9 Design and Construction

Following DuPont™ provide estimates and rough approximations for the design and construction of PES-UF systems. The given information is based on long-term experience in treating different types of source water.

The following parameters are the minimum basis needed to perform a feed water analysis:

- Suspended particulate matter:
    - Turbidity / Total Suspended Solids (TSS)
- Dissolved organic matter:
    - DOC/TOC and specific UV absorbance at 254 nm,
    - For Wastewater: Chemical Oxygen Demand (COD) and Biological Oxygen Demand (BOD)
- Inorganic compounds:
    - Ca, Mg, alkalinity / HCO3-, Fe, Mn, Al
- pH value
- Temperature
- Seasonal changes

If the UF feed water quality and temperature of the source water is subject to seasonal changes, details on the range of fluctuation are also required for the analysis (ideally in the form of a distribution, otherwise at least stating the minimum, maximum and median values). Other important information for surface waters (and for source waters affected by surface waters) includes the duration and impact of heavy rain and flooding events.

The collection of detailed information to the project specific pretreatment steps and/or intake situation (e.g. for seawater systems) is recommended.

Avoiding errors in the design and construction of a PES-UF system is fundamental to achieving smooth, trouble-free operation when the plant is completed. It also reduces the risk of damaging the membranes and modules or suffering irreversible loss of performance. Proper compliance with the following guidelines is a key prerequisite for making successful claims under the warranty should this become necessary.

NOTE	
	ATTENTION! Observe the following guidelines!

- The design and construction of any UF system should be based on state-of-the-art technology and in accordance with good engineering practices.
- The system should be specifically designed to avoid any pneumatic and/or hydraulic pressure surges or siphoning effects. All UF systems should include the following components and observe the following requirements:
- The system should include a means of controlling the feed and backwash volume flow rates (e.g. using frequency-controlled pumps or control valves with PID controllers). For the backwash pump controller, it is important to ensure that the set point value for the volume flow is reached within 5 - 7 seconds (time depends on pump capacity and valve dimension).
- The actuators of all (butterfly) valves should be equipped with air throttling valves to control the opening and closing procedure. Air/water hammer can occur if the valves open or close too abruptly.
- Air vent valves must be provided to vent the dead ends of the rack feed and filtrate headers to prevent pressure surges caused by air trapped in the dead end. Further air vent valves should be provided on all higher sections of the rack piping and connecting pipework.
- The rinse water piping must be equipped with vacuum breakers (air intake valves).
- The switching circuits of the pumps and valves must be designed to ensure that no pressure surges are produced in the system, .e.g. the pumps and valves should be actuated in a controlled sequence at intervals of approximately one second so that pumps are never running against closed valves.
- Any change of operating mode that involves a switch between the feed and backwash pump, including the switching of the required valves (e.g. backwash to filtration) must include an idle interval of approx. 5 - 7 seconds between the completion of one operating mode and the activation of the subsequent operating mode.
- Every module in a membrane rack must be operated under the same operating conditions.
- When designing and constructing an ultrafiltration system, it is important to ensure that there are no dead spaces, particularly on the filtrate side, which could encourage microbial growth. For the same reason, it is essential that there is no direct connection between the feed and filtrate sides which could create a bypass between the two sides of the filtration process.
- When designing/constructing an ultrafiltration system, it is also important to ensure that no corrosion or erosion products from the feed tank, backwash tank or piping can be rinsed back into the modules. For this reason, the tanks used for source water, filtrate/backwash and Clean-In-Place (CIP) must be made of non-corroding materials which will not release any contaminants or damaging (e.g. abrasive) substances into the water. The same applies to the piping and all other components installed within the ultrafiltration system.
- The dosing pumps must be designed and scaled to meet the concentrations and pH values required for CEBs.
- Only air release valves may be used. The use of combination vacuum valves/air release valves or valves designed purely for vacuum breaking is not recommended (with the exception of vacuum breakers in the rinse water piping) in order to prevent air from accidentally entering the system.
- The use of gap-type/edge filters is not recommended for the required pre-filter protection stage, which should have a maximum mesh size of 230 µm for membranes of the Multibore™ family with an inner diameter of 0.7 mm, or up to 300 for larger ID membranes. The pre-filter should be automatically backwashable.
- It is important to protect the water in the filtrate/BW tank and connecting pipework from direct sunlight and exposure to light in order to prevent excessive heating and avoid exposure to sunlight which could pose a risk of promoting bacterial and/or algae growth.
- Sealed filtrate/backwash tanks with air filters must be used to prevent microbiological contamination.

UF membranes cannot reject dissolved substances. This physical fact should be taken into account for all parameters (SDI15[†], turbidity[‡], etc.) when designing a UF system (including the effect on any downstream treatment processes) and when measuring UF filtrate quality.

- We recommend providing three chemical dosing points for CEBs for each membrane train (= independent backwashable unit of several modules). These dosing points should be as close to the train as possible. Experience has shown that it is sensible to place the acid dosing unit furthest upstream in the system. Any precipitation that builds up on the other dosing units further downstream can then be removed by means of acid dosing. It is important to ensure that the chemicals are properly mixed into the flow of water (mixing devices should be used if required). This system offers numerous advantages over the alternative of a central dosing unit:
- Reduces the volume of water that must be replaced when dosing and rinsing, thereby reducing dosing time.
- Avoids the mixing of different chemicals in the backwash piping which could otherwise occur if two CEBs were performed one immediately after the other for two different trains.
- Reduces chemical consumption and provides higher recovery rates because less water is used.
- Introduces fewer variables for the control system.
- When using coagulants in the pretreatment on an iron basis, residuals can only be removed with an acid CEB.
- UF systems with PES-UF Modules and UF systems with T-Rack™ should adhere to the basic flow diagrams shown in the following diagrams (see Figure 8.2-1 to Figure 8.2-4).

† SDI_{15}; (fouling index) measurement according to ASTM D4189-94

‡ Turbidity to be measured using analytical sensors and procedures in compliance with ISO 7027 and/or, Standard Methods 2130 B.

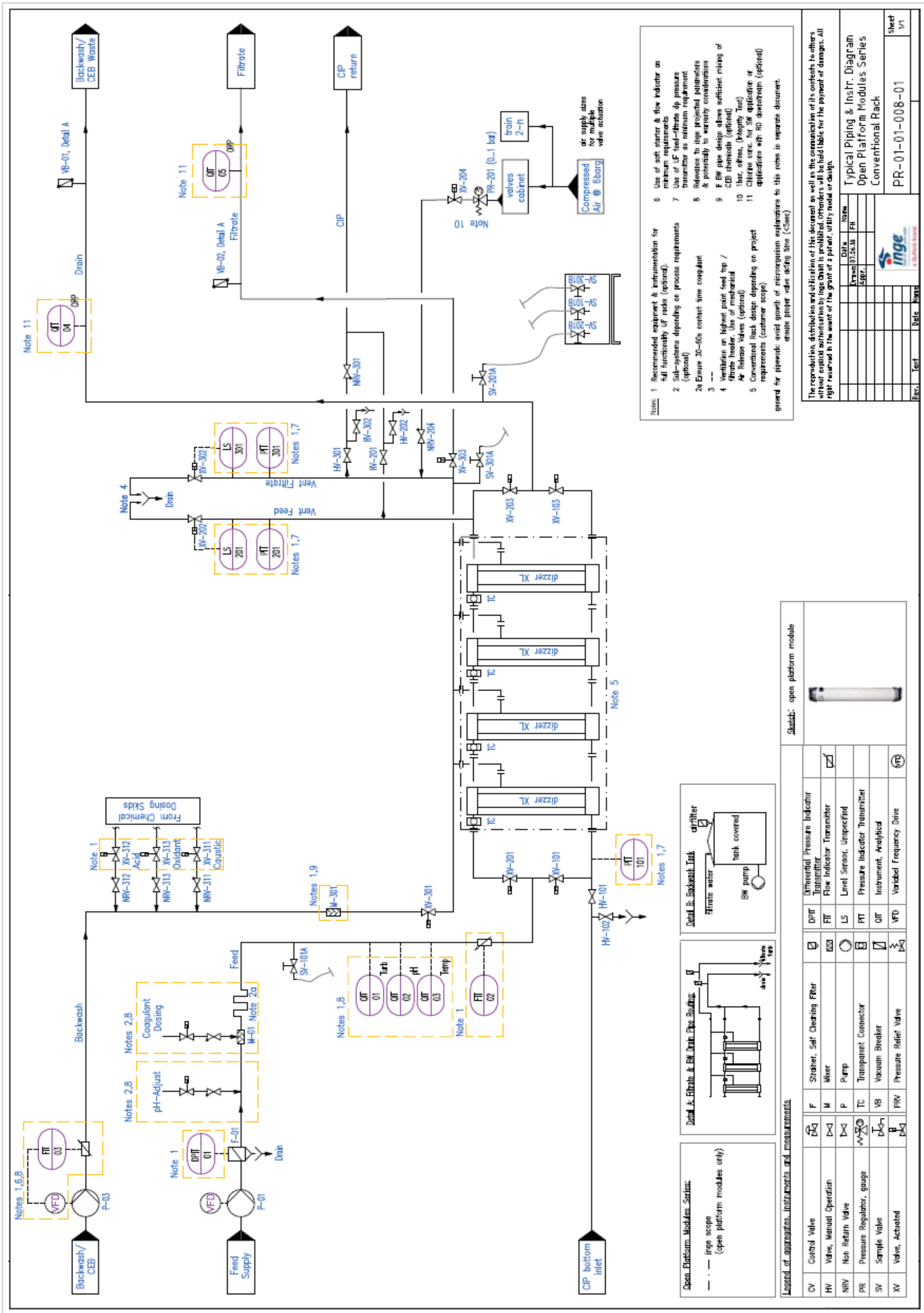

Figure 8.2-1 - Flow Diagram for a UF System PES-UF Modules for Open Platform (version conventional)

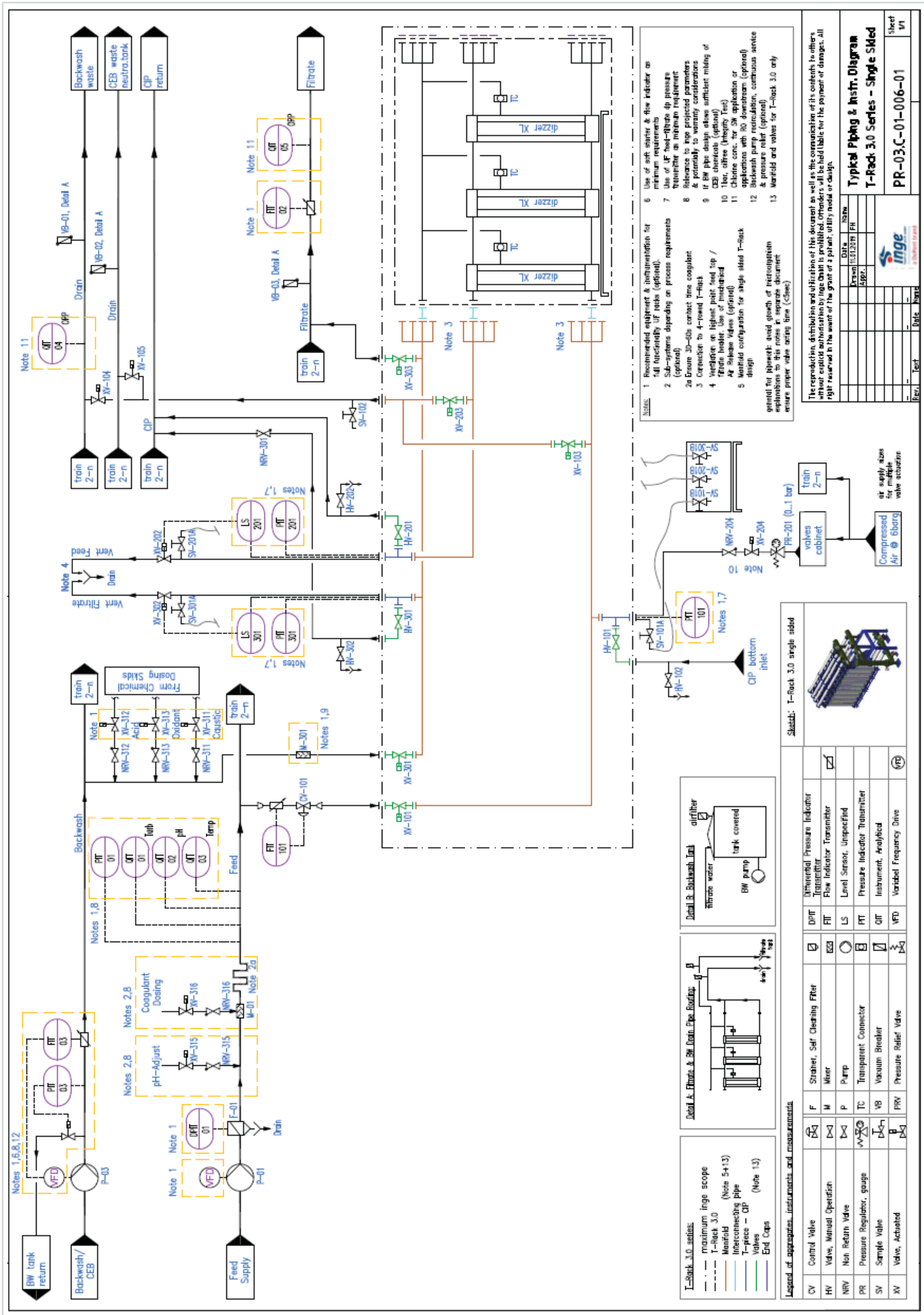

Figure 8.2-2 - Flow Diagram for UF System T- Rack®
(version single sided)

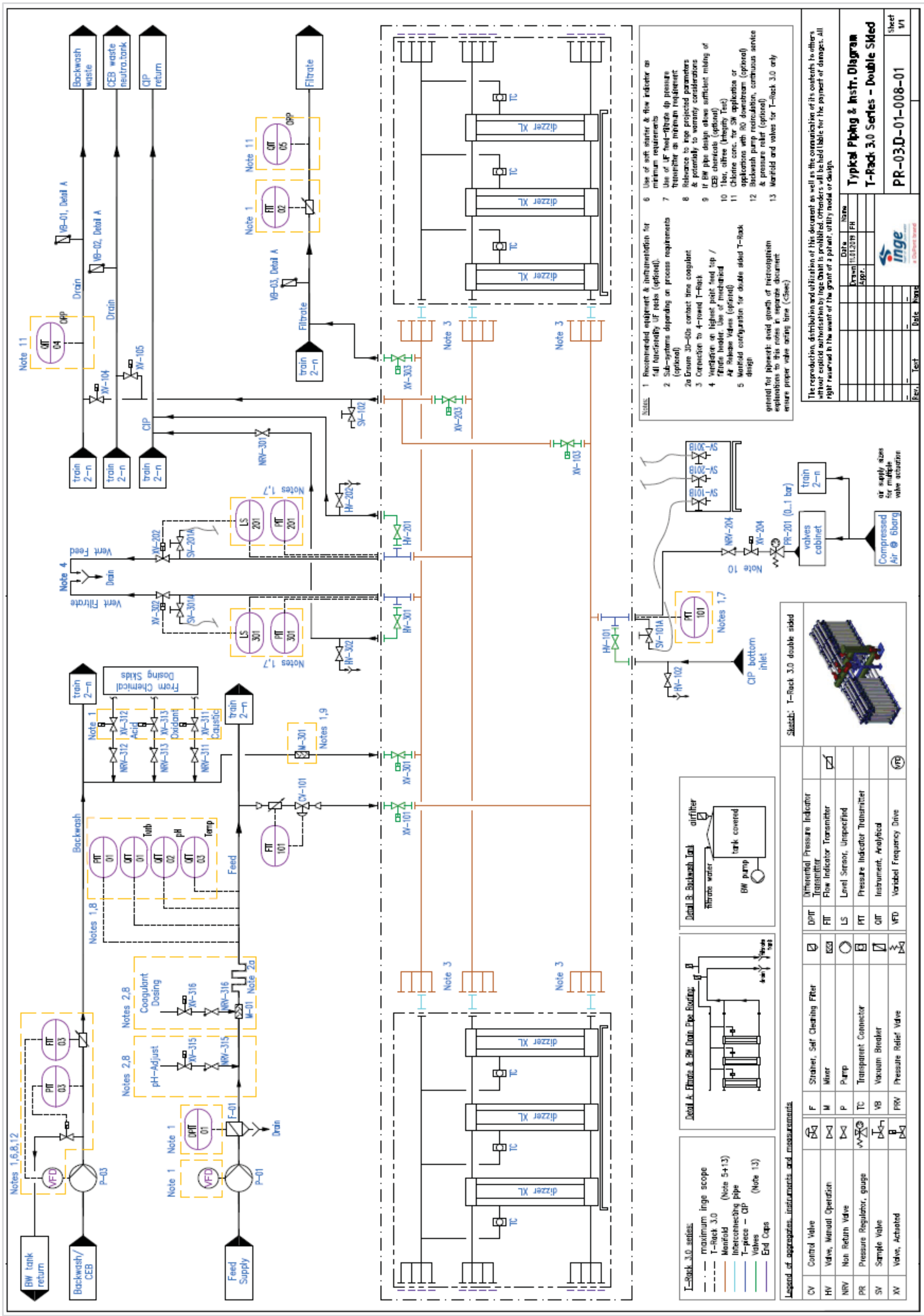

Figure 8.2-3 - Flow Diagram for UF System T-Rack™ (version double sided)

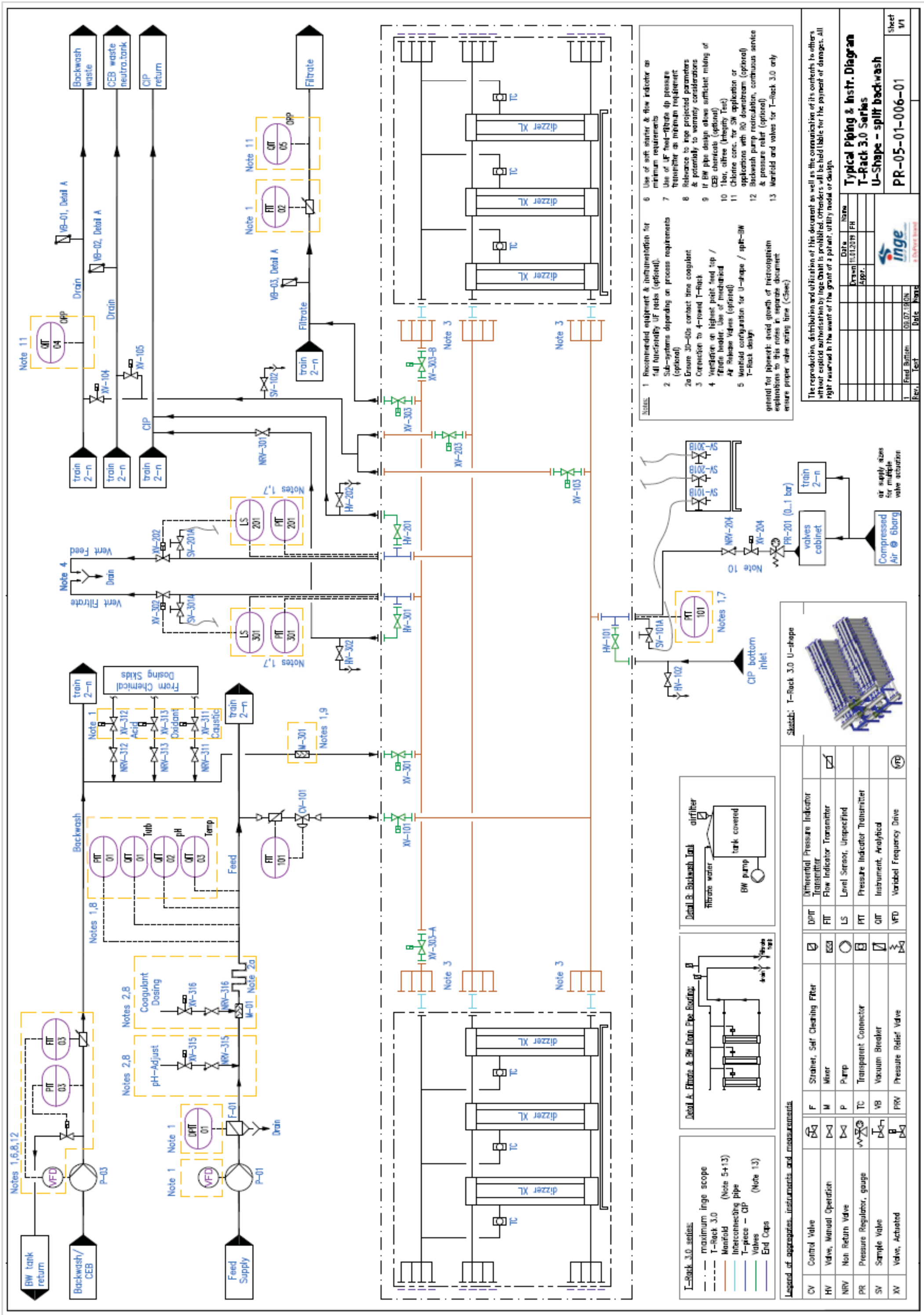

Figure 8.2-4 - Flow Diagram for UF System T-Rack™ (version split rack)