed.
- Instruments are calibrated to the manufacturer's specifications.
- SCADA (Supervisory Control and Data Acquisition) if provided is functioning and available for retrieval of historic operating data.
- Data collection routine for startup and long-term operation has been established.
- Data acquisition and analysis routine has been established.
- Arrangements have been made to use LG Chem's data acquisition program or direct transmission of data (in spreadsheet form) to LG Chem for review.
- Sample valves are located in the feed, filtrate, and concentrate piping of each UF train to be monitored
- Transparent tubing/piping should be installed on filtrate side of each module for visual inspection.

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UF System Start-Up Consideration and Checklist

Pre-startup Checklist

Before loading modules on the skid(s), confirm that the system is ready for commissioning and subsequent operation.

- The piping system is ready and clean
  Flush system piping repeatedly to ensure the pipes are free of debris.
- The feed water quality is satisfactory, within design expectations.
- All valves are in the closed status and work properly.
  Cycle all valves from the control system.
  Check and adjust opening and closing timing, as needed.
  The maximum module pressurization/depressurization rate is 0.25 bar (4 psi)/second.
- All equipment is in standby status and works properly.
  Cycle all equipment on and off from the control system.
  Check and adjust pump and blower ramp-up and ramp-down times, as needed.
  The maximum module pressurization/depressurization rate is 0.25 bar (4 psi)/second.
- CIP and drain system are ready.
- Auto control system is ready.
- The electric system is complete.
- Pretreatment processes and associated equipment, especially coarse and fine screening, is installed and working properly.

System Integrity Checklist

Before installing modules on the skid(s), a system integrity test should be carried out. This is to ensure that there is no leakage of water or air from the system. After installing the modules, it is more difficult to determine if a decrease in test pressure is due to a system or module integrity issue.

- Fill the system piping with water.
- Once full of water, close valves for the section of the system to be tested.
- Pressurize with air to 1 bar (15 psi).
- Once air pressure is stabilized, turn off the air supply. Note the pressure.
- Check for leaks and decline in the air pressure.
- Repair any leaks.
- Repeat until all leaks are fixed and there is effectively no decline in pressure.

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UF System Start-Up Consideration and Checklist

Prohibited Chemicals

In general, LG Chem UF membrane modules have very high chemical tolerance. However, generally speaking, chemicals commonly known to be incompatible with PVDF, PVC, ABS, polyurethane, and EPDM should be avoided. The following is a non-exhaustive list of chemicals that should not come into contact with the UF modules:

Class	Examples
Non-polar solvents	Pentane, Heptane, Hexane, Toluene, Benzene, Chloroform, Cyclohexane
Slightly polar solvents	Chlorobenzene, Cyclohexanone, Acetaldehyde, etc.
Polar aprotic solvents	Acetone, Acetonitrile, Dimethylformamide (DMF), Dimethylacetamide (DMAC), Dimethyl sulfoxide (DMSO), N methyl-2-Pyrolidone (NMP), Methyl ethyl ketone (MEK), Methyl Butyl Ketone (MBK), Methyl Isobutyl Ketone, Methyl Acetone etc.
Alcohols	High concentrations (E.g. >50%) of Methanol, Ethanol, Diacetone alcohol
Paint Thinners	Turpentine, Naphtha, Kerosene, Xylene, etc.
Ethers	Diethyl ether, Tetrahydrofuran, Isopropyl Ether, etc.
Esters	Ethyl acetate, Butyl acetate, Isopropyl Acetate, Cellulose acetate, Ethyl Benzoate etc.
Selected Strong Alkalis	50% NaOH
Chlorinated Compounds	Chlorinated solvents
Selected Acids	Chlorosulfonic Acid, Phosphoric Acid (molten and anhydride)

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Installation of UF Modules

Installation guidelines provide recommendations to ensure proper and safe installation of LG Chem UF membrane modules.

Drain Protective Solution

WARNING: The protective solution can cause serious eye irritation. Wear protective gloves, appropriate skin protection, and eye protection when handling. IF IN EYES: Rinse cautiously with water for several minutes

CAUTION: The protective solution can corrode metals. Should the metal pipes or skids come into contact with the protective solution, water should be used to clean the affected area immediately to prevent corrosion. Protective solution should be discharged according to your local requirements.

CAUTION: After removing the protective solution, module installation should be completed as soon as possible to prevent the membrane fibers from drying out. Once the membrane fibers become dry, the filtration performance of the module may deteriorate or even be totally lost.

CAUTION: Use two people when handling 6” and 7” modules. Use a forklift, or other lifting device, when handling 9” and 10” modules.

Prior to installing the UF module, the protective solution must be removed. To remove the protective solution, follow the below steps:

1. Move the module near a drain.
2. Stand the module up vertically with the feed/discharge port facing down. Secure the module with straps to prevent from falling over.
3. Remove the sealing caps from the feed/discharge and concentrate ports.
4. For the 6” modules – DN32 female threaded plastic cap.
5. For the 7” modules – DN40 and DN50 rubber caps slid over the grooved end ports.
6. For the 9” & 10” modules – DN50 rubber caps slid over the grooved end ports.
7. Allow the protective solution to pour out of the module for 1-2 minutes.
8. Immediately proceed to install the module on the skid.

Module installation should be conducted immediately after draining the protective solution.

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Installation of UF Modules

Installing the UF Module on the Skid

CAUTION: Before connection, clean the skid piping thoroughly by flushing with water. Ensure that there are no foreign particles, such as metal or plastic scraps from construction, or sand, inside the piping

CAUTION: Use two people when handling 6” and 7” modules. Use a forklift, or other lifting device, when handling 9” and 10” modules.

Note

Pay attention to the marks on the ports of the module. The concentrate port must be connected to the upper end of the skid, and the other end labelled with “feed port” must be connected to the lower end of the skid. Do not connect the module upside down, this will cause damage to the module.

CAUTION: Minimize time between draining the protective solution and installing on skid. Once the membrane fibers become dry, the filtration performance of the module may deteriorate or even be totally lost.

Module installation should be conducted immediately after draining the protective solution.

1. Ensure that connections ports on the skid are well aligned with skid piping connections.
2. Ensure all sealing caps are removed.
3. Place the module on the skid with the feed/discharge port side down.
4. Connect each port to the skid piping.
5. Refer to Table 1 for 6” module connection types.
6. Refer to Table 2 for 9” and 10” module connection types.
7. A section of transparent pipe is recommended to be installed on the concentrate piping for each module. This will facilitate identification of compromised modules during integrity testing.
8. When connecting to the individual module piping to the header, a grooved end style connection is recommended
9. Figure 1 shows an example of individual piping connection to the skid.
10. Installation of all modules on the same skid should be completed in < 8 hours. After installation of all modules on the same skid, fill the skid with water as soon as possible.

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Installation of UF Modules

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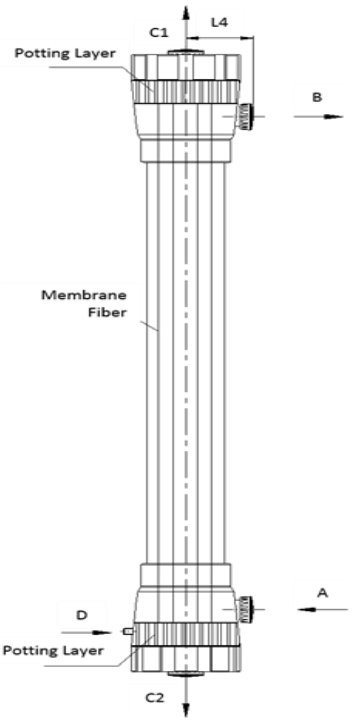

	P0615-S / P0620-S	P0615-D / P0620-D
A	Not Used	Feed/Discharge Port – DN32 Female Socket
B	Concentrate Port – DN32 Female Socket	Concentrate Port – DN32 Female Socket
C1	Permeate Port – DN32 Female Socket	Permeate Port – DN32 Female Socket
C2	Feed/Air Inlet/ Discharge Port – DN32 Female Socket	Permeate Port – DN32 Female Socket
D	N/A	Air Inlet Port – Φ12/9.5 Press Fitting

Table 1: 6” Module Connection information

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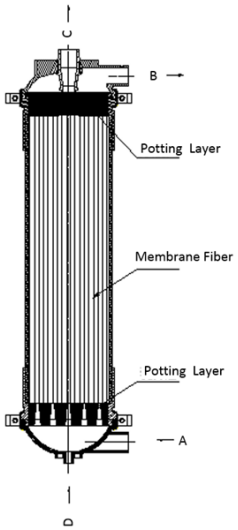
Installation of UF Modules



	P1010-S / P1015-S / P1020-S
A	Influent / Discharge Port – DN50 / 2” Grooved End (Victaulic Style)
B	Permeate Port – DN50 / 2” Grooved End (Victaulic Style)
C	Concentrate Port – DN50 / 2” Grooved End (Victaulic Style)
D	Air Inlet Port – Ø 25/19 Hose Barb

Table 2: 10" Module Connection Information

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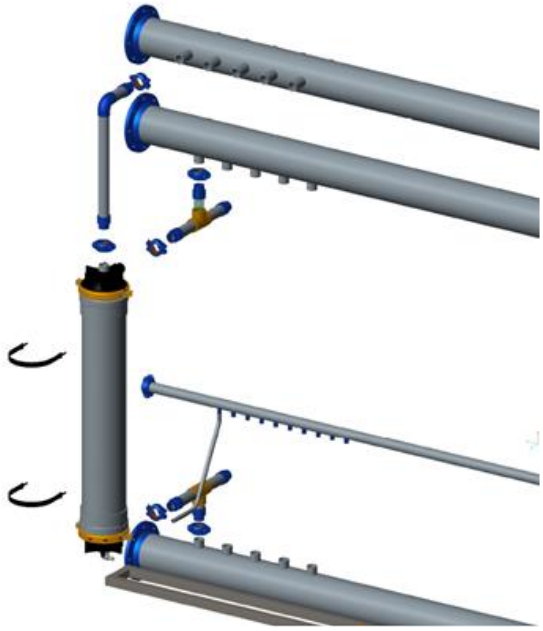
Installation of UF Modules



Note

This diagram is an example and does not apply to all module types.

Materials Required

- Eye protection
- Safety Shoes
- Protective gloves, (for jobs with post startup bacteria testing of UF filtrate, use sterile, powder free exam gloves)
- Other safety equipment and clothing as required by jobsite regulations
- Critical spare parts and pipe fittings that might break during unloading and loading process

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UF System Start-up / Operating Procedures

UF system commissioning should not occur until the plant is ready to start normal operations. If not, it is better to leave the UF modules in their shipping containers, stored according to TSB 601. Once the plant is ready to start normal operations, proceed in the following order:

1. Conduct pre-startup checks
2. System Integrity Test
3. Install UF modules on skid(s)
4. Perform start-up cleaning and module flush
5. Initial Flow Test
6. Integrity Test
7. Operating Sequence Test
8. Switch to auto mode

Startup Cleaning and Module Flush

Any remaining protective solution must be flushed before the system is started. If the system is shut down for a prolonged period, please refer to the module storage information in TSB 601.

1. Open the filtrate valve and concentrate valve
2. Open the feed valve
3. Start the feed pump slowly to get a low feed pressure, less than 0.1 MPa (14.5 psi)
4. Continue running clean water through the UF modules until there is no foam in the discharge water
5. Ensure the filtrate water meets the required quality

Initial Flow/Permeability Test

To confirm that the module(s) and skid(s) permeability are within expected range, an Initial Flow/Permeability Test should be conducted, according to the following steps. This process will also allow the flux to stabilize. Observation of the flow rate and Transmembrane Pressure(TMP) will provide a useful reference point/baseline for long term operations.

Note

Control the valve opening and closing speed, such that the pressure increases no faster than 0.25 bar/second (~4 psi/second).

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UF System Start-up / Operating Procedures

1. Open top drain valve and feed valve.
2. Start feed pump.
   When starting filtration, residual air may be present in the UF modules, and skid. To prevent any damage to the membrane fibers due to water hammer, keep the feed and concentrate valves open while filling the UF modules with feed water until all accumulated air is vented thoroughly through the concentrate port.
3. With the top drain valve open, slowly open the filtrate valve.
4. Once the filtrate valve is fully open, close the top drain valve.
5. Set the filtrate flow to 30% of the designed capacity.
   Record the filtrate flow rate, feed pressure, filtrate pressure, concentrate pressure and water temperature.
6. Increase the filtrate flow rate by 10% approximately every 4 to 6 hours until the designed value is reached.
   Record the filtrate flow rate, feed pressure, filtrate pressure, concentrate pressure and water temperature at each step

Integrity Test

An integrity test with the modules installed should be conducted prior to starting normal operations. This test will identify any modules with bad connections or compromised fibers. It is not uncommon to find some modules with leaks at the connections to the skid or broken fibers. Please follow the procedure explained in TSB 606.

Control Sequence Test

Prior to starting normal operations, all automatic sequences (Filtration, Air Scour, Maintenance Clean, Recovery Clean, Integrity Test) need to be tested in auto mode to ensure that the pumps, blowers, and valves are operating at the correct time. Use the sequence tables in Table 2 to confirm the control sequence is correct. Please also refer to your project specific design calculation control sequence tables.

Adjust Operating Setpoints.

Note
Feed water pressure should be less than 0.3 MPa (43.5 psi) during this adjustment.

Prior to switching to automatic operation, setpoints for key operating parameters should be made and verified. LG Chem suggests that the operating parameters in the following table are adjustable.

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UF System Start-up / Operating Procedures

Item	Description
1	Feed flow rate
2	Filtrate flow rate
3	Concentrate flow rate
4	Air scouring flow rate
5	Filtrate cycle time
6	Drain time
7	Fill time
8	MC interval
9	MC chemical dosing time
10	MC chemical soaking time
11	MC and RC drain time
12	RC interval
13	RC chemical dosing time
14	RC chemical soaking 1 time
15	RC chemical air scour time
16	RC chemical "top-off" time
17	RC chemical soaking 2 time

Table 1: Adjustable Operating Parameter Table

The initial set point for these parameters should be according to the system design recommendations provided by LG Chem. Adjustments will likely be made over time depending on the actual feed water quality and the observed system performance.

Many parameters can only be optimized on site. Use the following procedures to adjust these parameters to site specific conditions:

1. Concentrate flow rate adjustment – Open the auto concentrate valve and open the manual regulating valve slowly until the flow rate recommended by LG Chem is obtained. Most systems are operated in dead-end mode, meaning the concentrate flow rate is zero.

2. Air scour flow rate adjustment – Open the auto air scouring valve. Turn on the blower. If using a positive displacement

blower, adjust the blower speed slowly until the flow rate reaches the designed value. If using another type of blower, slowly adjust the manual regulating valve until the flow rate reaches the designed value.

1) Air flow rate per 10” module is 15 m³/h (9 cfm).
2) Air flow rate per 6” module is 5 m³/h (3 cfm).

3. Fill time adjustment - The fill time should be set on site by observing how long it takes for the skid to fill. This is critical to minimize water wastage and maximize recovery.
4. Drain time adjustment – The drain time should be set on site by observing how long it takes for the skid to be completely empty. This is critical to ensure foulants have been removed from the skids before refilling.
   Chemical dosing rate –
   1) Turn on the chemical cleaning pump. Measure the water flow rate. Turn off the chemical cleaning pump.
   2) Calculate the required chemical dosing rate to achieve the desired chemical concentration.
   3) Set the chemical dosing pump accordingly.
   4) Turn on the chemical cleaning pump and the chemical dosing pump.
   5) Take a sample of the chemical cleaning solution at the modules. Measure the concentration (for chlorine cleans) or pH (for caustic and acidic cleans).
   6) Adjust the chemical dosing rate up or down to achieve the desired target.
   7) Repeat d. through f. until the target is met.
5. RC chemical "top-off" time adjustment – During RC air scour, a portion of the water in the skid is displaced by air. Prior to RC soak, the skid should be topped off with chemical solution so that the entire length of membrane fibers will be exposed to chemical. The top-off time should be set by observing the amount of time it takes for chemical solution to start flowing out of the concentrate valve.

When all the parameters are set under manual mode, the system should be switched to auto mode.

Normal Operations

After completing the commissioning process above, normal operations should commence immediately. If there is a break between commissioning and normal operations, follow the instructions in TSB 601.

LG Chem suggests the control system to be capable of being operated in Manual or Auto mode. In each mode, there are six working conditions. The working conditions are as follows:

- Standby - All the equipment and valves are closed. When power is on, the system will be in stand by condition.
- Filtration – The system is filtering water.
- Air scour – The filtration process is stopped, and the air scour process is started.
- Maintenance cleaning - The filtration process is stopped, and the maintenance cleaning process is started.
- Recovery cleaning - The filtration process is stopped, and the recovery cleaning process is started.
- Integrity testing - The filtration process is stopped, and the integrity testing process is started.

When the power is off, the system will be shut down. All the equipment and valves will be in the stop or closed state.

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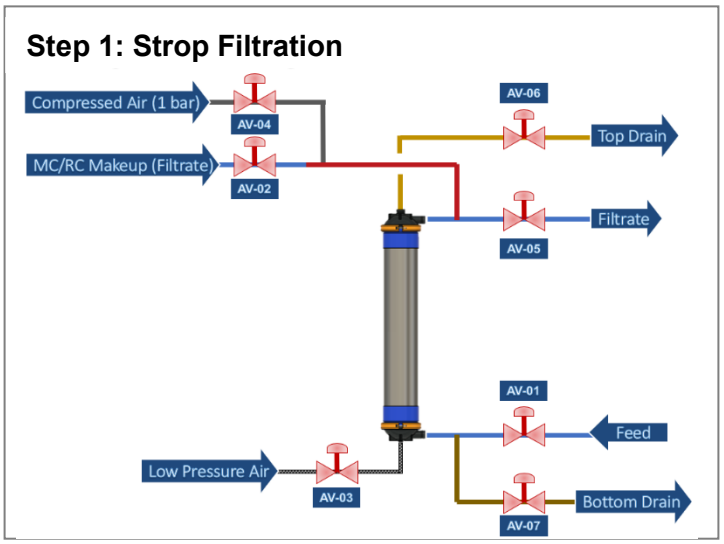
UF System Start-up / Operating Procedures

Filtration Mode

Most systems using LG Chem UF membrane modules are designed to operate in dead end mode. In dead end mode, all feed water is converted to filtrate water. During dead end filtration, the feed water valve (AV-01), the filtrate valve (AV-05), and the feed pump (P-1) are all on. In certain situations, where the solids concentration in the feed water is high, a small concentrate bleed (5-10% of the feed flow rate) will be utilized to control the solids accumulations rate in the modules. During filtration, suspended solids are deposited on the membrane surface. The filtration cycle duration is usually based on a set time interval but may also be set by meeting a certain processing volume.



Operating Pressures

- Feed water pressure: The maximum pressure for the UF module is 0.3 MPa (43.5 psi).
- TMP: The maximum TMP is 0.15 MPa (22 psi).

Air Scour Mode

To remove the suspended solids accumulated during filtration, the system should automatically go into the air scouring process after completion of the set filtration cycle time. During air scour, air is pumped by the blower (B-1) to the bottom of the UF modules while the air scour valve (AV-03) and top drain valve (AV-06) are open. Hollow fibers swing and vibrate in rising air bubbles and the contaminants are stripped away from membrane surfaces, as a result of the frictional impact from the fiber movements and shearing from localized eddies formed around rising bubbles. Air scour pressure is equal to the water head above the bottom of the UF modules plus some minor losses in the module and piping losses.

Note

Make sure the module(s) are full of water throughout the air scour step to gain maximum cleaning effect.

After reaching the preset air scour time, the skid should be drained by closing the concentrate valve and opening the drain valve (AV-07). The air scour valve (AV-03) should remain open while the skid is drained. This will keep solids in suspension and expedite the drain pressure slightly.

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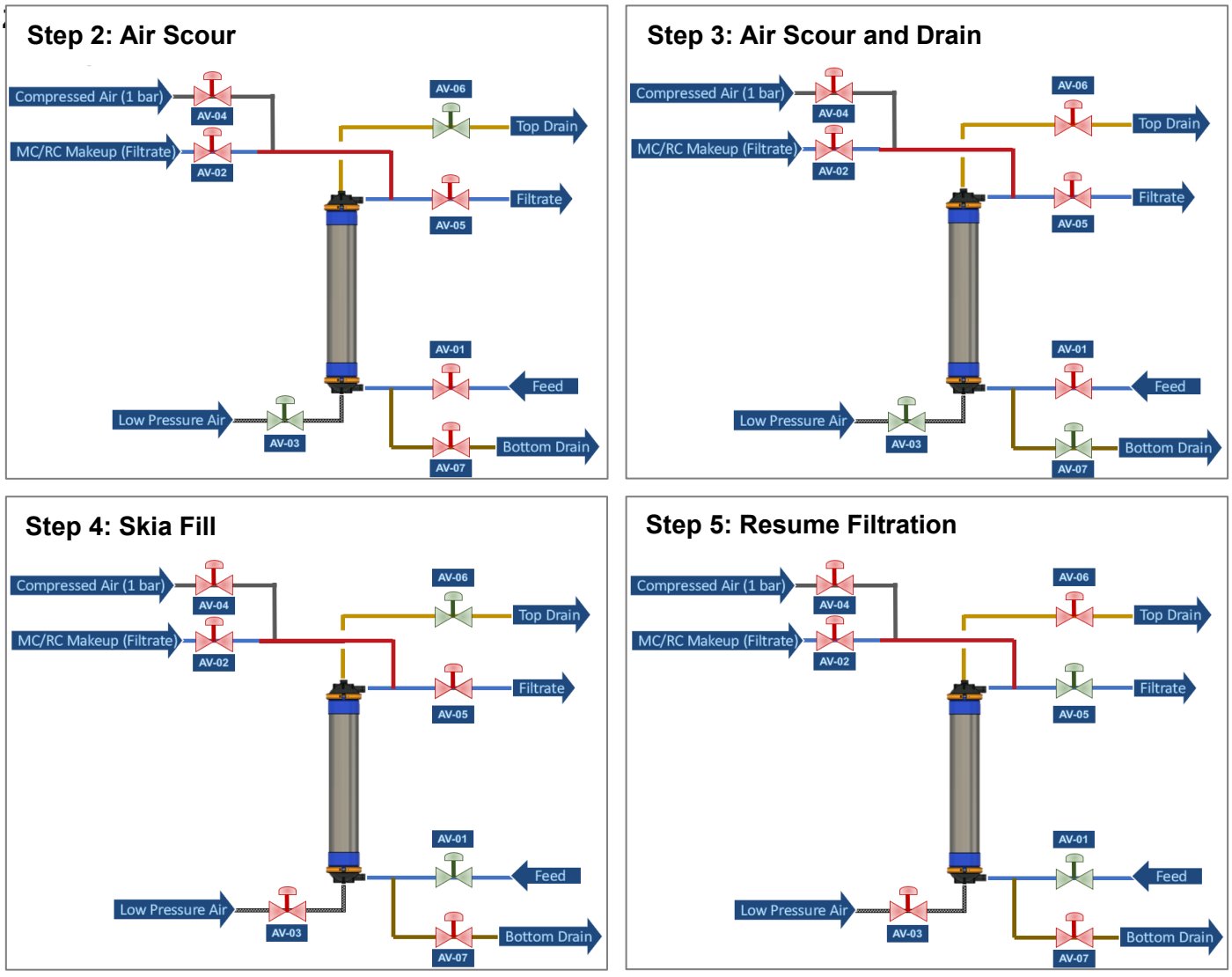
Note

Make sure the module(s) are completely drained. Failure to do so will result in accelerated fouling of the UF module.

Note

The air scouring pressure should be less than 0.05 MPa (7.3 psi).

Once the skid is empty, turn off the air scour valve (AV-03) and the drain valve (AV-07). Open the feed valve (AV-01) and top drain valve (AV-06). Slowly start the feed pump (AV-01). Once the skid is full of water, and all air has been evacuated, open the filtrate valve (AV-05) and close the top drain valve (AV-06).



Full details of the air scour sequence can be found in Table 2.

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Air Scour: 1 Sequence

				Valve Position									Pump Status			
Step	Step Description	Typical Step Duration (s)	Typical Cumulative Sequence Duration (s)	Feed (AV-01)	Filtrate (AV-05)	Top Drain (AV-06)	Drain (AV-07)	Air Scour (AV-03)	Filtrate to Drain (AV-08)	Air for MIT (AV-04)	MC/RC Feed (AV-02)	Chemical Injection	Feed Pump (P-1)	MC/RC Pump (P-2)	Air Blower (B-1)	Chemcal Dosing Pump (DP-1/2/3)
1	Stop Filtration	0		O	O	X	X	X	X	X	X	X	R	S	S	S
	Step Transition - Feed pump speed adjustment	10	10	O	O	X	X	X	X	X	X	X	R → S	S	S	S
	Step Transition - Valve positioning and blower speed adjustment	5	15	O → X	O → X	X → O	X	X → O	X	X	X	X	S	S	S → R	S
2	Air Scour	60	75	X	X	O	X	O	X	X	X	X	S	S	R	S
	Step Transition - Valve positioning	5	80	X	X	O → X	X → O	O	X	X	X	X	S	S	R	S
3	Air Scour and Drain	80	160	X	X	X	O	O	O	X	X	X	S	S	R	S
	Step Transition - Valve positioning and blower speed adjustment	5	165	X → O	X	X → O	O → X	O → X	X	X	X	X	S	S	R → S	S
	Step Transition - RC pump and chemical pump speed adjustmen	10	175	O	X	O	X	X	X	X	X	X	S	S → R	S	S → R
7	Skid Fill	30	205	X	X	O	X	X	X	X	X	X	S	R	S	R
	Step Transition - Valve positioning	5	210	X	X → O	O → X	X	X	X	X	X	X	R	S	S	S
14	Resume Filtration	0	210	O	O	X	X	X	X	X	X	X	R	S	S	S
	Sequence duration (s)		210	Notes: O = Open valve X = Closed valve									R = Run pump S = Stop pump			
	Sequence duration (min)		3.5													

Table 2: Control Sequence Table – Air Sour

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Air scouring will remove most fouling from the membranes, but not all. Over time, fouling will accumulate. Chemical cleanings are used to remove fouling that is not removed by air scouring. Chemicals should be selected based on the type of foulants present. The chemicals used should not damage the UF module or create secondary pollution. LG Chem utilizes two types of chemical cleaning to recover membrane performance.

⚠ **DANGER:** If sodium hypochlorite and acid are mixed, poisonous chlorine gas will be formed. The skids should be thoroughly rinsed between chemical cleanings so that the chemicals do not mix.

⚠ **CAUTION**: Maintain cleaning solutions within allowable pH ranges and only use approved chemicals.

Maintenance Clean (MC)

The maintenance clean is a shorter clean designed to maintain the membrane permeability. In general, a chemical solution is pumped into a drained skid from the feed or filtrate side of the membranes, usually the filtrate side. After a set soaking time is reached, low pressure air is used to scour the membrane. After air scouring, the skid is drained and rinsed, before resuming filtration. After maintenance cleaning, the Transmembrane Pressure(TMP) should be at least partially recovered.

Recovery Clean (RC)

The recovery clean is similar to the maintenance clean but uses a higher concentration of the chemical and longer soak times. The recovery clean is designed to recover the membrane permeability to the original value. The steps of the RC are very similar to the MC, but with an extra soaking step. A recovery clean may be triggered by time (every 30-90 days), or when MC fails to restore membrane permeability and the TMP continues to rise a certain amount above the initial value. For example, more than 50KPa (7.3 psi) of the initial value.

Chemical Cleaning Regime Design

The chemical cleaning regime (chemicals, frequencies, durations, and concentrations) should be uniquely selected for each site-specific condition. Contact LG Chem for assistance selecting the cleaning regime for your system. The following table is an indicative guide for various water types with typical quality. Variation from this table due to site-specific water quality is common.

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	Oxidant MC Frequency (# per skid/day)	Basic MC Frequency (# per skid/day)	Acid MC Frequency (# per skid/day)	Oxidant RC Frequency (Days between clean)	Basic RC Frequency (Days between clean)	Acid RC Frequency (Days between clean)
Chemical & Concentration	**200 ppm NaOCl**	**3500 ppm NaOH**	**1500 ppm H_2SO_4**	**500 ppm NaOCl**	**3500 ppm NaOH**	**2000 ppm Citric Acid + 1500 ppm H_2SO_4**
Ground Water	0.5	-	0.14	90	-	90
Seawater	1	-	0.14	60	-	60
Surface Water	1	0.33 [2)]	0.25	60	60 [2)]	60
Municipal WW - Clarifier Effluent	1	1 [2)]	0.14	45	45 [2)]	45
Industrial WW - Treated Effluent	2	1 [2)]	0.25	30	30 [2)]	30

Table 1: Chemical Cleaning Parameters

[1)] Please contact us for the cleaning formulation for special contaminants.
[2)] Only for TIPS products. pH would exceed limits of NIPS products.

Method to Verify the Effectiveness of the Cleaning

Please record the following parameters before and after the cleaning:

1. Feed and filtrate flow rate
2. Feed, concentrate, and filtrate pressure
3. Water temperature

After the cleaning compare the data. If the filtrate flow rate, or TMP could not be recovered it means the cleaning is not effective, please contact our engineer to find a solution for this issue.

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Cleaning Process Procedures

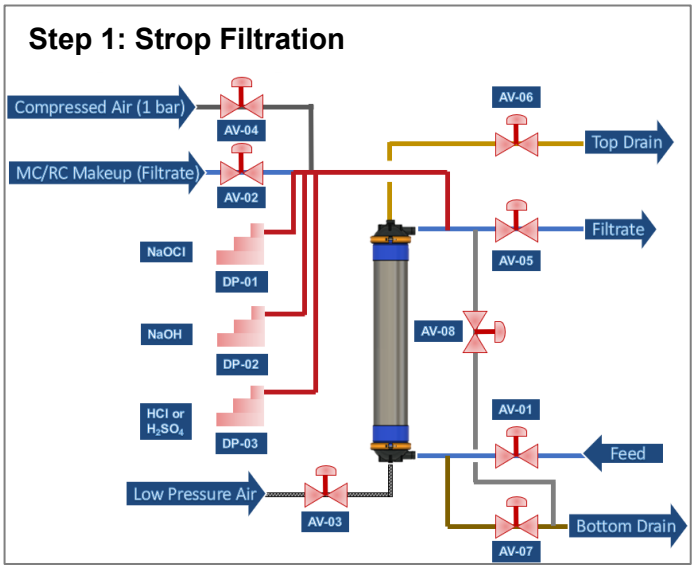
The cleaning process for both maintenance clean and recovery clean have been outlined. On the following pages, you can find step-by-step diagrams and detailed sequence tables.

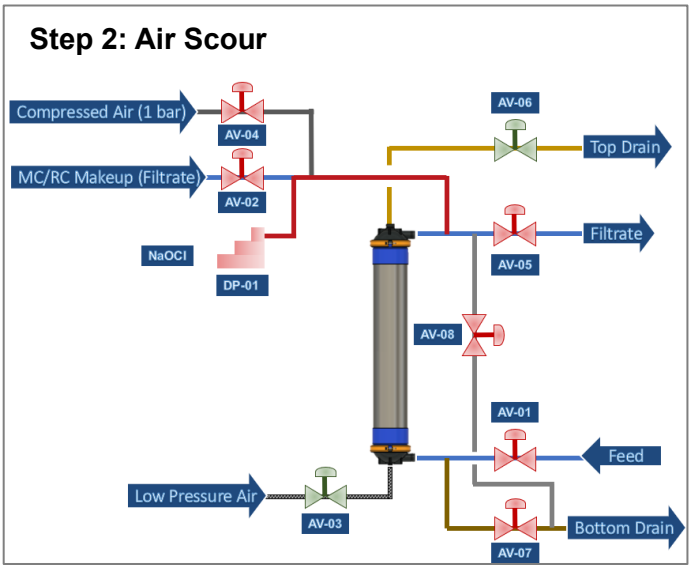
The maintenance clean and recovery clean procedures should be programmed into the control system. Maintenance cleans should occur automatically based on time or number of completed filtration cycles. Recovery Cleans should be manually initiated when an established number of days have passed (commonly, 30 days), or the TMP reaches 1.5 bar (22 psi). The procedure should be repeated for each chemical. Ensure rinsing is complete before introducing a new chemical. Typically, sodium hypochlorite is first, followed by sodium hydroxide. Finally, citric, hydrochloric, or sulfuric acid is used.

⚠ **CAUTION:** Ensure top drain valve is open during chemical soak step

⚠ **CAUTION:** Check for potential exothermic reactions between cleaning solutions and foulants.

Maintenance Cleaning Process Steps





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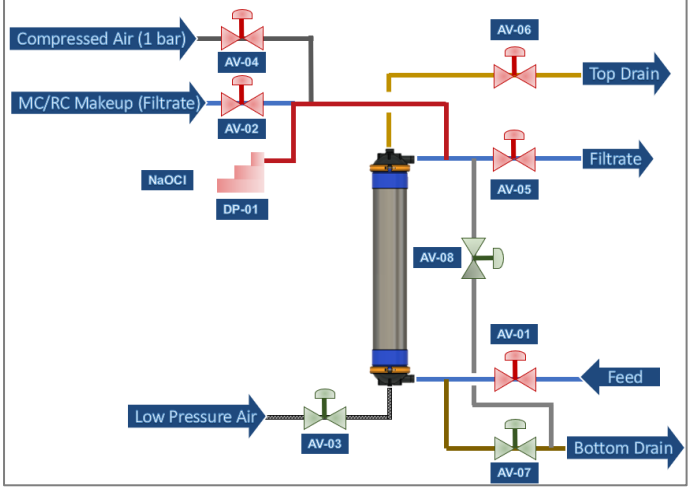
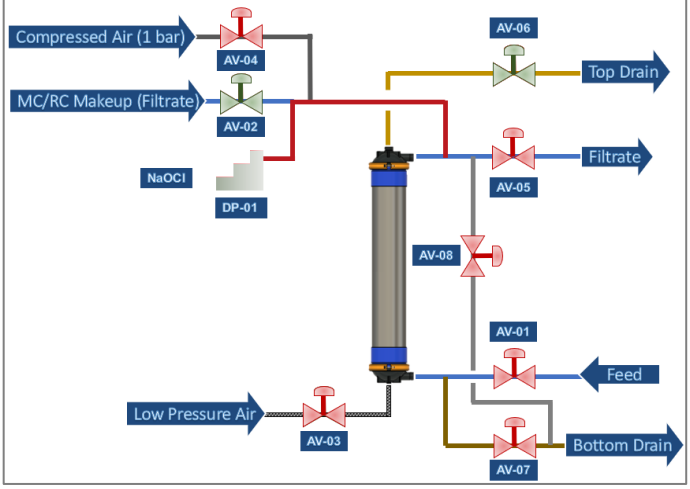
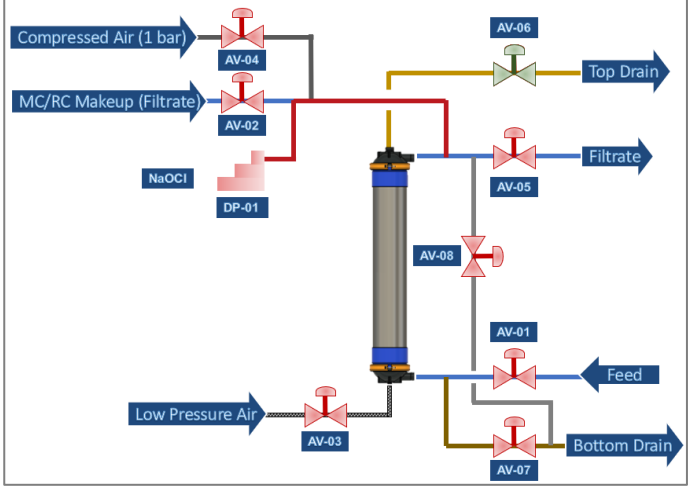
Step 3: Air Scour and Drain



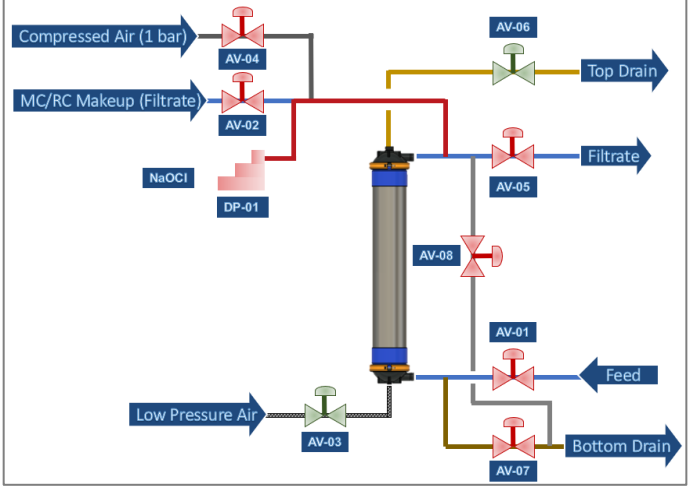
Step 4: Fill with Chemical



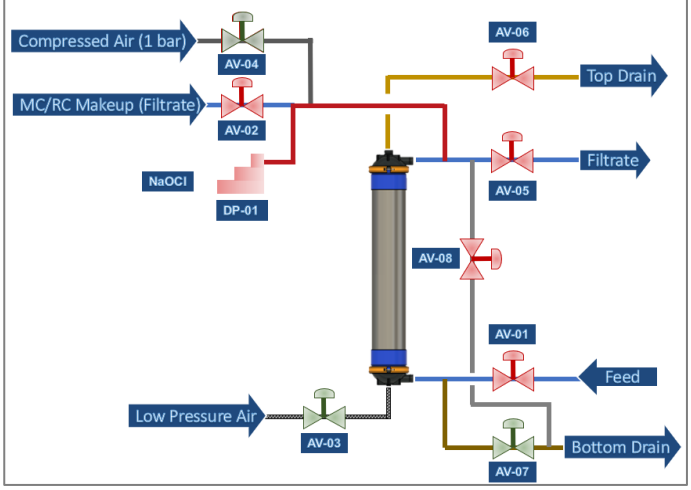
Step 5: Chemical Soak



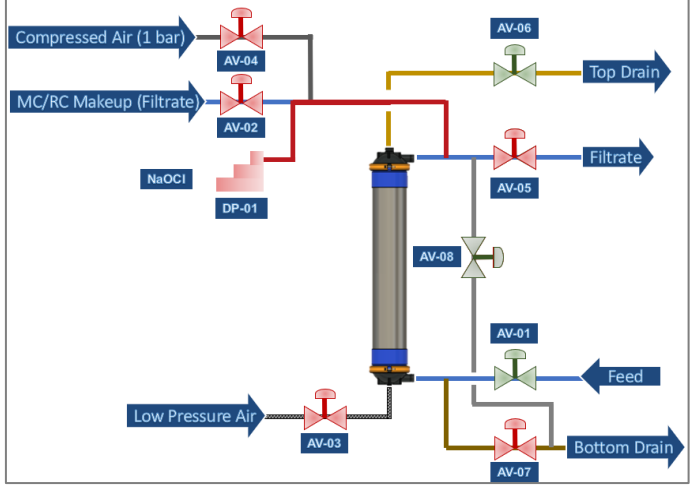
Step 6: Chemical Air Scour



Step 7: Air Scour and Pressurized Drain



Step 8: Refill and Rinse



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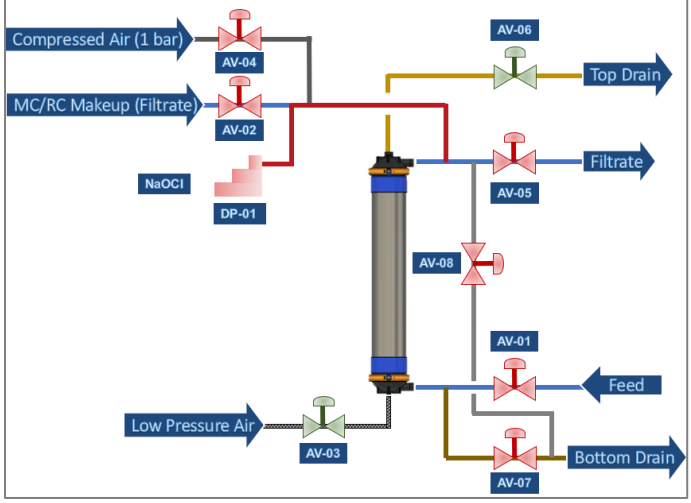
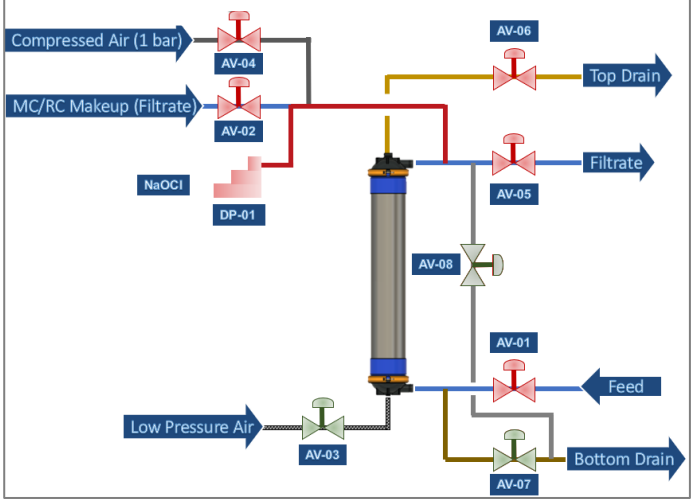
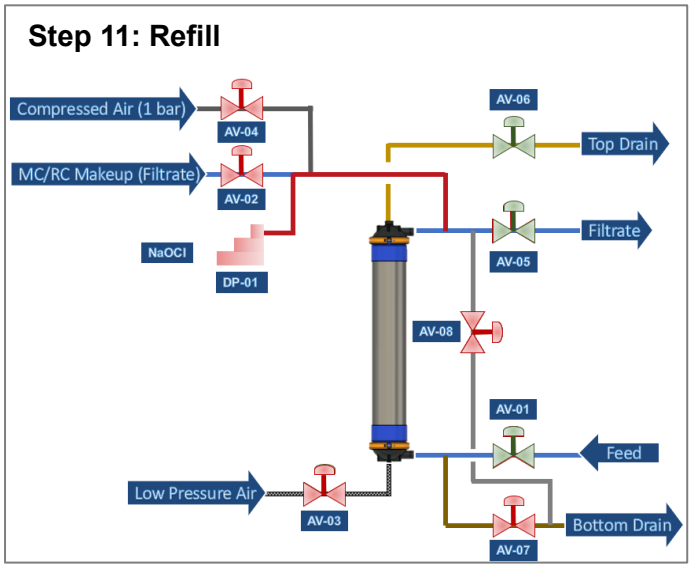
Step 9: Chemical Air Scour



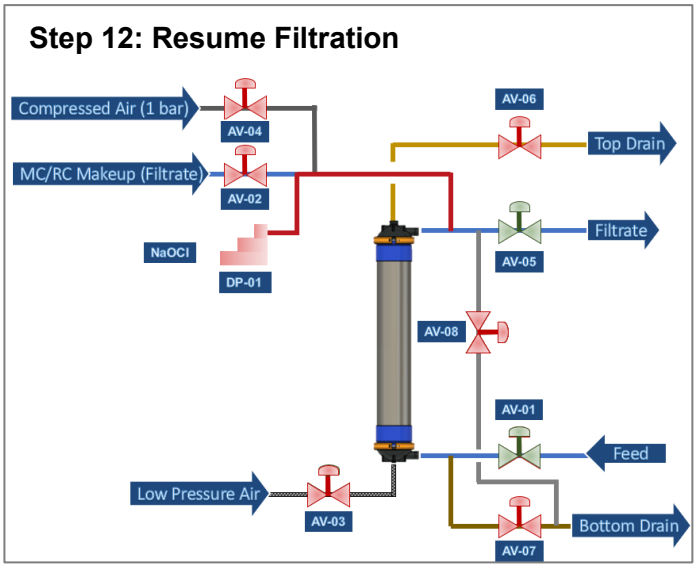
Step 10: Chemical Air Scour Rinse and Drain



Step 11: Refill



Step 12: Resume Filtration



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				Valve Position									Pump Status			
Step Number	Step Description	Typical Step Duration (s)	Typical Cumulative Sequence Duration (s)	Feed (AV-01)	Filtrate (AV-05)	Top Drain (AV-06)	Drain (AV-07)	Air Scour (AV-03)	Filtrate to Drain (AV-08)	Air for MIT (AV-04)	MC/RC Feed (AV-02)	Chemical Injection	Feed Pump (P-1)	MC/RC Pump (P-2)	Air Blower (B-1)	Chemcal Dosing Pump (DP-1/2/3)
1	Stop Filtration	0		O	O	X	X	X	X	X	X	X	R	S	S	S
	Step Transition - Feed pump speed adjustment	10	10	O	O	X	X	X	X	X	X	X	R → S	S	S	S
	Step Transition - Valve positioning and blower speed adjustment	5	15	O → X	O → X	X → O	X	X → O	X	X	X	X	S	S	S → R	S
2	Air Scour	60	75	X	X	O	X	O	X	X	X	X	S	S	R	S
	Step Transition - Valve positioning	5	80	X	X	O → X	X → O	O	X → O	X	X	X	S	S	R	S
3	Air Scour and Drain	60	140	X	X	X	O	O	O	X	X	X	S	S	R	S
	Step Transition - Valve positioning and blower speed adjustment	5	145	X	X	X → O	O → X	O → X	O → X	X	X → O	O → X	S	S	R → S	S
	Step Transition - RC pump and chemical pump speed adjustment	10	155	X	X	O	X	X	X	X	O	O	S	S → R	S	S → R
4	Fill with cleaning solution	60	215	X	X	O	X	X	X	X	O	O	S	R	S	R
	Step Transition - RC pump and chemical pump speed adjustment	10	225	X	X	O	X	X	X	X	O	O	S	R → S	S	R → S
	Step Transition - Valve positioning	5	230	X	X	O	X	X	X	X	O → X	O → X	S	S	S	S
5	Chemical soak	600	830	X	X	O	X	X	X	X	X	X	S	S	S	S
	Step Transition - Valve positioning and blower speed adjustment	5	835	X	X	O	X	X → O	X	X	X	X	S	S	S → R	S
6	Chemical Air Scour	300	1135	X	X	O	X	O	X	X	X	X	S	S	R	S
	Step Transition - Valve positioning	5	1140	X	X	O → X	X → O	O	X	X → O	X	X	S	S	R	S
7	Air Scour and Pressurized Chemical Drain	10	1150	X	X	X	O	O	X	O	X	X	S	S	R	S
	Step Transition - Valve positioning and blower speed adjustment	5	1155	X → O	X	X → O	O → X	O → X	X → O	O → X	X	X	S	S	R → S	S
	Step Transition - Feed pump speed adjustment and valve positioning	10	1165	O	X	O	X	X	O	X	X	X	S → R	S	S	S
8	Refill	30	1195	O	X	O	X	X	O	X	X	X	R	S	S	S
	Step Transition - Valve positioning	5	1200	O	X	O → X	X	X	O	X	X	X	R	S	S → R	S
9	Chem Rinse Air Scour	60	1260	X	X	O	X	O	X	X	X	X	S	S	R	S
	Step Transition - Valve positioning	5	1265	X	X	O → X	X → O	O	X → O	X	X	X	S	S	R	S
10	Chemical Rince Air Scour and Drain	60	1325	X	X	X	O	O	O	X	X	X	S	S	R	S
	Step Transition - Valve positioning and blower speed adjustment	5	1330	X → O	O	X → O	O → X	O → X	O → X	X	X	X → O	S	S	R → S	S
11	Refill	30	1230	O	X	X	X	X	O	X	X	X	R	S	S	S
	Step Transition - Valve positioning	5	1235	O	X → O	X	X	X	O → X	X	X	X	R	S	S	S
	Step Transition - Feed pump speed adjustment	10	1245	O	O	X	X	X	X	X	X	X	R	S	S	S
12	Resume Filtration	0	1245	O	O	X	X	X	X	X	X	X	R	S	S	S
	Sequence duration (s)		1245													
	Sequence duration (min)		21													

Notes: O = Open valve, X = Closed valve, R = Run pump, S = Stop pump

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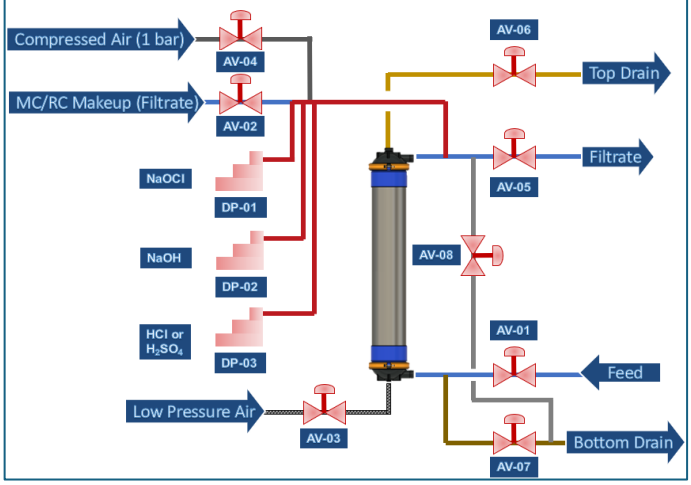
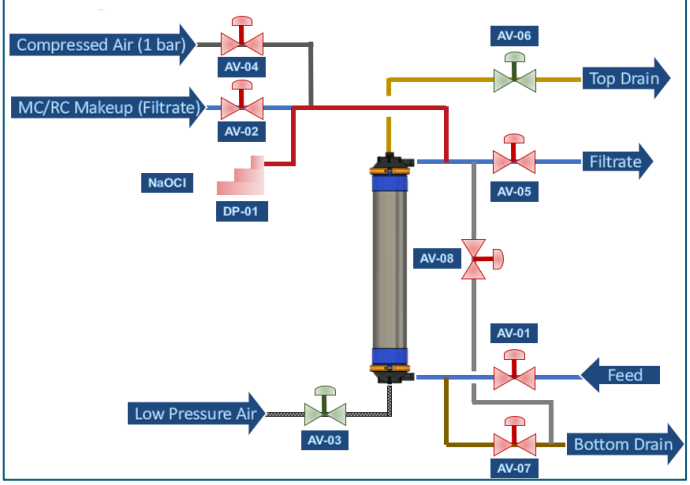
Recovery Cleaning Process

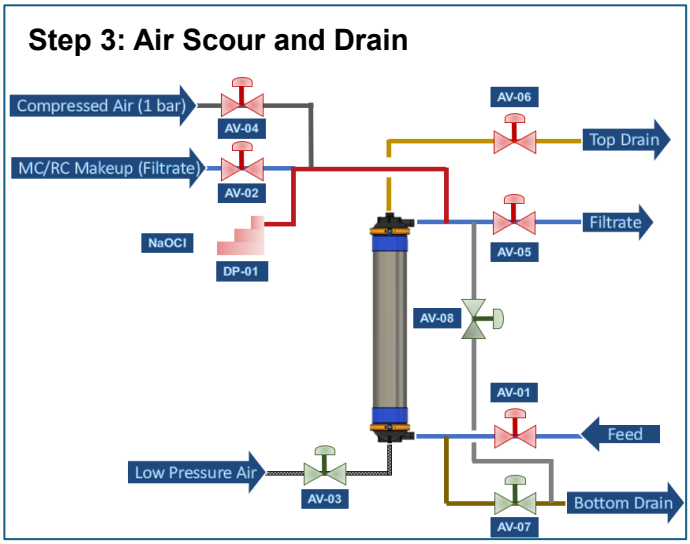
Step 1: Stop Filtration



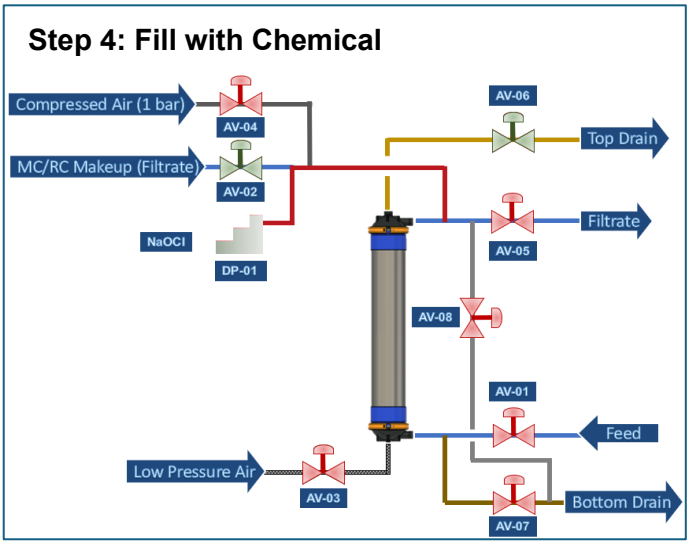
Step 2: Air Scour



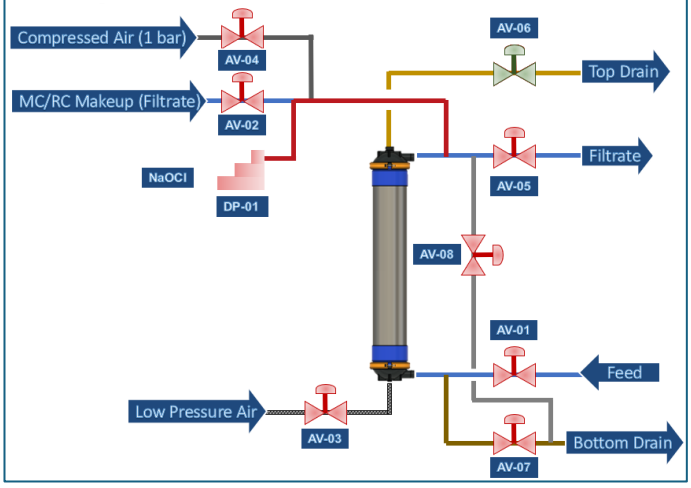
Step 3: Air Scour and Drain



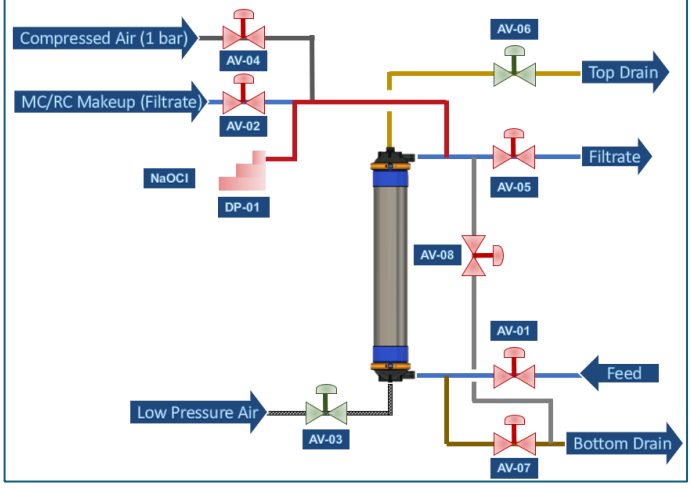
Step 4: Fill with Chemical



Step 5: Chemical Soak



Step 6: Chemical Air Scour



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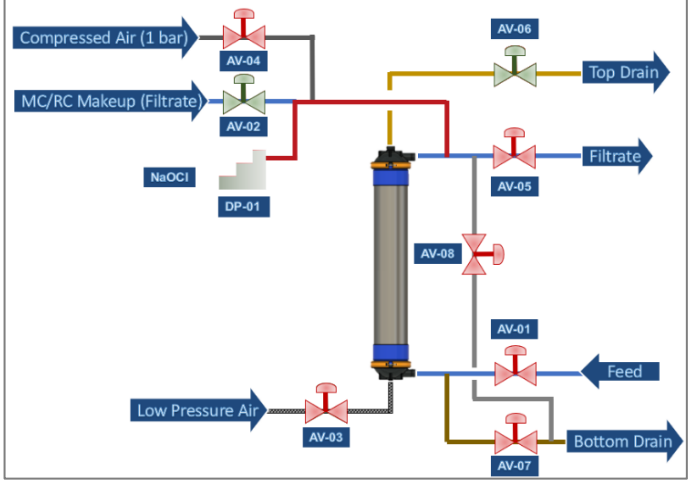
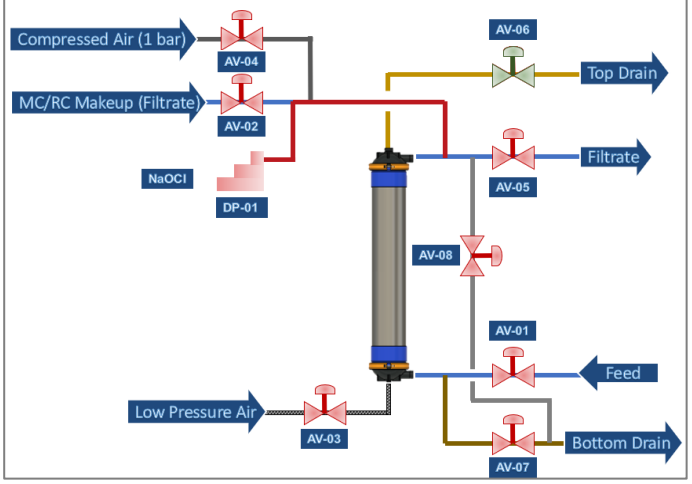
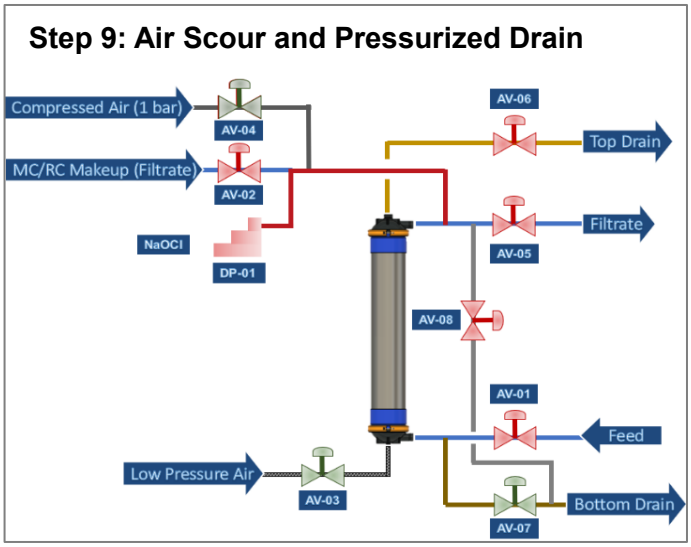
Step 7: Chemical "Top-Off"



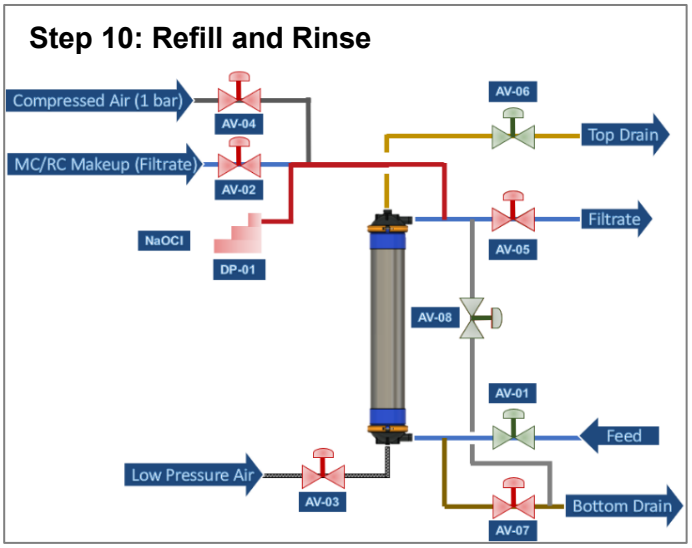
Step 8: Chemical Soak



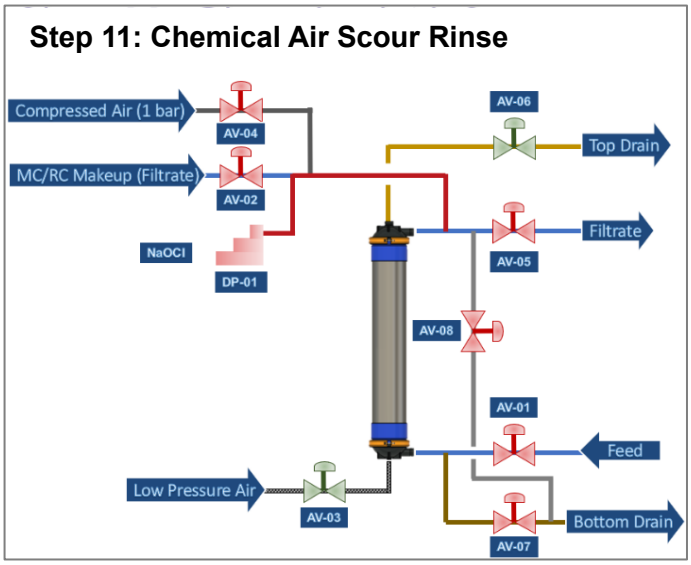
Step 9: Air Scour and Pressurized Drain



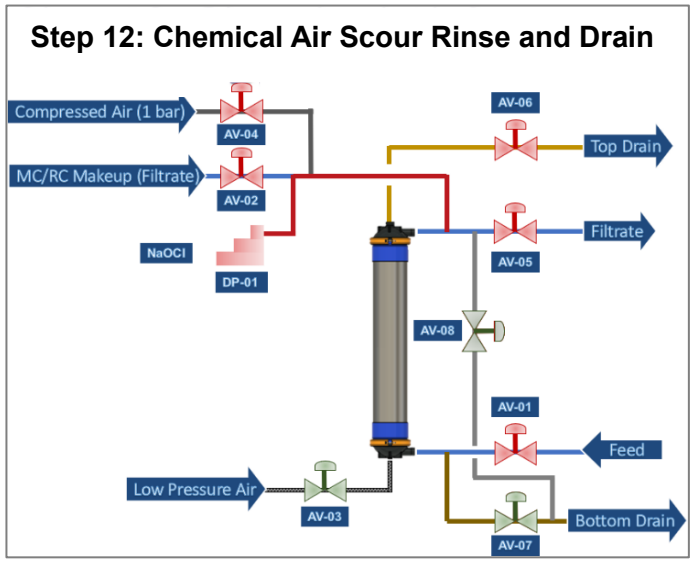
Step 10: Refill and Rinse



Step 11: Chemical Air Scour Rinse



Step 12: Chemical Air Scour Rinse and Drain



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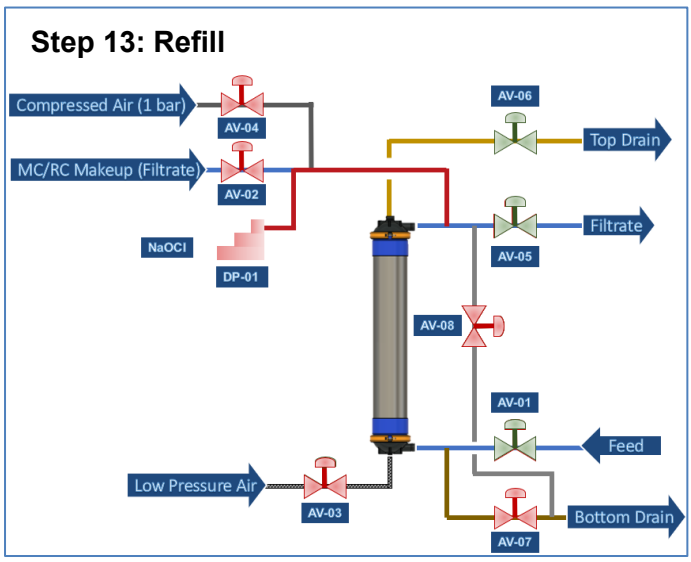

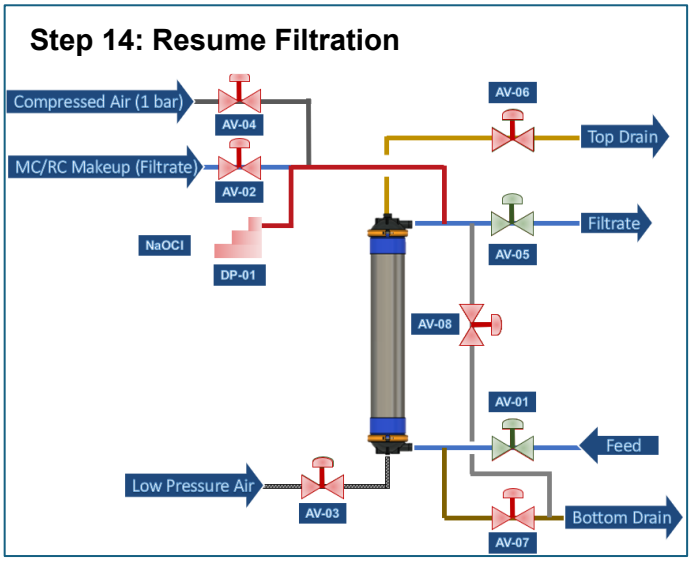

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				Valve Position								Pump Status			
Step Number	Step Description	Typical Step Duration (s)	Typical Cumulative Sequence Duration (s)	Feed (AV-01)	Filtrate (AV-05)	Top Drain (AV-06)	Drain (AV-07)	Air Scour (AV-03)	Filtrate to Drain (AV-08)	Air for MIT (AV-04)	MC/RC Feed (AV-02)	Feed Pump (P-1)	MC/RC Pump (P-2)	Air Blower (B-1)	Chemcal Dosing Pump (DP-1/2/3)
1	Stop Filtration	0		O	O	X	X	X	X	X	X	R	S	S	S
	Step Transition - Feed pump speed adjustment	10	10	O	O	X	X	X	X	X	X	R → S	S	S	S
	Step Transition - Valve positioning and blower speed adjustment	5	15	O → X	O → X	X → O	X	X → O	X	X	X	S	S	S → R	S
2	Air Scour	60	75	X	X	O	X	O	X	X	X	S	S	R	S
	Step Transition - Valve positioning	5	80	X	X	O → X	X → O	O	X → O	X	X	S	S	R	S
3	Air Scour and Drain	60	140	X	X	X	O	O	O	X	X	S	S	R	S
	Step Transition - Valve positioning and blower speed adjustment	5	145	X	X	X → O	O → X	O → X	O → X	X	X → O	S	S	R → S	S
	Step Transition - RC pump and chemical pump speed adjustmen	10	155	X	X	O	X	X	X	X	O	S	S → R	S	S → R
4	Fill with cleaning solution	600	755	X	X	O	X	X	X	X	O	S	R	S	R
	Step Transition - RC pump and chemical pump speed adjustmen	10	765	X	X	O	X	X	X	X	O	S	R → S	S	R → S
	Step Transition - Valve positioning	5	770	X	X	O	X	X	X	X	O → X	S	S	S	S
5	Chemical soak	2700	3470	X	X	O	X	X	X	X	X	S	S	S	S
	Step Transition - Valve positioning and blower speed adjustment	5	3475	X	X	O	X	X → O	X	X	X	S	S	S → R	S
6	Chemical Air Scour	300	3775	X	X	O	X	O	X	X	X	S	S	R	S
	Step Transition - Valve positioning	5	3780	X	X	O	X	O	X	X	X → O	S	S → R	R → S	S → R
7	Skid Topoff	10	3790	X	X	O	X	X	X	X	O	S	R	S	R
	Step Transition - Valve positioning	5	3795	X	X	O	X	X	X	X	O → X	S	R → S	S → R	R → S
8	Chemical soak	2700	6480	X	X	O	X	X	X	X	X	S	S	S	S
	Step Transition - Valve positioning and blower speed adjustment	5	6485	X	X	O → X	X → O	X → O	X	X → O	X	S	S	S → R	S
9	Air Scour and Pressurized Chemical Drain	10	6495	X	X	X	O	O	X	O	X	S	S	R	S
	Step Transition - Valve positioning and blower speed adjustment	5	6500	X → O	X	X → O	O → X	O → X	X → O	O → X	X	S	S	R → S	S
	Step Transition - Feed pump speed adjustment and valve positioning	10	6510	O	X	O	X	X	O	X	X	S → R	S	S	S
10	Refill	30	6540	O	X	O	X	X	O	X	X	R	S	S	S
	Step Transition - Valve positioning	5	6545	O	X	O → X	X	X	O	X	X	R	S	S → R	S
11	Chem Rinse Air Scour	60	6605	X	X	O	X	O	X	X	X	S	S	R	S
	Step Transition - Valve positioning	5	6610	X	X	O → X	X → O	O	X → O	X	X	S	S	R	S
12	Chemical Rince Air Scour and Drain	60	6670	X	X	X	O	O	O	X	X	S	S	R	S
	Step Transition - Valve positioning and blower speed adjustment	5	6675	X → O	O	X → O	O → X	O → X	O → X	X	X	S	S	R → S	S
13	Refill	30	6575	O	X	X	X	X	O	X	X	R	S	S	S
	Step Transition - Valve positioning	5	6580	O	X → O	X	X	X	O → X	X	X	R	S	S	S
	Step Transition - Feed pump speed adjustment	10	6590	O	O	X	X	X	X	X	X	R	S	S	S
14	Resume Filtration	0	6590	O	O	X	X	X	X	X	X	R	S	S	S
	Sequence duration (s)		6590	Notes: O = Open valve X = Closed valve								R = Run pump S = Stop pump			
	Sequence duration (min)		110												

Table 3: Control Sequence Table – Recovery Clean

LG QuantumFlux™ Pressurized UF Membrane

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UF Membrane Integrity Testing and Repair

Integrity testing is used to confirm that the system and modules are intact. If membrane fibers are damaged or broken, or module or skid seals are not made correctly, feed water may pass to the filtrate side of the membrane and filtrate quality may be affected. This may be indicated by an increase in turbidity. Therefore, it may be necessary to conduct an integrity test and repair any damaged membrane fibers or leaking points.

Integrity Test principle

Pressurized air is applied to one side of the wetted membrane fibers. If the membrane integrity is intact, and the air pressure is lower than the bubbling point, there will be no observable air flow from the membrane pores. However, if there are damaged membrane fibers, air flow can be easily observed at pressure far below the bubbling point. Therefore, the integrity of the UF module can be tested by observing bubble flow or the pressure change on one side of the membrane fibers.

System Integrity Test Procedure

⚠ **CAUTION**: The compressed air used for integrity testing must be oil free. Dirty air will contaminate the membrane. The maximum air pressure allowed during testing is 100kPa (14.5 psi)

⚠ **CAUTION**: The testing should be completed in less than 5 minutes. Immediately after testing, the modules must be filled with water.

The following procedure is used to confirm system integrity and identify any integrity breach in need of repair.

1. Fill up the skid with water to make the UF modules completely wet.
2. Open the integrity test (IT) valve (AV-04) and the concentrate valve (AV-06). Compressed air applied through the integrity test valve will drive the water from the filtrate side of the membrane to the feed side. As water evacuates and air fills the feed side, the pressure will slowly increase until it reaches a regulated set point, which should be less than 100KPa (14.5 psi).
3. Allow the pressure to stabilize at the set point, typically ~2 minutes. This will occur once all the water on the feed side of the membrane has been evacuated.
4. After the pressure has stabilized, close the IT valve. Note the pressure.
5. Hold the pressure for 5 minutes.
6. Typically, if the pressure drop is less than 17 KPa (2.5 psi) in 5 minutes, the system integrity is intact. If the pressure drops rapidly, it indicates that there is a leak in the system.

Check the transparent pipe section at the top of each module for leaks. If vigorous bubbles are observed in the transparent pipe of a module, it should be removed for further testing and repair.

LG QuantumFlux™ Pressurized UF Membrane

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UF Membrane Integrity Testing and Repair

Removal of UF Modules

⚠ **CAUTION**: Use two people when handling 6” and 7” modules. Use a forklift, or other lifting device, when handling 9” and 10” modules.

⚠ **CAUTION**: Once the membrane fibers become dry, the filtration performance of the module may deteriorate or even be totally lost. When removing the membrane prevent it from become dry due to air drying.

When necessary, remove the UF module according to the following instructions:

1. Prior to removal, use the chemical cleaning pump to rinse all the modules on the same skid with about 2 skid volumes of clean water.
2. Stop the operation of the skid.
3. Open the drain valve for the skid and discharge the water from the UF module through the feed/discharge port.
4. Disconnect the module at the filtrate port(s), followed by the feed/drain port. Leave the top concentrate port connected.
5. For 6” or 7” modules: Use two people. One person should hold the UF module steady, while the other makes disconnection by unscrewing the union nuts.
6. For 9” or 10” modules: Use a lifting device. Connect the module to the lifting device. Disconnect by undoing the grooved end style couplings.
7. Use one person to hold the module steady, while the other makes the final disconnection.
8. Lift the module from the skid and place horizontally on the ground, with the side ports facing up.
9. Cap all the ports of the module immediately using the sealing caps.

Individual Module Integrity Test Procedure

The individual module integrity test includes bubble testing, fiber pinning and a membrane leak test. Each of these procedures is described below.

⚠ **CAUTION**: Use two people when handling 6” and &” modules. Use a forklift, or other lifting device, when handling 9” and 10” modules

⚠ **CAUTION**: Properly support the module with straps to prevent the module from falling over.

LG QuantumFlux™ Pressurized UF Membrane

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UF Membrane Integrity Testing and Repair

Bubble Test Procedure

After removing the suspect module from the skid, perform an integrity test on the module according to one of the following procedures:

For 9” and 10” modules

1. Remove the top end cap.
2. Install integrity test kit, as shown in Figure 1.
    1) Fix clamp on filtrate end of module with the eye bolts pointing out from module.
    2) Insert air supply adaptor in the central opening of the module.
    3) Move eye bolts into slots of fixing bar.
    4) Tighten wing nuts on eye bolts until the fixing bar cannot move.
    5) Connect compressed air supply line.

Note

Do not apply excess force. Excess force may damage the module. The fixing bar is only intended to prevent movement of the air supply adaptor

Figure 1: Integrity Test Kit for 10" Modules

3. Compressed air supply line should be regulated to a maximum pressure of 1.3 bar (19 psi)
4. Equip compressed air supply line with air pressure vent valve.
5. Place the module in a clear rectangular tank full of water so that it is fully submerged. Fix the module in place, below the water level. The filtrate end of the module must be accessible and clearly viewable
6. Apply a small amount of pressure on the membrane 50-100kPa (7.2-14.5 psi), never more than 15 psi
7. If vigorous bubbling is observed on the surface, one or more membrane fiber(s) are damaged and need to be isolated from operation. Proceed to procedure B below.
8. If vigorous bubbling is not observed, proceed to procedure C below.

LG QuantumFlux™ Pressurized UF Membrane

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UF Membrane Integrity Testing and Repair

For 6” and 7” Modules

1. Fix module on testing stand vertically (the feed water port down)
2. Dismantle the clamp and end cap of the two ends
3. Seal the concentrate port and feed water port with sealing cap
4. Connect compressed air to the air inlet
5. Apply a small amount of pressure on the membrane 50-100kPa (7.2-14.5 psi), never more than 15 psi
6. Spray clean water on the end surface of the potting
7. If bubbling (like a fizz) is observed on the surface in a specific location, one or more membrane fiber(s) are damaged and need to be isolated from operation. Proceed to Fiber Pinning procedure below.
8. If bubbling (like a fizz) is not observed, proceed to Module Leak Test Procedure and Repair procedure below.

Fiber Pinning Procedure

1. Once the source of the bubbling has been identified, turn off the pressurized air.
2. Insert a LG Chem repair pin into the opening of the damaged fiber and press it in until 2/3 of the pin is inside the module.
3. Cut the pin.
   1) Do not pull the pin out while cutting
4. Press any extruding portion of the pin into the fiber.
5. Follow the bubble test procedure above to make sure the broken fiber is completely sealed.

After the completion of repairing the top filtrate side, the UF module is turned upside down and is repaired as per above procedure.

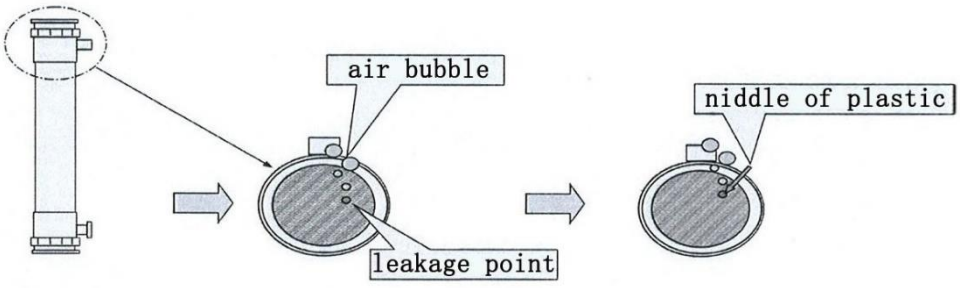

Figure 2: Membrane Repair Procedure

LG QuantumFlux™ Pressurized UF Membrane

Technical Service Bulletin 606

UF Membrane Integrity Testing and Repair

Module Leak Test Procedure and Repair

1. Install end cap and clamp at discharge/filtrate port end. Also cap the concentrate and feed ports.
2. Place the module horizontally in a water tank large enough to completely submerged it in water
3. Connect an air supply and pressure gauge
4. Apply up to, but never exceeding, 0.1MPa (14psi) of air
5. For the first minute or two air that has been trapped may escape. After that the pressure should hold steady
6. Observe any air bubbles from the housing, or clamp joints. If a bubble is observed, mark the leaking point
7. If leak is found around a clamp joint, simply replace the old O-rings with new ones. If the housing is the source of the leak, it can be repaired using epoxy resin. Contact LG Chem for recommendation on selecting an epoxy resin.
8. Repeat Steps 4-7 until no leakage is detected on the module.

Figure 3: UF Module Leak Test

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Technical Service Bulletin 607

UF System Troubleshooting

The UF system troubleshooting are covered in this TSB under two sections:

General Membrane Troubleshooting

Common UF System Troubleshooting Basics

If the operating problems are not addressed herein, contact LG Chem for support.

General UF Module Troubleshooting

The following are critical to maintain stable operation and produce high quality water over the long term:

1. Properly pre-treated feed water
   1) Pretreatment equipment should remain in proper working condition.
   2) Feedwater should be within the ranges provided in Table 1. The purpose of controlling these parameters is to minimize the risk of membrane damage and/or fouling. These ranges apply to all systems using LG Chem UF pressurized modules. Selection of operating parameters depends on the specific project.
2. Appropriate filtrate flux
3. Suitable filtration cycle time
4. Sufficient air scour flow rate
5. Targeted chemical cleaning regime

Feed water quality should be monitored closely. Changes in feed water quality may require adjustment of operational settings. Careful attention to how the membrane performance is affected by changing feed water quality is required to make necessary system adjustments.

Parameter	Allowed Range	Comments
pH	1 – 10 (NIPS) 1-14 (TIPS)	1—14 allowed during cleaning (TIPS)
Particle Size	≤0.5 mm, ≤0.12 mm for seawater feeds, no sharp particles allowed	To prevent mechanical damage
Oil	≤0.5 mg/L (NIPS) ≤2 mg/L (TIPS)	To prevent membrane fouling
Turbidity	<300 NTU	Contact the sales team if your operating parameters exceed the allowed

CAUTION

This is not an extensive list and does not constitute the only conditions for a valid warranty claim.
Refer to your project specific warranty document for all conditions that apply to your warranty

LG QuantumFlux™ Pressurized UF Membrane

Technical Service Bulletin 607

UF System Troubleshooting

Common UF System Troubleshooting Basics

Symptom	Possible Causes	Solutions
High TMP	Fouling of the membrane	Undergo suitable cleaning; Adjust filtration flux; Adjust filtration cycle time; Verify automated cleanings are occurring correctly
Low air scouring flow rate	Blower fault	Check the blower
	Valve closed	Check the piping and valve
High feed water pressure	Control system failure	Check PID and flow meter
	Pressure meter fault	Calibrate the pressure meter
Low feed water pressure	Feed pump failure	Check feed pump and piping
	Valve failure	Check feed valve
Motor break down	No electricity	Check power supply
	VFD failure	Check the VFD unit
	Amperage Overload	Check the setting of overload for the motor. If the value is exceeded, contact the supplier.
IT failure	Membrane leakage	Check the transparent tube on the top of each module, locate the damaged module and repair it.
Valve failure	No open or close action	Check the compressed air. Check the solenoid valve.
	Switch fault	Check the switch and the 24V power supply.
High turbidity of product water	Air in the meter	Check the water pipe and eliminate the air.
	UF module integrity issue	Repair the damaged seal or fiber(s).

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LG QuantumFlux™ Pressurized UF Membrane

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UF System Design

Although LG Chem does not typically supply the UF system, it is critical to have a properly designed system, capable of following LG Chem recommended operating process. Please refer to the LG Chem Technical Service Bulletins (TSB's) for system design recommendations.

Key Operating Parameter Definitions

- **Filtrate flow rate**

Filtrate flow rate is the rate of the water that passes through the membrane from the feed side to the filtrate side. It is a function of the pressure, and the quality of the feed water. The filtrate flow rate should be set in according to LG Chem's recommended membrane flux.

- **Filtrate flux**

Filtrate flux is the volume of filtered water passing through a unit of membrane surface area in a specified period of time. It is commonly expressed as lmh (Liters of filtered water/m2 of surface area/hour of filtration time), gfd (gallons of filtered water/ft2 of surface area/day of filtration time), or m/d (m3 of filtered water/m2 of surface area/day of filtration time). Appropriate flux selection is one of the most important design and operating considerations. The filtrate flux should be set according to LG Chem's recommendation for your specific application. The flux may be increased or decreased during operation to account for changes in feed water quality, temperature or product water demand.

- **Transmembrane Pressure**

Transmembrane Pressure (TMP) is the pressure difference between the feed and filtrate sides of the membrane. It is commonly measured in units of bar, psi, or kPa. TMP is the driving force for filtration. Most ultrafiltration systems operate at a constant flow rate during filtration. As filtration occurs, solids deposited on the membrane surface will create resistance to filtration causing the TMP to increase. Proper design filtrate flux is necessary to control the rate of TMP increase. Physical and chemical cleaning are required to remove accumulated fouling and reduce TMP. The maximum allowable TMP is 0.15 MPa (22.1 psi).

- **Normalized permeability**

Normalized permeability, or specific flux, is defined as filtrate flux per applied transmembrane pressure (differential pressure) corrected to a specified temperature, typically 20 or 25 degrees Celsius. It is commonly measured in units of lmh/bar or gfd/psi @20 deg C. Normalized permeability is one of the most important parameters used to measure the performance of the membrane system. In a properly designed and operated UF system, the normalized permeability will decrease slowly between cleanings and will return to previous levels after cleaning such that it remains essentially constant over long-term operation.

- **Filtration cycle duration**

The filtration cycle duration is dependent on the quality of the feed water. An appropriate design value should be selected per LG Chem's recommendation. The actual time should be set by testing at site and adjusted according to the changes of the feed water quality during the operation. Typical filtration cycle duration is 20-60 minutes.

To facilitate operation explanation, the following typical P&IDs are provided.

LG QuantumFlux™ Pressurized UF Membrane

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UF System Design

Feedwater Limiting Conditions

Parameter	Allowed Range	Comments
pH	1 – 10 (NIPS) 1-14 (TIPS)	1—14 allowed during cleaning (TIPS)
Particle Size	≤0.5 mm, ≤0.12 mm for seawater feeds, no sharp particles allowed	To prevent mechanical damage
Oil	≤0.5 mg/L (NIPS) ≤2 mg/L (TIPS)	To prevent membrane fouling
Turbidity	<300 NTU	Contact the sales team if your operating parameters exceed the allowed

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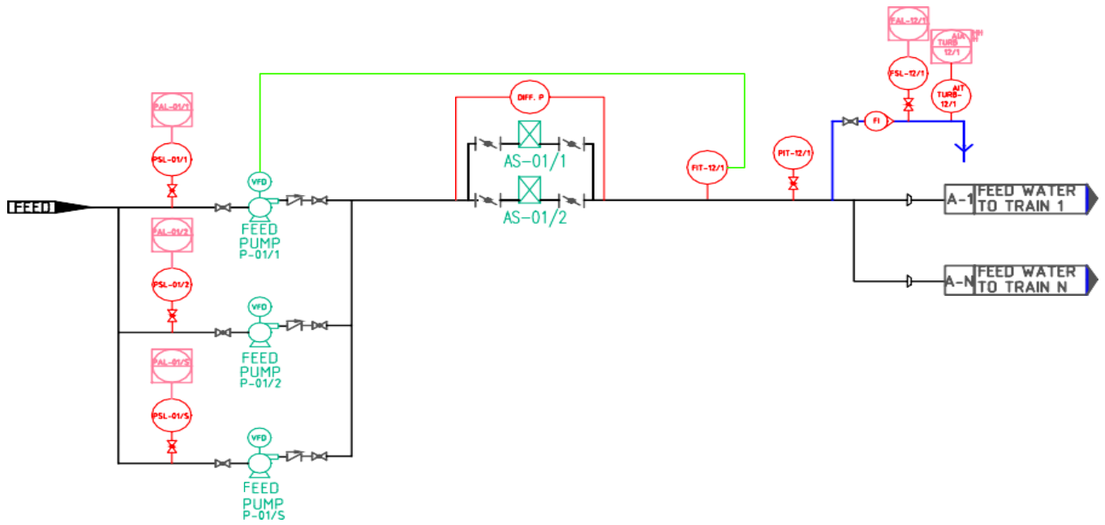
FEED PUMPING CENTER TO ALL TRAINS

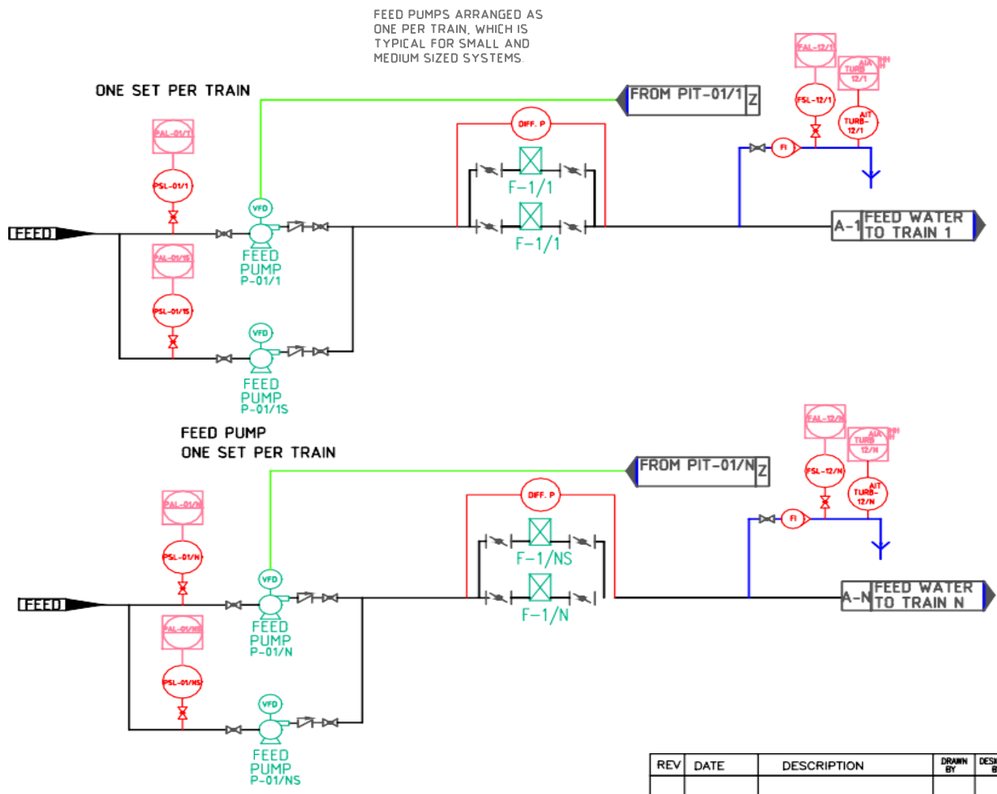
FEED PUMPS ARRANGED IN PARALLEL WITH DISCHARGE TO FEED WATER HEADER, WHICH IS TYPICAL FOR LARGER SYSTEMS.



OR

ONE FEED PUMP PER TRAIN

FEED PUMPS ARRANGED AS ONE PER TRAIN, WHICH IS TYPICAL FOR SMALL AND MEDIUM SIZED SYSTEMS.



REV	DATE	DESCRIPTION	DRAWN BY	DESIGNED BY	APPROVED BY
0	12/06/24	Initial Release			

CLIENT

DESCRIPTION: FEED PUMPS

SCALE: NTS

UNIT: NTS

TITLE: PRESSURIZED QF Pxxxx-D
TYPICAL P&ID
FILTRATE SIDE MC/RC and AIT

STATUS: PRELIMINARY

JOB NO

DRAWING NO: UFP-I-PID-ETS-500002-001

REV: 0

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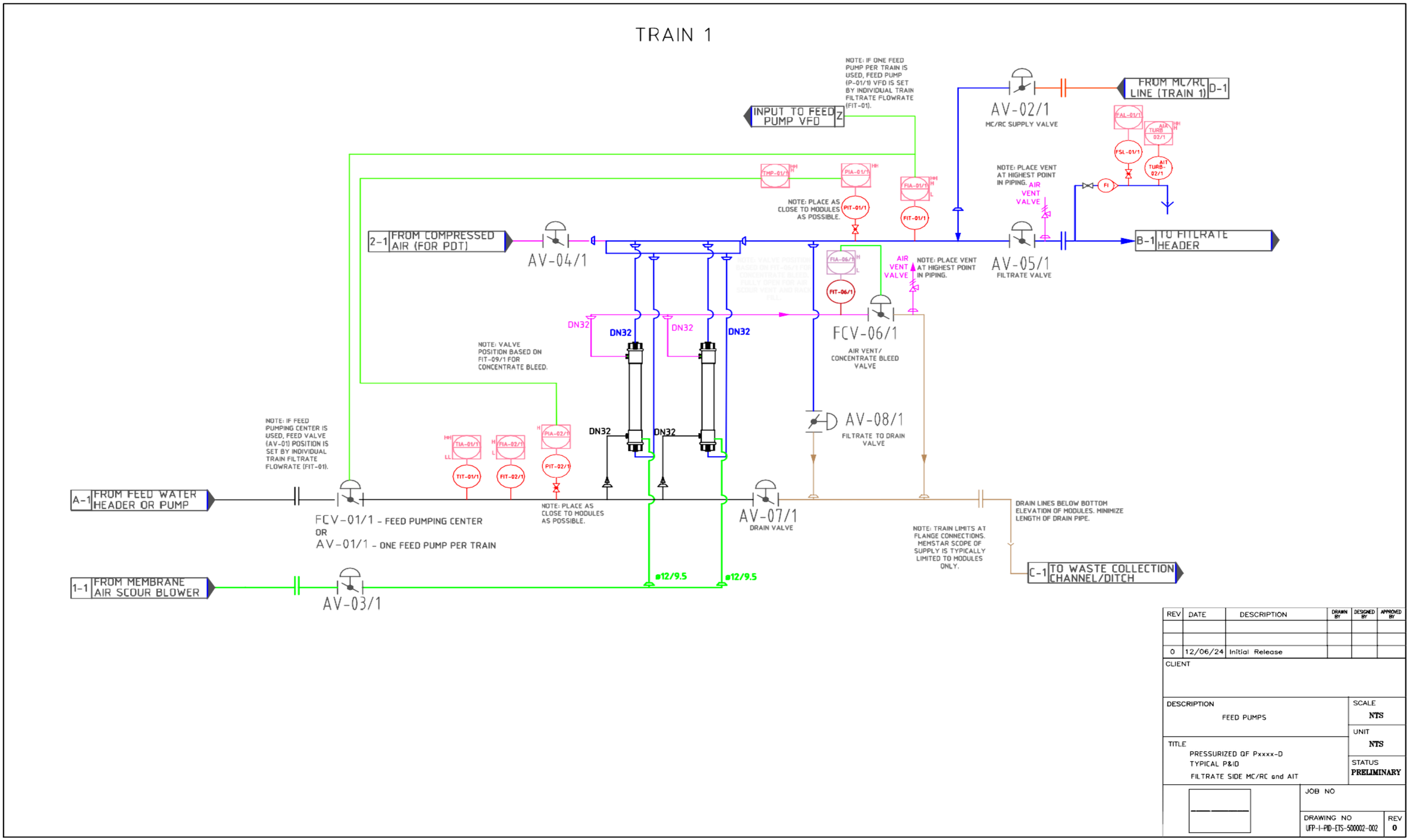

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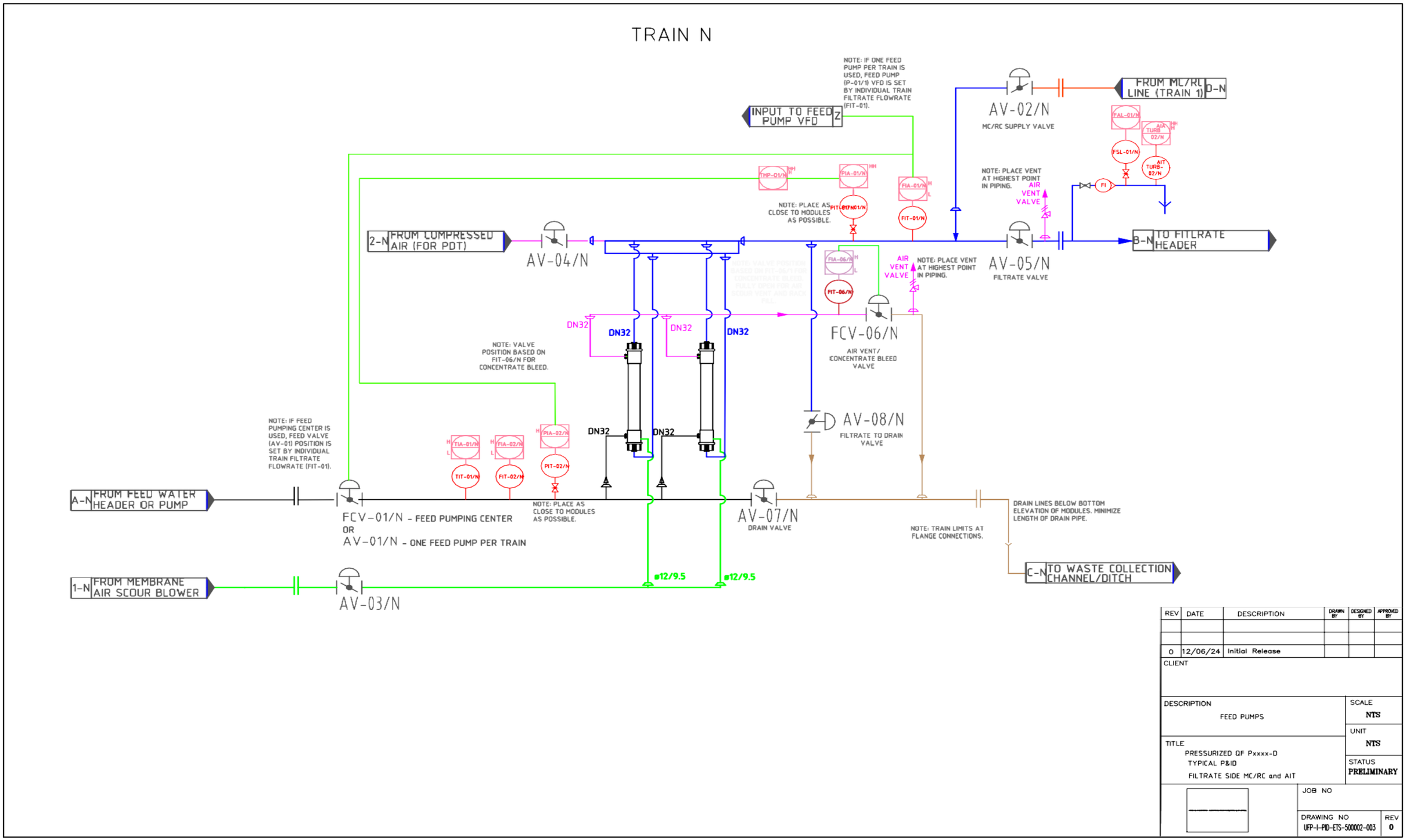

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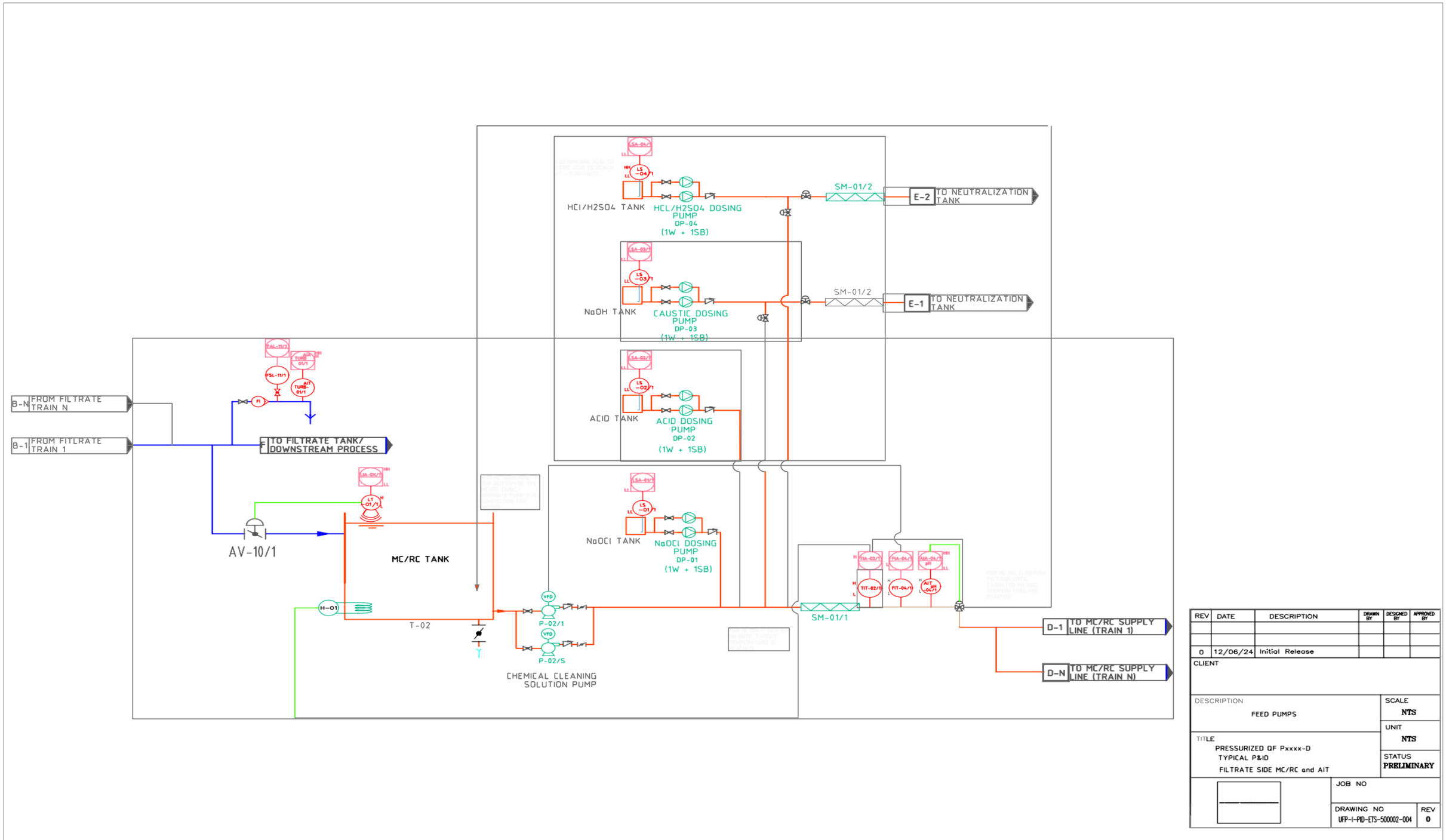

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0	12/06/24	Initial Release			

CLIENT

DESCRIPTION
FEED PUMPS

SCALE
NTS

UNIT
NTS

TITLE
PRESSURIZED QF Pxxxx-D
TYPICAL P&ID
FILTRATE SIDE MC/RC and AIT

STATUS
PRELIMINARY

JOB NO

DRAWING NO
UFP-I-PID-ETS-500002-004

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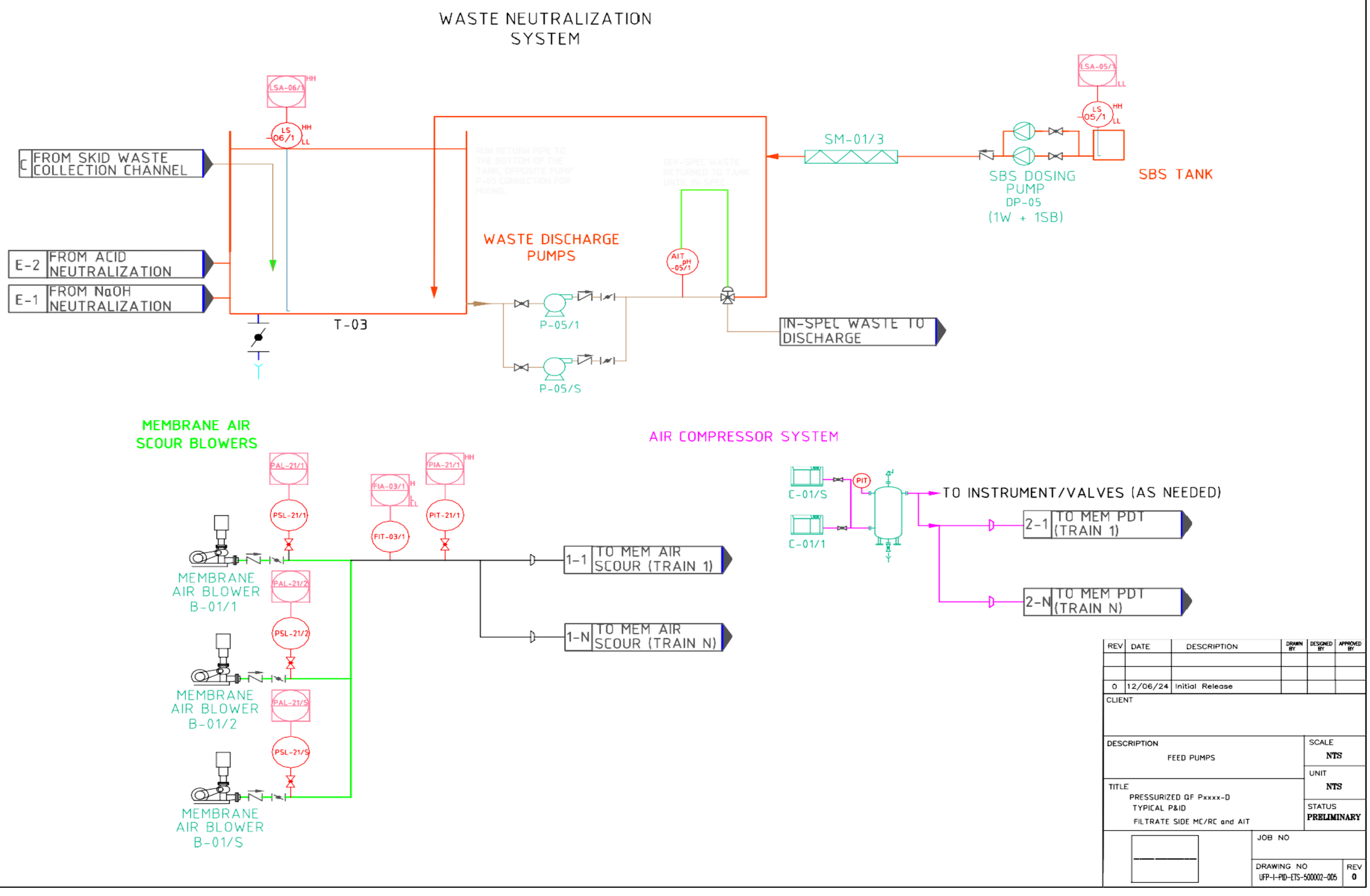

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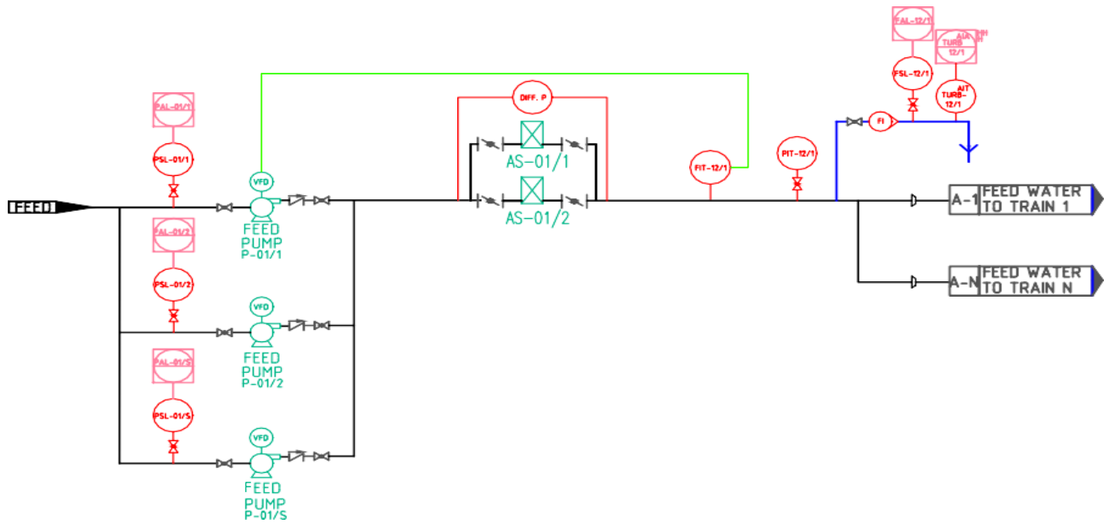


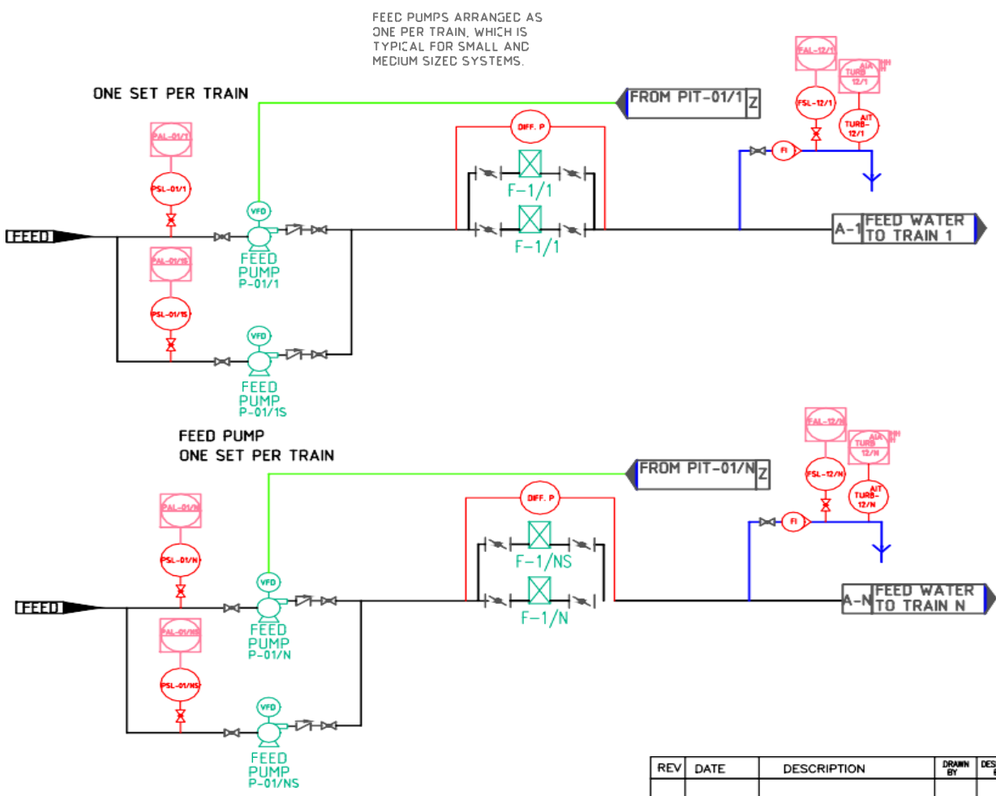
OR

ONE FEED PUMP PER TRAIN

FEED PUMPS ARRANGED AS ONE PER TRAIN, WHICH IS TYPICAL FOR SMALL AND MEDIUM SIZED SYSTEMS.

ONE SET PER TRAIN

FEED PUMP ONE SET PER TRAIN



REV	DATE	DESCRIPTION	DRAWN BY	DESIGNED BY	APPROVED BY
0	12/06/24	Initial Release			

CLIENT

DESCRIPTION: FEED PUMPS	SCALE: NTS
TITLE: PRESSURIZED QF Pxxxx-S TYPICAL P&ID FILTRATE SIDE MC/RC and AIT	UNIT: NTS STATUS: PRELIMINARY
	JOB NO
	DRAWING NO: UFP-I-PID-ETS-500001-001 / REV: 0

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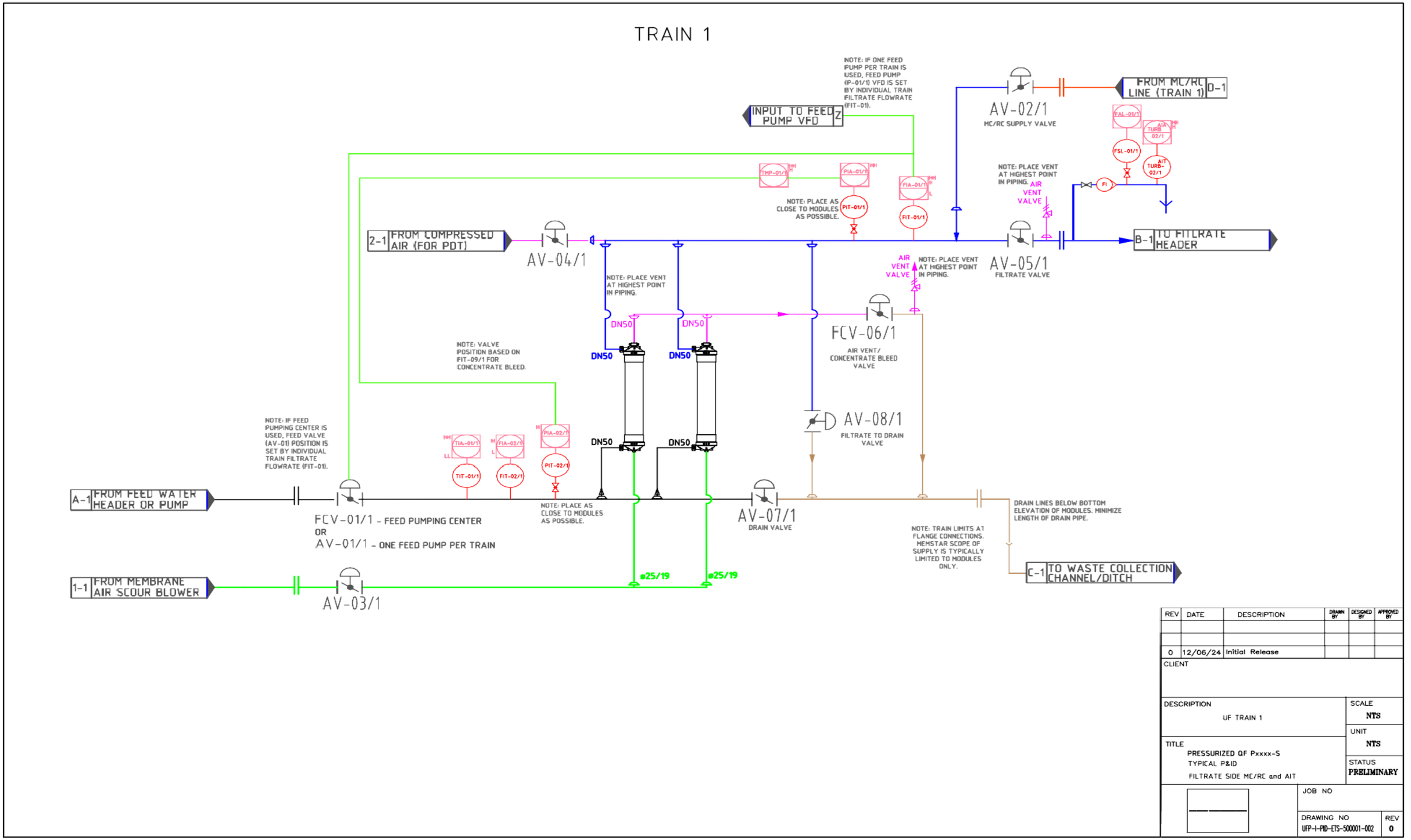

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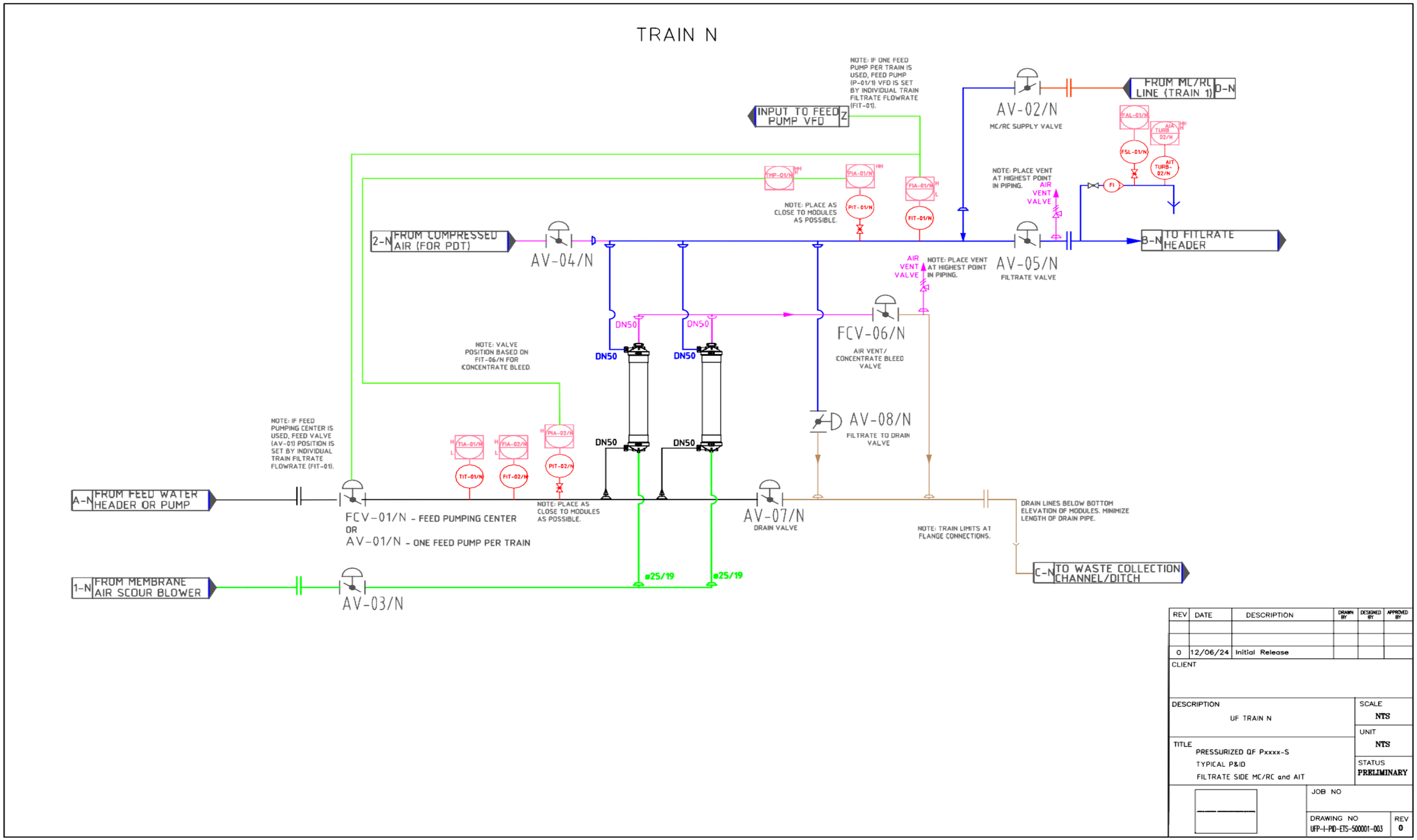

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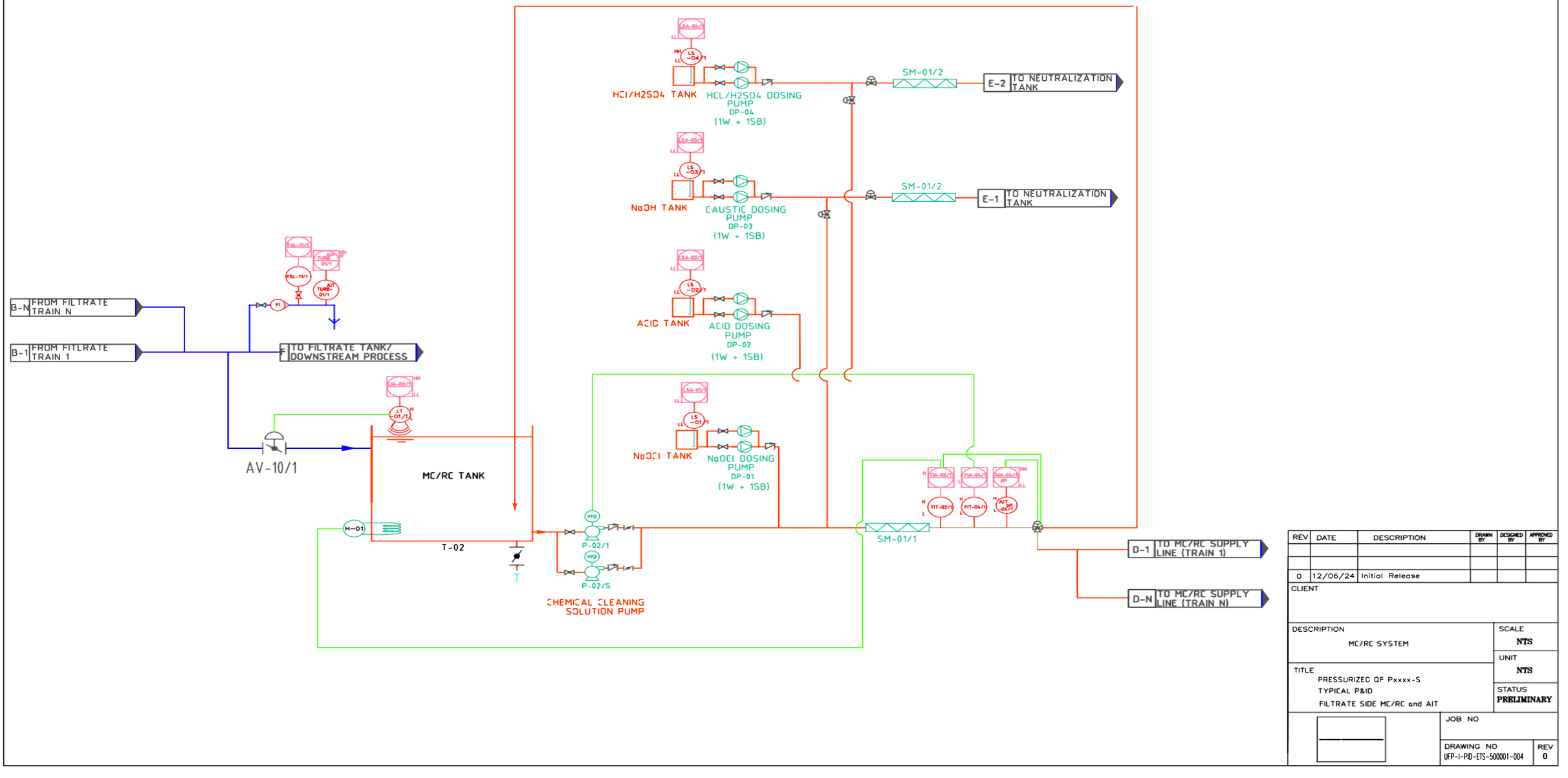

REV	DATE	DESCRIPTION	DRAWN BY	DESIGNED BY	APPROVED BY
0	12/06/24	Initial Release			

CLIENT

DESCRIPTION: MC/RC SYSTEM

SCALE: NTS

UNIT: NTS

TITLE: PRESSURIZED QF Pxxxx-S TYPICAL P&ID FILTRATE SIDE MC/RC and AIT

STATUS: PRELIMINARY

JOB NO

DRAWING NO: UFP-I-PID-ETS-500001-004

REV: 0

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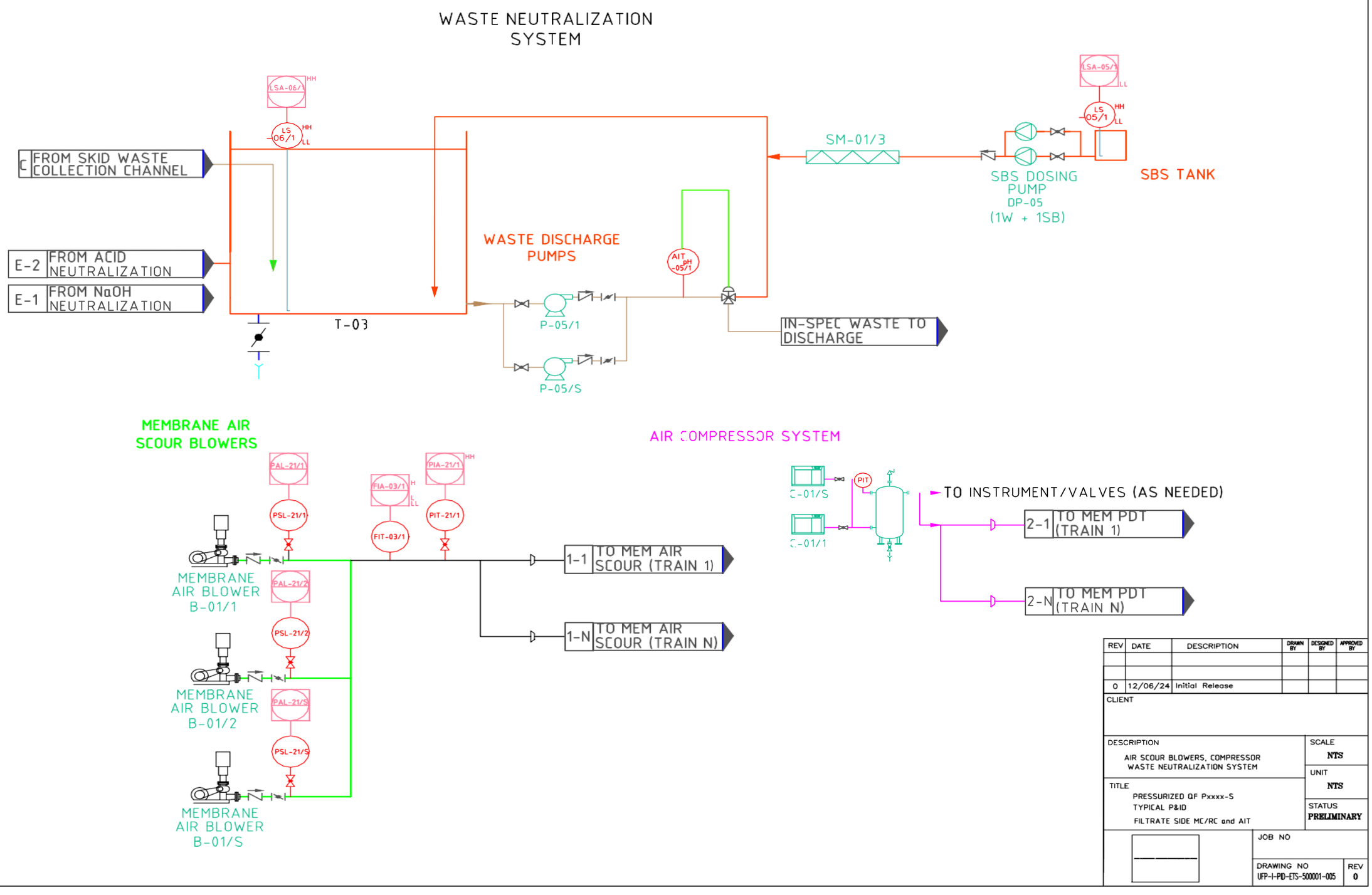

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LG QuantumFlux™ Pressurized UF Membrane

Technical Service Bulletin 609

Data Logging and Performance Normalization

In order to properly troubleshoot UF module performance issues, identify system operational issues, develop cleaning and maintenance procedures and ensure the validity of the product/system warranty, it is critical that feedwater quality and system performance data be recorded and filed on a regular basis so that such information is readily available for review in the event of a performance problem or a warranty claim.

Why is Data Collection Important?

Because UF membrane performance can be affected by a variety of factors, such as a change in feedwater quality or a change in operating conditions, the only way to determine whether your membranes are performing as expected is through regular collection and routine analysis of feedwater quality and system performance data. This information can then be evaluated over time to determine whether membrane performance is tracking as expected or if adverse trends develop which then require corrective action. All data collected should be systematically logged and filed for future access to allow analysis of longer-term performance trends that may require troubleshooting or support a warranty claim.

⚠

CAUTION

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Refer to your project specific warranty document for all conditions that apply to your warranty

Why Normalize Data?

UF membrane performance will vary depending on feedwater characteristics, feedwater composition and operating conditions. Parameters such as feedwater temperature, feedwater turbidity, membrane fouling, or flux rate will change key membrane performance characteristics such as feed pressure, filtrate flow and filtrate quality.

To determine whether changed performance is the result of changed feedwater or operating conditions, or whether it is due to a change in actual membrane performance, operating data must be taken at regular intervals and then “normalized” to baseline reference conditions. Whether changed performance is apparent or actual can only be determined by comparing “normalized” performance over time with baseline performance. To ensure optimized membrane performance and a long service life, it is important that any changes in membrane performance be identified and corrective action be taken as quickly as possible. A complete record of normalized data is therefore essential for users to realize the best performance and longest operating life of LG Chem UF membrane modules.

Causes for Changes in Apparent Membrane Performance

Certain changes in the operating parameters of the UF system or train will result in changes in UF membrane performance. Such changes can result in an apparent or actual change in permeate flow or quality. Below is a list of the changed conditions that typically affect UF membrane performance

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Data Logging and Performance Normalization

Data Collection Procedures

The following tables identify the data to be regularly collected and the frequency of collection.

LG Chem UF Membrane Minimum Logging Requirements

UF Feedwater Characteristics - Required Data:

Parameter	Frequency of Collection	Comment or Unit of Measure
Temperature	Once per day (every 24 hours)	°C or °F
Turbidity	Once per shift (every 8 hours)	Nephelometric Turbidity Units
Feedwater Chemical Analysis	Once per month	

UF System or Each Train – Required Data:

Parameter	Frequency of Collection	Comment or Unit of Measure
Transmembrane Pressure (TMP)	Once per day (every 24 hours)	Record Feed, Concentrate and Permeate Pressure for calculating TMP
Feed Flow	Once per shift (every 8 hours)	
Filtrate Flow	Once per shift (every 8 hours)	
Cumulative Hours of Operation	Once per day (every 24 hours)	
Specific Flux	Once per day (every 24 hours)	Calculation

Operating or Maintenance Events for UF System or Each Train:

Parameter	Frequency of Collection	Comment or Unit of Measure
System or Train Start-up	As applicable	Record date and time
System or Train Shutdown	As applicable	Record reason for shutdown, date, and time
Membrane Cleaning-In-Place (CIP)	As applicable	Record reason for cleaning, chemical(s) used, method or procedure, concentration, date and time. Record results following cleaning.

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Data Logging and Performance Normalization

Data Normalization Equations

To calculate Trans Membrane Pressure, use the following equation:

$$\boldsymbol{TMP} = \frac{\boldsymbol{P}feed + \boldsymbol{P}concentrate}{2} - \boldsymbol{P}filtrate$$

Note

Pressures may be in psi or bar

TMP	Trans Membrane Pressure (psi or bar)
P feed	Train UF Feed Pressure (psi or bar)
P concentrate	Train UF Concentrate Pressure (psi or bar)
P filtrate	Train Filtrate Pressure (psi or bar)

To calculate the filtrate flux rate, use the following equation:

$J = 1440 * Q/A$ for U.S. units or $J = Q/A$ for SI units

J	Filtration Flux in liters/m²/hour (SI units) or gallons/ft²/day (US units)
Q	Filtrate flow (GPM or l/h)
A	Train membrane area (ft² or m²)

To obtain the Normalized Specific Flux (SF):

$$\boldsymbol{JSP} = \frac{\boldsymbol{J} * \boldsymbol{TCF}}{\boldsymbol{TMP}}$$

JSP	Normalized Specific Flux
J	Actual Filtration Flux in liters/m²/hour (SI units) or gallons/ft²/day (US units)
TMP	Calculated Trans Membrane Pressure in bar or psi
TCF	Temperature Correction Factor

TCF is calculated using the following equation:

$$\boldsymbol{TCF} = \mathbf{0.0239} * \boldsymbol{T} + \mathbf{0.443}$$

T	Actual temperature in degrees Celsius

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Customer Claim and Complaint Procedure

This procedure is for customers whom LG Water Solutions ("Manufacturer") have advised to return their purchased product for evaluation in support of a warranty claim ("Return Merchandise").

Before returning the Return Merchandise, customers are required to complete the 'Request for Return Merchandise Authorization Form (see a copy at the end of this bulletin, or download from our website www.LGwatersolutions.com) and email the completed form to the email corresponding to your region listed below:

Region	E-mail
Americas	nasales@lgchem.com
Europe, Africa	eumanasales@lgchem.com
Middle East, Egypt	mesales@lgchem.com
Korea	krsales@lgchem.com
China	cnsales@lgchem.com
India	insales@lgchem.com
Southeast Asia	seasales@lgchem.com

Customers will receive a Return Merchandise Authorization (RMA) number by email within 48 hours after submitting the Request for Return Merchandise Authorization form. The RMA number MUST appear on all shipping documents accompanying Return Merchandise to ensure that Return Merchandise is identified, accepted, and routed to the proper department for processing and evaluation. Any Return Merchandise received without an identifiable RMA number will be refused at the expense of delivery charges to the sender.

Please ship all Return Merchandise corresponding to the RMA claim to the Manufacturer immediately upon confirmation of your RMA number by the Manufacturer. Immediate shipping allows for a more accurate analysis of Return Merchandise claims. The Manufacturer must receive the Return Merchandise within 30 days for domestic shipments and 60 days for international shipments from when the RMA number is issued. Failure to comply with this requirement may void your warranty claim, and the Manufacturer will not be liable for any incurred costs (i.e., shipping).

Shipping of Return Merchandise to Manufacturer does not mean that the Manufacturer accepts all responsibility of a warranty claim. The sole purpose of returning the Return Merchandise to the Manufacturer is to carefully inspect the Return Merchandise to determine whether it falls within or outside of the warranty terms. Before any conclusions are determined through analysis of the Return Merchandise, all expenses will be the customer's responsibility.

Merchandise should be prepared for shipment and packaged per the Packing and Shipping Requirements detailed below:

DO NOT RETURN MERCHANDISE UNTIL YOU HAVE RECEIVED A WRITTEN AUTHORIZATION AND A VALID RMA NUMBER FROM LG WATER SOLUTIONS

LG QuantumFlux™ Pressurized UF Membrane

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Customer Claim and Complaint Procedure

Packing and Shipping Requirements:

Flush membrane elements with UF Filtrate for a minimum of 30-minutes at pH 6-8 to ensure that any hazardous liquids contained in the Return Merchandise are flushed out and for safe handling of the Return Merchandise.

LIQUIDS CONTAINING A STRONG ACID OR AN ALKALI CLEANING SOLUTION ARE CONSIDERED TO BE HAZARDOUS FOR TRANSPORT AND MUST BE FLUSHED OUT BEFORE SHIPMENT.

Before shipping, the Return Merchandise ports must be sealed with rubber caps, packaged in a leak-proof polyethylene bag, and securely packaged in wooden crate to keep the element hydrated and protect it from physical damage during shipment.

DURING SHIPMENT, TAKE PRECAUTIONS TO ENSURE THAT MEMBRANE ELEMENTS ARE PROTECTED FROM FREEZING OR PROLONGED EXPOSURE TO TEMPERATURES EXCEEDING 40°C.

Contact LG Chem Technical Service representative

for return merchandise shipping instructions

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Customer Claim and Complaint Procedure

Warranty Claim Validation Procedure

1. The return of the UF modules will only be necessary when both the customer and the manufacturer agree.
2. Before any UF modules are returned, the requester must submit a request and seek approval from the manufacturer.
3. The cost of shipment will be solely borne by the requester.
4. The manufacturer will bear the cost of the membrane autopsy and will be responsible for delivering the autopsy reports, which will typically include visual inspection, permeability testing, cleaning testing, contaminant analysis, fiber analysis, and potting layer analysis, unless otherwise specified.
5. Determination
    1) Return Merchandise found to comply with warranted performance values will be returned to the customer at the customer's expense ("freight collect").
    2) Return Merchandise found to be defective based on the Material and Workmanship Warranty will be replaced or credited to the customer according to the applicable warranty terms and conditions.
    3) Return Merchandise performing below warranted performance values regarding filtrate flow, or turbidity removal, will be replaced or credited to the customer according to the applicable warranty terms and conditions.

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Customer Claim and Complaint Procedure

General Conditions

The customer is responsible for prepaying the shipping charges of the Return Merchandise. The Manufacturer will not accept any Return Merchandise unless it is prepaid. The Manufacturer may request that the customer issue a valid purchase order covering all work related to the warranty inspection, such as analytical work.

When inspection of the Return Merchandise by the Manufacturer concludes that a defect did not cause the warranty claim in material and workmanship:

- The Return Merchandise shall be returned to the customer at the expense of the customer (freight collect); and
- The customer will be billed for the Return Merchandise evaluated including autopsy and house analysis.

When inspection of the Return Merchandise by the Manufacturer concludes that a defect caused the warranty claim in material and workmanship:

The Return Merchandise will be shipped to the customer free of charge. Please review your warranty for the terms and conditions applicable to your purchase order.

All terms, conditions, and specific remedies outlined in the customer's applicable warranty shall apply in processing all warranty claims. Please contact LG Water Solutions through the email address corresponding to your region listed above for further questions.

The customer is responsible for returning the Return Merchandise to the Manufacturer for membrane analysis. The warranty claim will not be accepted unless the membrane analysis is complete.

The Manufacturer advises the customer to complete the Request for Return Merchandise Authorization Form, including "The option for prior compensation request" on the form if replacement UF modules are required to prevent the shutdown of the system while the Manufacturer conducts the warranty claim inspection.

When the customer receives replacement UF modules by prior compensation request, the Return Merchandise must be shipped immediately to the Manufacturer following UF module replacement. If the Return Merchandise is not returned within two months, the customer is responsible for the compensation UF modules at current pricing plus shipping charges.

The UF modules delivered under prior compensation will be billed to the customer at their recent purchase price if the conclusion of the analysis of the used module is that the problem has not been caused by the membrane supplier.

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UF/MBR Module RMA Request Form

New or Used Elements Removed from Original Packaging

Section 1			
TO BE FILLED OUT BY REQUESTOR			
Name of Requestor		Date of Request	
CUSTOMER INFORMATION			
Company Name			
Address/ Region			
Contact Person			
Phone/ Mobile		Email	
Purchase Order No.		Ship Date	
REPORTED PROBLEM			
☐ Low Flow (High Feed Pressure)		☐ High Filtrate Turbidity	
☐ High Differential Pressure		☐ Visual Product Defect	
☐ Other:			
TIME WHEN PROBLEM FIRST OCCURRED			
☐ Before UF Module Installation			
☐ At Startup (Less than 24 hours of continuous operation)			
☐ After Startup (2 to 14 days)			
☐ XXX Months After Startup			
☐ Describe failure mode and attach pictures			
SYSTEM INFORMATION			
Feed Water Type Surface water, seawater, tertiary wastewater etc.			
Filtrate Application RO pretreatment, drinking, discharge etc.			
Upstream treatment e.g. Primary clarification, aerobic system, secondary clarifier, media filter, bag filter etc.			
Downstream treatment	e.g. RO		

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SKID/MODULE INFORMATION			
Total No. of skids		No. of modules per skid	
No. of skids per train		Total modules per system	
Serial numbers of affected modules (attach separate file if necessary)			
Have the modules been exposed to hazardous materials?	☐ Yes ☐ No		
	If **Yes**, provide details (attach to this document) and advise customer that MSDS sheets for all hazardous materials have to be submitted along with this RMA request.		

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FEED AND FILTRATE WATER QUALITY INFORMATION

For performance warranty claims, please provide historical trend data in addition to the following.

		Feed		**Filtrate**	
Parameter	**Units**	Design	Actual	Design	Actual
Water Temp	ºC				
Total suspended solids	mg/l				
Turbidity	NTU				
TOC	mg/l				
BOD_5	mg/l				
COD	mg/l				
Iron	mg/l as ion				
Manganese	mg/l as ion				
Aluminum	mg/l as ion				
Calcium	mg/l as ion				
Alkalinity	mg/l as CaCO3				
Total Hardness	mg/l as CaCO3				
Total dissolved solids	mg/l				
pH	S.U				
O&G	mg/l				
Chlorine	mg/l as Cl2				
SDI_{15}					
Other (specify)					

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OPERATING PARAMETERS AND PERFORMANCE					
Provide historical trends in addition to the following. Trend files in raw data form to be attached in a separate file					
Process Fluid	**Parameter**	**Position**	**Units**	**Design**	**Actual**
Filtration	Feed Flow Rate	All skids (total)	m3/h		
		Single skid	m3/h		
	Pressure (single skid)	Feed	Bar		
		Filtrate	Bar		
		Concentrate	Bar		
		TMP	Bar		
		Pressurization Rate	Bar/second		
Air Scour	Air Scour Flow Rate		m3/h		
(per skid)	Air Scour Pressure		Bar		
	Air Scour Duration		minutes		
	BW Flow (if used)		seconds		
	BW Frequency (if used)		m3/h / GPM		
	BW Duration (if used)		Bar / kPa / psi		
	Air Scour /Backwash process (if applicable)				
	Describe steps				

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PROCESS SEQUENCES					
Process	**Sequence**		**Units**	**Design**	**Actual**
Maintenance Cleaning (MC) / Chemically Enhanced Backwash (CEB) / Enhanced Flux Maintenance (EFM)	MC1	1. Recipe			
		2. Cleaning Frequency			
		3. Wash Orientation			
		4. Backwash flow rate (if used)			
		5. MC 1 duration			
		6. MC1 protocol			
	MC2	1. Recipe			
		2. Cleaning Frequency			
		3. Wash Orientation			
		4. Backwash flow rate (if used)			
		5. MC 2 duration			
		6. MC2 protocol			
Recovery Cleaning (RC) / Clean-In-Place (CIP)	RC1	1. Recipe			
		2. Cleaning Frequency			
		3. Duration			
		4. Protocol			
	RC2	1. Recipe			
		2. Cleaning Frequency			
		3. Duration			
		4. Protocol			

Integrity Test	Air pressure applied to inside or outside of fibers?		
	Starting Pressure	Bar / kPa / psi	
	Frequency	days	
	Duration	mins	

Other process sequences e.g. Forward flush (describe)	

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Customer Claim and Complaint Procedure

COMMERCIAL CLASSIFICATION	
☐ Warranty Claim	☐ Non-Warranty Replacement
☐ Non-Warranty Credit	☐ Billable Technical Service Evaluation
☐ No Charge Technical Service Evaluation	☐ Application Engineering

Section 2
TO BE FILLED OUT
REQUIRED TEST
☐ As Received Visual Inspection
☐ Autopsy including permeability test, cleaning test, contaminant analysis, fiber analysis and potting layer analysis
☐ Other:
☐ Other:
☐

Section 3		
INFORMATION FOR CUSTOMER SERVICE		
No of Modules to be Returned:		
Serial Numbers and Customer PO:		
Commercial Classification:	☐ Credit	☐ Replacement
Further Instructions:		
RMA NUMBER		

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Customer Claim and Complaint Procedure

Commercial Invoice

Sender: Email Address: Phone Number:			Recipient: *Contact LG Chem Technical Service representative for shipping information*			
Invoice Date:			Invoice Number:			
Waybill Number:			Sender's Reference:			
Carrier:			Recipient's Reference:			
Quantity	Country of Origin	Description of Contents	Harmonized Code	Unit Weight	Unit Value	Sub Total
Total Net Weight			Total Declared Value: (USD)			
Total Gross Weight			Freight & Insurance Charges (USD):			
Total Shipment Pieces			Other Charges (USD):			
Currency Code			Total Invoice Amount (USD):			
Type of Export			Terms of Trade:			
Reason for Export						
General Notes						

The exporter of the products covered by this document declares that, except where otherwise clearly indicated, these products are of Republic of Korea, preferential origin.

I/We hereby certify that the information on this invoice is true and correct and that the contents of this shipment are as stated above.

Name: Position in Company: Signature: _____ _.	Company Stamp