POLITÉCNICA

ESCUELA TÉCNICA SUPERIOR DE INGENIEROS INDUSTRIALES
UNIVERSIDAD POLITÉCNICA DE MADRID

José Gutiérrez Abascal, 2. 28006 Madrid
Tel.: 91 336 3060
info.industriales@upm.es

www.industriales.upm.es

Sara Charco Iniesta

05 PROYECTO FIN DE CARRERA

INDUSTRIALES

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INSTRUMENTATION PROJECT OF 3rd DESALINATION PLANT AT TUAS (SINGAPORE)

PROYECTO FIN DE CARRERA
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Sara Charco Iniesta

DIRECTOR DEL PROYECTO:
Rafael Borge García

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University tutor: **Rafael Borge García**
Company tutor: **Eduardo Arroyo González**
Author: **Sara Charco Iniesta**

SUMMARY

This project consists on the description of instrumentation used in Tuas III desalination plant at Singapore and its flow process description.

The project has been developed as part of the work of the instrumentation department of the responsible company of the engineering design of Tuas III desalination plant.

First of all is important to know the water problems which suffer all the people who live in Singapore. Singapore is a city-state and is home to 5.5 million residents. The country has one of the highest per capita incomes. Unfortunately Singapore has few rivers, only 1.4% of its surface is fresh water.

For that reason, PUB (Public Utilities Board) a national water agency of Singapore, has built a water supply plant based on four water sources known as the Four National Taps: Local Catchment Water, Imported Water, Reclaimed water (known as NEWater) and Desalinated water. The four taps are explained into the project.

The objective of this project is defining a real desalination project from the point of view of instrumentation.

Tuas III desalination plant consist on a Sea Water Reverse Osmosis (SWRO) plant which will have a total net design capacity of 47,45 Hm^3/year of product water in an operational period of 365 days a year, with a net daily design capacity of 130.000 m^3/day of product water.

One important part of this project is the instrumentation because this entire project has been described by instrumentation point of view. Instrumentation is the development or use of measuring instruments for observation, monitoring or control. An instrument is a device that measures a physical quantity variable, such as flow, temperature, level and pressure, these are the most important variables that should be controlled to get a safety and efficient process. Instruments may be as simple as direct reading hand-held thermometers or as complex as multi-variable process analyzers. The part of instrumentation is described in chapter 2. The instruments used in Tuas III are listed below.

Pressure: bourdon manometers and membrane pressure and differential pressure transmitters. For assembly pressure transmitters is used a two valves manometer and for differential pressure is used a five valve manifold.

Flow: electromagnetic flowmeter, vortex, rotameters and thermal flow switches.

Level: magnetic level indicator, hydrostatic level transmitter, float level switches, ultrasonic transmitter, radar transmitter and vibrating fork switches.

Temperature: Resistive Temperature Detector (RTD) sensors with thermowell and transmitter.

Analyzer: Oxygen reduction potential (ORP), O_2, Turbidity, Conductivity, pH, Particle counter, total organic carbon (TOC), Chlorine, Hydrocarbon, Algae, Fluoride and Ammonia.

Desalination is a separation process used to reduce the dissolved salt content of saline water to a usable level. All desalination processes involve three liquid streams: the saline feedwater (seawater), low-salinity product water, and very saline concentrate water (brine).

A desalination plant transforms seawater into drinkable water. This plant uses reverse osmosis (RO) which retires all the salts and ions dissolved in seawater. The RO membranes consist on some special membranes which allow the water pass, but not the ions. The problem is that any solid matter could obstruct these membranes and for that reason previously the water is filtered and ultra-filtered.

In the RO process, water from a pressurized saline solution is separated from the dissolved salts by flowing through a water-permeable membrane. The permeate (the liquid flowing through the membrane) is encouraged to flow through the membrane by the pressure differential created between the pressurized feedwater and the product water, which is at near-atmospheric pressure. The remaining feedwater continues through the pressurized side of the reactor as brine. No heating or phase change takes place. The major energy requirement is for the initial pressurization of the feedwater.

In practice, the feedwater is pumped into a closed container, against the membrane, to pressurize it. As the product water passes through the membrane, the remaining feedwater and brine solution becomes more and more concentrated. This brine solution is adequate treated before sending this steam to shoreline.
A desalination process can be resumed as follows:

Pretreatment: The incoming feedwater is pretreated to be compatible with the membranes by removing suspended solids, adjusting the pH, and adding a threshold inhibitor to control scaling caused by constituents such as calcium sulphate.

Pressurization: The pump raises the pressure of the pretreated feedwater to an operating pressure appropriate for the membrane and the salinity of the feedwater.

Separation: The permeable membranes inhibit the passage of dissolved salts while permitting the desalinated product water to pass through. Applying feedwater to the membrane assembly results in a freshwater product stream and a concentrated brine reject stream. Because no membrane is perfect in its rejection of dissolved salts, a small percentage of salt passes through the membrane and remains in the product water.

Stabilization: The product water from the membrane assembly usually requires pH adjustment and degasification before being transferred to the distribution system for use as drinking water.

This process is controlled by instruments assembled on it. For this reason, instrumentation is an important part of engineering process.

In this project there are two different solutions which shall be evaluated; the first one is about instrumentation used to this project and the second one is about desalination as drinking water solution.

The instrumentation design has been developed to be the most efficient, safe, productive and environment friendly as possible.

The most efficiently is referred to the power is correctly used and like example; the energy recovery system is controlled by two differential pressure transmitter, four pressure transmitter and three pressure transmitter.

The safest is referred to control all the process values like pressure and make sure that an alarm is switch on when the pressure is out of range.

The most productive is referred to the production is controlled by a flowmeter (FIT-15601) which measure the flow sent to the network.

The most environmental friendly is referred to control the quality of brine which is sent back to the sea; this part of the plant is controlled by six analyzers.

To resume the second important point of this project, the list of pros and cons of construction of a desalination plant is included.

- **List of pros**

1. *It is proven and effective.* The method of reverse osmosis to remove salt from seawater has been proven to be effective in creating a fresh source of drinking water that is needed to increase the health benefits to people who has not other water source. In fact desalination plants can create water that is good quality and drinkable.
2. *It has the massive ocean water as source.* Even if all water would come from desalination plants, seawater can serve as almost inexhaustible source. This implies that people would have sufficient access to freshwater needed for growing crops, for everyday living and other needs, even in times of drought.
3. *Its method is highly understood.* The desalination method is backed up by scientific data and is highly understood. The technology used is so reliable that it allows for high-quality water, which means that using such method should allow for great results and could help eliminate water shortage crisis that the world might face in the future.
4. *Its plants are built in safe locations.* Desalination plants are and will be located away from large residential communities. Some of those already existing today are located in industrial facilities, which mean that people are not put at risk. Companies that are planning to construct desalination plants have plans in place to make the projects safer in the long run.

- **List of cons**

1. *It can be a very costly process***.** For the average desalination plant these days, it takes 2 kWh of energy in order to produce 1 cubic meter of fresh water. Though this would translate to a cost of just under 2 dollars on a lot of power grids, the real production cost comes from the expenditure of fossil fuels that are needed to create electricity for its process.
2. *Its plants are expensive to build.* Though most plants have operations cost reasonably, building them is not always available for a country or a community. The cost is so very high that some authorities prevented the technology to be developed because they just cannot afford its initial investment.
3. *It demands high energy costs.* One big problem with desalination is the enormous amount of energy it consumes. The process includes reverse osmosis which demands a high amount of energy to reverse. This plant has been designed with a energy recovery system to reduce the energy consumption but this consumption is still a big problem.

In conclusion, I think that the costs of desalination are worth the gains because desalination means an alternative to fresh water. All we need to survive is fresh water and desalination is a good method to do it possible.
At the end of the project there are five annexes which show the most of the work done in the company during the period of work time. These annexes are the habitual deliverables in a general project.

Annex I: Pipe and instrumentation diagrams (P&ID). This document consist on a map where there is installed the pipes, instruments and equipments which are needed for the correct and safe process work.

Annex II: Datasheets. These sheets show all the necessary characteristics of the instruments that shall be purchasing. These sheets are grouped by three or four instruments per sheet; however there are too many instruments, so only one sheet per instrument is included at this annex.

Annex III: Instrument specification. In this document is included the characteristics that the instruments shall comply by the tender or contract with the client. The difference between this document and data sheet is that sometimes there are deviations between the instrument required and the instrument finally purchased. However at the beginning of the project the difference between these two documents is that datasheets are like a summary of the instrument specifications.

Annex IV: Instrument list. This list shows all the instruments included in the plant. When all the P&ID are updated, the instruments list shall be modified in concordance.

Annex V: Hook up. These pictures are a sketch of instruments assembly, the process connection, the tubing used, how the instrument will be installed in the plant...all these data are drawn and specified in this document. This document is important to complete the instrument list, to purchase the correct instrument and to clarify which part is piping department and which part is instrumentation department.

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1. INTRODUCTION

1.1. Seawater problems and solutions for human consumption

Water is a vital element for human life, for that reason people lives near to drinking water sources. However sometimes this situation is not possible, one of those cases is the case of Singapore.

Singapore is a city-state and is home to 5.5 million residents. The country has one of the highest per capita incomes. Unfortunately Singapore has few rivers, only 1.4% of its surface is fresh water.

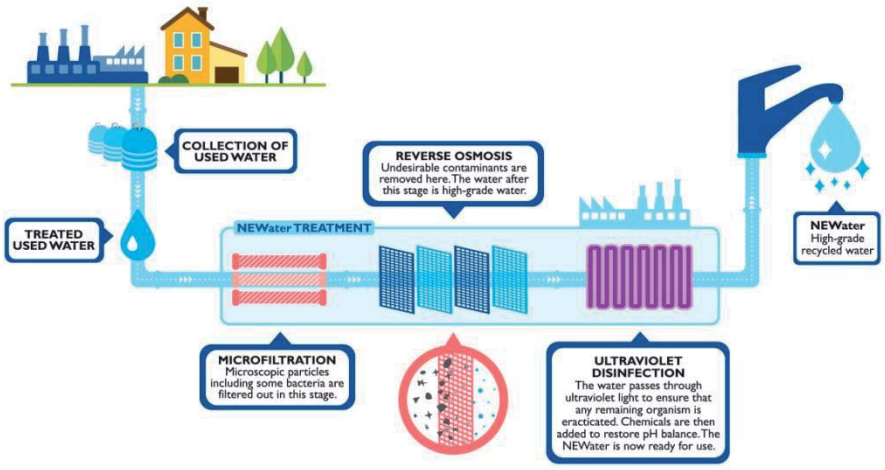
Nowadays a Singapore national water agency, named PUB or Public Utilities Board which is the national water agency that manages Singapore's water supply, water catchment and used water in an integrated way. PUB is a statutory board under the Ministry of the Environment and Water Resource.

Singapore has built a robust, diversified and sustainable water supply from four water sources known as the Four National Taps – Local Catchment Water, Imported Water, Reclaimed water (known as NEWater) and Desalinated water. In integrating the water system and maximizing the efficiency of each of the four taps, Singapore has overcome its lack of natural water resources to meet the needs of a growing nation. These four taps are describing by following lines:

1) Water for local catchment: as I mentioned before, Singapore has no natural water resources. As it is only about 700 square kilometers in land area, it lacks the space to catch and store the rain that falls on this island. For that reason, two-thirds of Singapore's land area is used to collect rainwater and constitutes their 17 reservoirs which through a network of rivers, canals and drains, collect so much rain as they can. Singapore oldest reservoirs are located in the Central Catchment Nature Reserve, a protected area that has been reforested to protect the water resources and act as a "green lung" for the city. The larger reservoirs, however, have been built after independence and are located in river estuaries that have been closed off by barrages. Reservoir water is treated through chemical coagulation, rapid gravity filtration and disinfection.
2) Imported water: under two bilateral agreements, Singapore has been importing water from Johor, Malaysia. The first agreement expired in August 2011. The second agreement will expire in 2061.
   Singapore imports water from Johor state in Malaysia through a pipeline that runs along a 1 km bridge, the Johor–Singapore Causeway, which also carries a road and a railway. As of 2009, imported water had been reduced from 50% previously to 40% of total consumption. After the expiry of a 1961 water agreement between Malaysia and Singapore in 2011, two agreements are in force now. One was signed in 1962 and another one in 2000. Both will expire in 2061. Under the first agreement the price of raw water is set at a very low level of 3 Malaysian cents per 1,000 imperial gallons (4,500 L), corresponding to about 0,2 US cents per cubic meter.

Illustration 1: Singapore map

3) Reclaimed water: this water, called NEWater, is treated wastewater (sewage) that has been purified using dual-membrane (via microfiltration and reverse osmosis) and ultraviolet technologies, in addition to conventional water treatment processes. The water is potable and is consumed by humans, but is mostly used by industries requiring high purity water.
   Presently Singapore's four NEWater plants can meet up to 30% of the nation's current water needs. By 2060, NEWater is expected to meet up to 55% of Singapore's future water demand. This is the reason why Singapore has two water pipelines, one for drinking water and the other one is used for catching all wastewater.

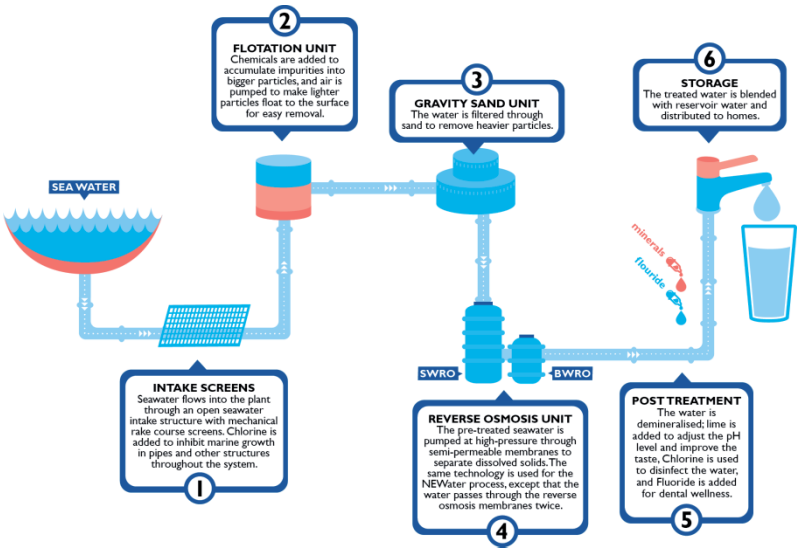


4) Desalination water: nowadays, Singapore has two desalination plants with a third desalination plant to be completed in 2017. Singspring, the first plant opened in 2005, produces 30 million gallons of water a day (136,000 m^3). The latest plant, Tuaspring opened in 2013 has a capacity of treating 70 million gallons of water (318,500 m^3) a day.

   In September 2005, Singapore turned on its fourth National Tap - desalinated water, with the opening of the SingSpring Desalination Plant in Tuas. It was PUB's first public-private partnership (PPP) project. SingSpring Pte Ltd was appointed to design, build, own and operate the plant and supply water to PUB. One of the region's largest seawater reverse-osmosis plants, this plant can produce 30 million gallons of water (130,000 m^3) a day.

   At the SingSpring desalination plant, sea water first goes through a pre-treatment process where suspended particles are removed before reverse osmosis (RO), using the same technology for the production of NEWater. The water produced is very pure and is then remineralised. After treatment, desalinated water is blended with treated water before it is supplied to homes and industries in the western part of Singapore.

   Tuaspring Desalination Plant is the second and larger desalination plant with a capacity of 70 million or 318,500 m^3 of desalinated water per day. Today, desalinated water can meet up to 25% of Singapore's current water demand and it is slated to continue doing so until 2060.



Water demand in Singapore is currently about 430 million gallons a day (mgd), with homes consuming 45% and the non-domestic sector taking up the rest. By 2060, total water demand could almost double, with the non-domestic sector accounting for about 70%. By then, NEWater and desalination will meet up to 80% of Singapore's future water demand.

1.2. Tuas III desalination plant at Tuas, Singapore

Tuas III desalination plant consist on a Sea Water Reverse Osmosis (SWRO) plant which will have a total net design capacity of 47,45 Hm³/year of product water in an operational period of 365 days a year, with a net daily design capacity of 130.000 m³/day of product water.

Reverse osmosis (RO) is a water purification technology that uses a semi permeable membrane to remove ions, molecules, and larger particles from drinking water. In reverse osmosis, an applied pressure is used to overcome osmotic pressure, a colligative property, which is driven by chemical potential differences of the solvent, a thermodynamic parameter. Reverse osmosis can remove many types of dissolved and suspended species from water, including bacteria, and is used in both industrial processes and the production of potable water. The result is that the solute is retained on the pressurized side of the membrane and the pure solvent is allowed to pass to the other side. To be "selective", this membrane should not allow large molecules or ions through the pores (holes), but should allow smaller components of the solution (such as solvent molecules) to pass freely.

In the normal osmosis process, the solvent naturally moves from an area of low solute concentration (high water potential), through a membrane, to an area of high solute concentration (low water potential). The driving force for the movement of the solvent is the reduction in the free energy of the system when the difference in solvent concentration on either side of a membrane is reduced, generating osmotic pressure due to the solvent moving into the more concentrated solution. Applying an external pressure to reverse the natural flow of pure solvent, thus, is reverse osmosis. The process is similar to other membrane technology applications. However, key

differences are found between reverse osmosis and filtration. The predominant removal mechanism in membrane filtration is straining, or size exclusion, so the process can theoretically achieve perfect efficiency regardless of parameters such as the solution's pressure and concentration. Reverse osmosis also involves diffusion, making the process dependent on pressure, flow rate, and other conditions. Reverse osmosis is most commonly known for its use in drinking water purification from seawater, removing the salt and other effluent materials from the water molecules.

1.3. Objective

The objective of this project is defining a real desalination project from the point of view of instrumentation.

In order to reach this objective, is necessary to begin explaining basic instrumentation concepts until explain the example of Tuas desalination plant.

The project has been developed as part of the work of the instrumentation department of the responsible company of the engineering design of Tuas III desalination plant.

2. INSTRUMENTATION FOR DESALINATION PLANTS

2.1. Introduction to instrumentation

Instrumentation is the development or use of measuring instruments for observation, monitoring or control.

An instrument is a device that measures a physical quantity variable, such as flow, temperature, level and pressure, these are the most important variables that should be controlled to get a safety and efficient process. Instruments may be as simple as direct reading hand-held thermometers or as complex as multi-variable process analyzers.

Characteristics of instruments are included in datasheets (Annex II includes one example of each instrument datasheet, but not all the instruments datasheets due to the extension of the real documents) which show data as measure type, power supply, process data, material… and technical specifications (in Annex III has just been included flow specification document due to the extension of all the real documents) define the minimum requirements for developing the detailed engineering, manufacture, supply of material, testing, packing, delivery, assembly and commissioning of the instruments. These two documents are commonly used for purchasing all the instruments needed.

2.2. Instruments classification attending to process variable

a) Pressure instruments

In many ways, pressure is the primary variable for a wide range of process measurements. Many types of industrial measurements are actually inferred from pressure, such as:

- Flow (measuring the pressure dropped across a restriction)
- Liquid level (measuring the pressure created by a vertical liquid column)
- Liquid density (measuring the pressure difference across a fixed-height liquid column)
- Weight (hydraulic load cell)

As such, pressure is a very important quantity to measure, and measure accurately.

Pressure is the force per unit area that a liquid or gas exerts on its surroundings and the force that liquids exert on the bottom and walls of a container.

Pressure units are a measure of force acting over unit area. It is most commonly expressed in pounds per square inch (psi) or sometimes pounds per square foot (psf) in English units; or Pascals (Pa) in metric units, which is the force in Newtons per square meter (N/m2).

$$Pressure = \frac{force}{area}$$

	Water		*Mercury***		*kPa*	*psi*
	in#	*cm**	*mm*	*in*		
1 psi	27.7	70.3	51.7	2.04	6.895	1
1 psf	0.19	0.488	0.359	0.014	0.048	0.007
1 kPa	4.015	10.2	7.5	0.295	1	0.145
1 atm	407.2	1034	761	29.96	101.3	14.7
1 torr	0.535	1.36	1	0.04	0.133	0.019
1 millibar	0.401	1.02	0.75	0.029	0.1	0.014

#at 39°F *at 4°C **Mercury at 0°C

There are many methods to measure pressure; some of them will be explained in this chapter.

➢ Manometers

A very simple device used to measure pressure is the manometer: a fluid-filled tube where an applied gas pressure causes the fluid height to shift proportionately. This is why pressure is often measured in units of liquid height (e.g. inches of water, inches of mercury). A manometer is fundamentally an instrument of differential pressure measurement, indicating the difference between two pressures by a shift in liquid column height; as shown in the Illustration 2.

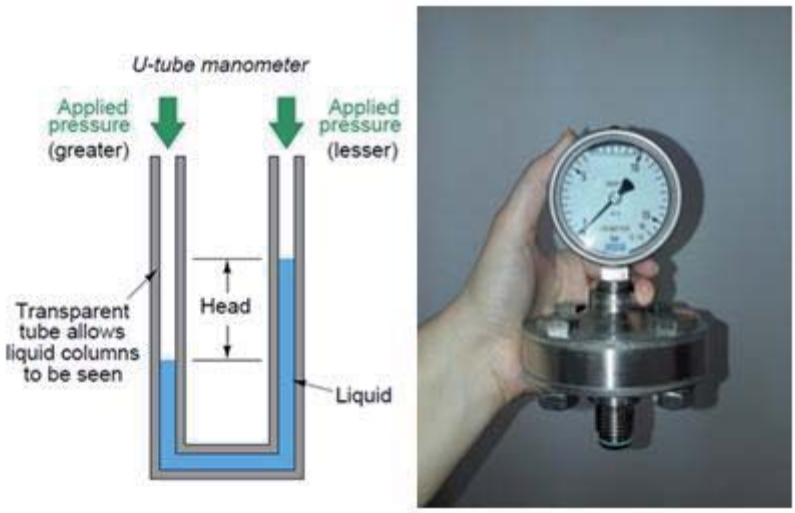


Illustration 2: Manometer operation (left) and manometer example

The term manometer is derived from the ancient Greek words 'manós', meaning thin or rare, and 'métron'. A manometer is inexpensive.

Note that venting one side of a manometer is standard practice when using is as a gauge pressure indicator (responding to pressure in excess of atmospheric). Both pressure ports will be used if the manometer is applied to the measurement of differential pressure. Absolute pressure may also be measured by a manometer, if one of the pressure ports connects to a sealed vacuum chamber.

- **Mechanical pressure elements**

Mechanical pressure-sensing elements include the bellows, the diaphragm, and the bourdon tube. Each of these devices converts a fluid pressure into a force. If unrestrained, the natural elastic properties of the element will produce a motion proportional to the applied pressure.

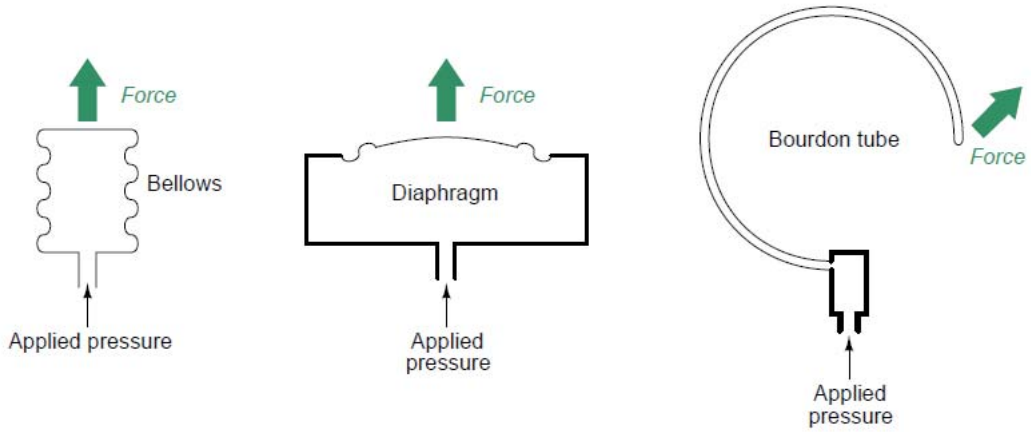


Illustration 3: Mechanical pressure sensing elements

The bellows is a one piece, collapsible, seamless metallic unit that has deep folds formed from very thin walled tubing. System of line pressure is applied to the internal volume of the bellows. As the inlet pressure to the instrument varies, the bellows will expand or contract. The moving end of the bellows is connected to a mechanical linkage assembly. As the bellows and linkage assembly moves, either an electrical signal is generated or a direct pressure indication is provided. Up to the elastic limit of the bellows, the relation between increments of load and deflection is linear.

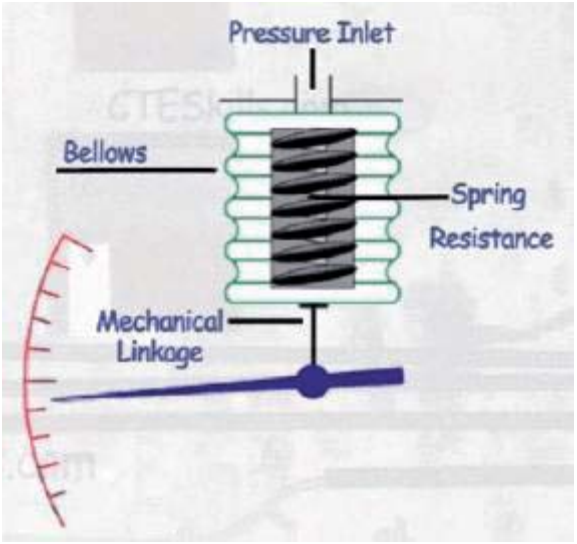


Illustration 4: Bellows working principle

However, this relationship exists only when the bellows is under compression. It is necessary to construct the bellows such that all of the travel occurs on the compression side of the point of equilibrium. Therefore, in practice, the bellows must always be opposed by a spring, and the deflection characteristics will be the resulting force of the spring and bellows. Phosphor Bronze, Brass, Beryllium Copper, Stainless Steel are normally used as the materials for bellows.

A diaphragm is nothing more than a thin disk of material which bows outward under the influence of a fluid pressure. Many diaphragms are constructed from metal, which gives them spring-like qualities. Some diaphragms are intentionally constructed out of materials with little strength, such that there is negligible spring effect. These are called slack diaphragms, and they are used in conjunction with external mechanisms that produce the necessary restraining force to prevent damage from applied pressure.

As pressure is applied to the rear of the diaphragm, it distends upward, causing a small shaft to twist in response. This twisting motion is transferred to a lever which pulls on a tiny link chain wrapped around the pointer shaft, causing it to rotate and move the pointer needle around the gauge scale.

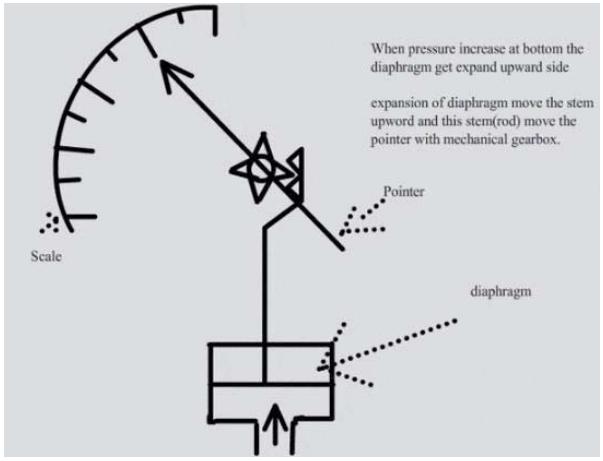


Illustration 5: Diaphragm working principle

To this project, Bourdon pressure gauges are used. This manometer works on a simple principle that a bent tube will change its shape when exposed to variations of internal and external pressure. As pressure is applied internally, the tube straightens and returns to its original form when pressure is released. The tip of the tube moves with the internal pressure change and is easily converted with a pointer onto a scale. A connector link is used to transfer the tip movement to the geared movement sector. The pointer is rotated through a toothed pinion by the geared sector. As shows Illustration 6.

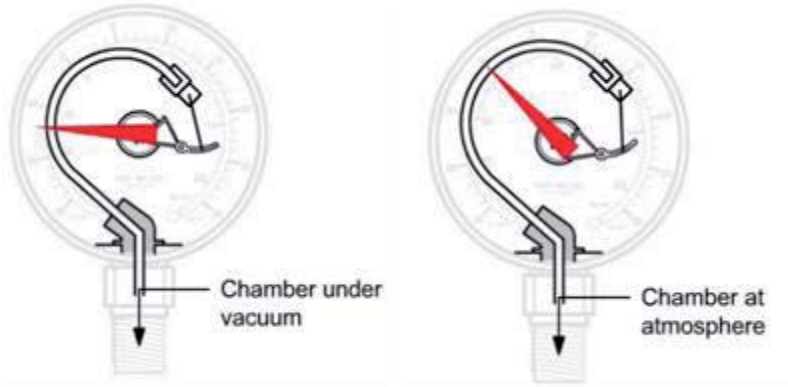


Illustration 6: Bourdon tube working principle

The main advantage with Bourbon tube is that it has a wide operation (depending on the tube material). This type of pressure measurement can be used for positive or negative pressure ranges, although the accuracy is impaired when in a vacuum. For that reason and its inexpensive price, this pressure gauge has been chosen for Tuas III desalination plant.

Illustration 7 shows a real bourdon manometer with a seal, this seal is used when the fluid is corrosive to protect the manometer.

Illustration 7: Bourdon manometer

- **Pressure and Differential pressure transmitters**

Pressure transmitter has a inside diaphragm that expands or compress depending on the applied force and differential pressure transmitters sense the difference in pressure between two ports and outputs a signal representing that pressure in relation to a calibrated range.

Illustration 8: Pressure transmitter

Differential pressure (DP) measurement is largely used in domestic and industrial applications. It is often the basis of other measurements such as flow, level, density, viscosity and even temperature.

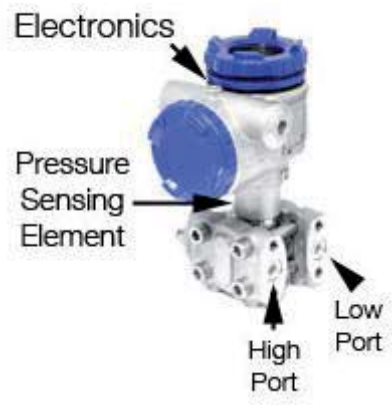


Illustration 9: Differential pressure transmitter

5) Manifold

A manifold is a device that is used to ensure that the capsule will not be over-ranged. It also allows isolation of the transmitter from the process loop.

Tuas desalination Plant will have only 2 types of manifolds: 2 valves or 5 valves.

2 valves manifold: It consists of two block valves (high pressure “HP” and low pressure “LP” block valve) and one tap for drain. Two block valves provide instrumentation isolation and one drain tap is positioned between the high and low transmitter process connections to allow drainage for instrument or for process.

During normal operation, the drain tap is closed and the two block valves are open (like shows the Illustration 10). When the transmitter is put into or removed from service, the valves must be operated in such a manner that very high pressure is never applied to only one side of the DP capsule.

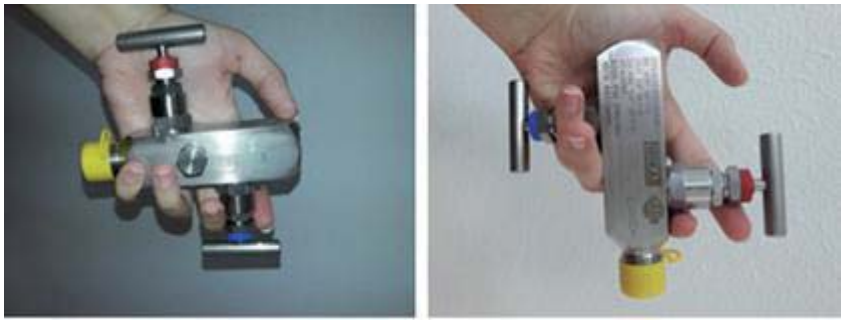


Illustration 10: 2 valve manifold

5 valves manifold: During normal operation, the HP and LP valves are open while the equalizing valves and the bleed valve are closed. However, it is critically important that the equalizing valve(s) never be open while both block valves are open. If the process fluid is dangerously hot or radioactive, a combination of open equalizing and block

valves will let that dangerous fluid reach the transmitter and manifold, possibly causing damage or creating a personal hazard.

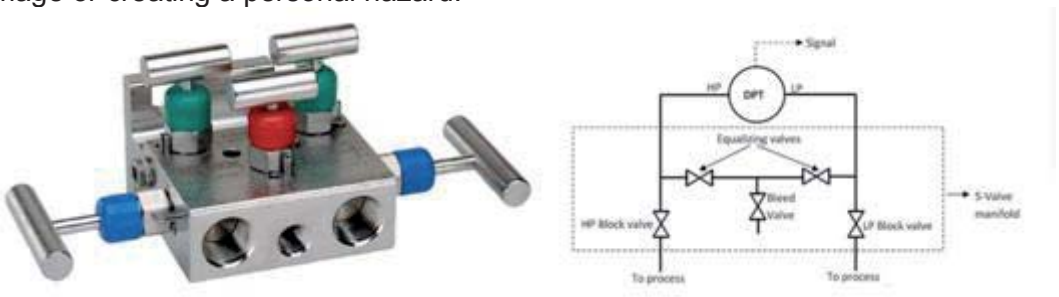


Illustration 11: Five valves manifold

As the Illustration 11 shows 5 valve manifold is used when differential pressure transmitter is installed.

b) Flow instruments

Flow measurements can be divided depending on principle of measurement: differential pressure, electromagnetic, ultrasonic, vortex and rotameters. The choice of measuring device will depend on the required accuracy, flow rate, range, and fluid characteristics

- **Differential pressure**

Many flow measurement instruments use indirect measurements, such as differential pressures, to measure the flow rate. These instruments measure the differential pressures produced when a fluid flows through a restriction. The differential pressure produced is directly proportional to flow rate. Such commonly used restrictions are: the orifice plate, the Venturi tube, the flow nozzle and the Dall tube.

The *orifice plate* is normally a metal diaphragm with a constricting hole. The diaphragm is normally clamped between pipe flanges to give easy access. The differential pressure ports can be located in the flange on either side of the orifice plate, or alternatively, at specific locations in the pipe on either side of the flange. A differential pressure gauge is used to measure the difference in pressure between the two ports. The differential pressure gauge can be calibrated in flow rates. The lagging edge of the hole in the diaphragm is bevelled to minimize turbulence.

Illustration 12: Orifice plate

The *Venturi tube* uses the same differential pressure principal as the orifice plate. The Venturi tube normally uses a specific reduction in tube size, and is normally well suited for use in larger diameter pipes, but it becomes heavy and excessively long. One advantage of the Venturi tube is its ability to handle large amounts of suspended solids. It creates less turbulence and insertion loss than the orifice plate. The differential pressure taps in the Venturi tube are located at the minimum and maximum pipe diameters. The Venturi tube has good accuracy, but is expensive.

Illustration 13: Venturi tube

The *flow nozzle* is a good compromise on cost and accuracy between the orifice plate and the Venturi tube for clean liquids. It is not normally used with suspended particles. Its main use is the measurement of steam flow.

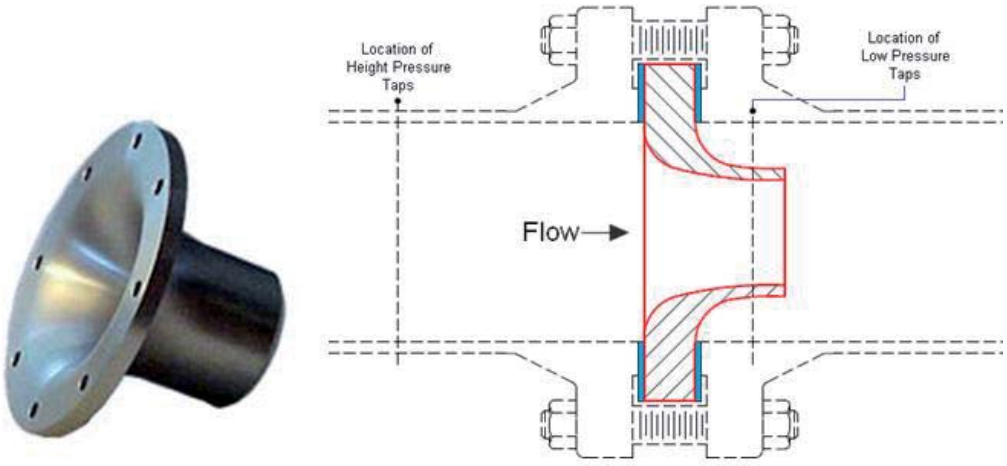


Illustration 14: Flow nozzle

The *Dall tube* has the lowest insertion loss, but is not suitable for use with slurries. Dall tube is a shortened version of a Venturi tube with a lower pressure drop than an orifice plate. The flow rate in a Dall tube is determinate by measuring the pressure drop caused by restriction in the conduit. Dall tubes are widely used for measuring the flow rate of large pipe works. Differential pressure produced by a Dall tube is higher than Venturi tube and nozzle, all of them with same throat diameters.

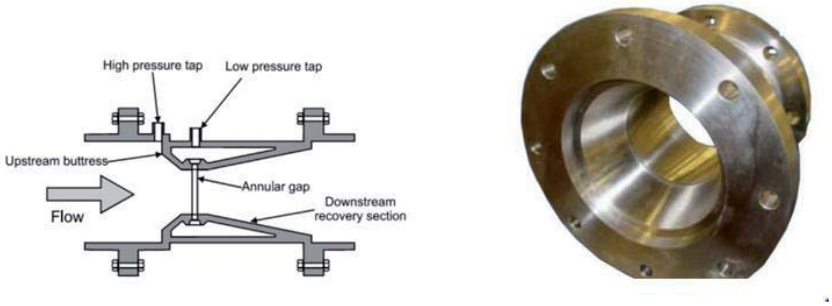


Illustration 15: Dall tube

These instruments type (differential pressure for flow measurement) is not used for Tuas III desalination plant due to the pressure drop which makes necessary more power to recovery energy waste in that pressure drop.

- **Electromagnetic**

These flow meters work on Faraday's Law of electromagnetic induction. According to this principle, when a conductive medium get into a magnetic field, a voltage is generated which is proportional to the velocity of the fluid which is passed through it.

Magnetic flow meter is instead, a volumetric flow meter which is ideally used for wastewater applications (like in a desalination plant) and applications that experience low pressure drop and with appropriate liquid conductivity required.

Electromagnetic flow meter consist on an electromagnetic coil which generates a magnetic field and electrodes that capture the voltage, when there is no fluid flow, the voltage between electrodes is zero. This voltage which is detected by those sensing

electrodes is sent to a transmitter which calculates the volumetric flow rate based on the pipe dimensions.

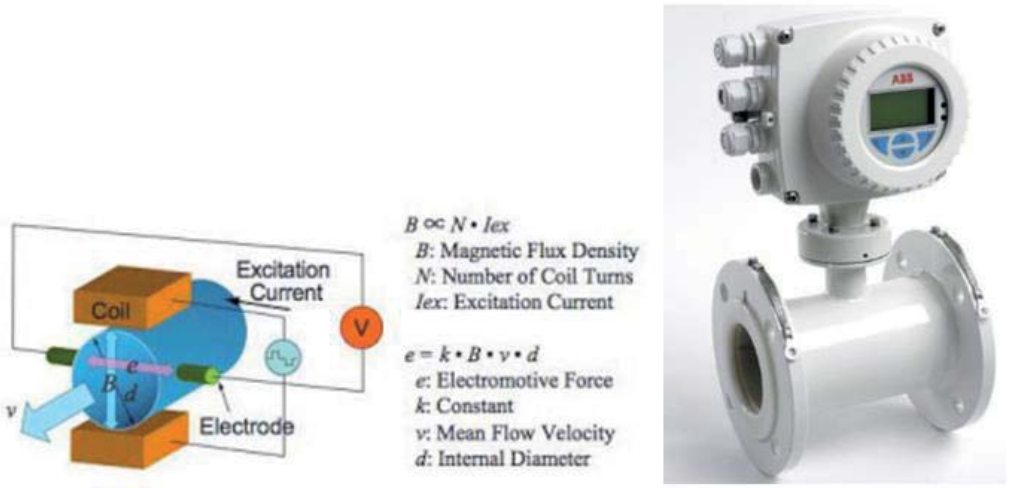


Illustration 16: Electromagnetic flow meter

- **Ultrasonic flowmeter**

The term ultrasonic is used to describe a pressure waves at frequencies higher than the human ears can detect. The velocity of sound waves in the fluid is the same as velocity of sound in the fluid. If an ultrasonic beam is transmitted across the pipeline at an angle to the flow direction, the tame taken for the pulse to reach the receiver is a function of the flow velocity of fluid, as well as the velocity of sound in the fluid.

Thus, this type of flowmeter operates on the principle of transit time differences. An acoustic signal (ultrasonic) is transmitted from one sensor to another. This can be either in the direction of flow (downstream) or against the direction of flow (upstream). The time (transit) that the signal requires to arrive at the receiver in then measured.

Two transducers with receivers are mounted diametrically opposite to each other, but inclined at 45° to the axis of the pipe. Each transducer transmits an ultrasonic beam at a frequency of approximately 1 MHz, which is produced by a piezoelectric crystal.

For that reason, flowcells are obliquely at a 45 angle across the diameter of the pipe. This type of flowcell (tilted diameter flowcell) can be configured as a single traverse or multiple traverses.

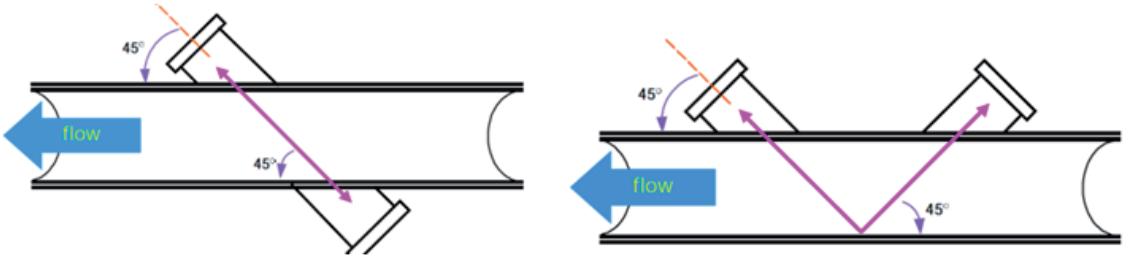


Illustration 17: Left shows single traverse flowcell and right shows multiple traverses flowcell

Ultrasonic flow meters are normally used to measure flow rates in large diameter, nonporous pipes and they required periodic calibration.

The advantage of this type of sensor is that the effects of temperature density changes cancel in the two beams. There is no obstruction to fluid flow, and corrosive or varying flow rates are not a problem, but the measurements can be affected by the Reynolds number or velocity profile. The transmitters can be in contact with the liquid, or can be clamped externally on to the pipe.

- **Vortex**

Vortex meters are volume flow meters. When a fluid moves with high Reynolds number past a stationary object (a“bluff body”), there is a tendency for the fluid to form vortices on either side of the object. Vortices will only occur from a certain velocity; consequently vortex meter will have an elevated zero referred to as the “cut-off” point. Before the velocity becomes nil, the meter output will be cut to zero.

At a certain back-flow (above the cut-off point) some vortex meters could produce an output signal which could lead to a false interpretation.

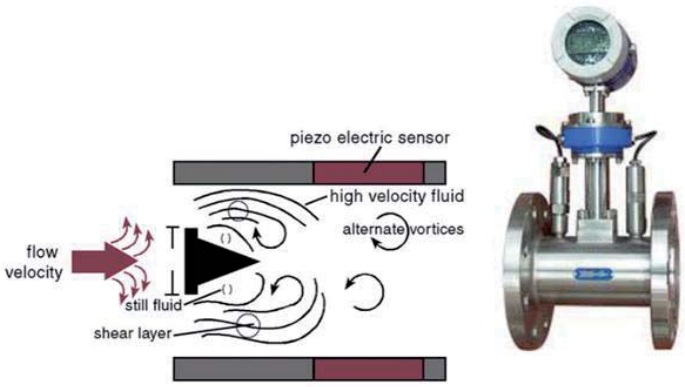


Illustration 18: Vortex

A significant disadvantage of vortex meters is a behavior known as low flow cutoff, where the flowmeter simply stops working below a certain flow rate. The reason for this is the cessation of vortices when the fluid’s Reynolds number drops below a critical value and the flow regime passes from turbulent to laminar. When the flow is laminar, fluid viscosity is sufficient to prevent vortices from forming, causing the vortex

flowmeter to register zero flow even when there may be some (laminar) flow through the pipe.

To the Tuas desalination plant, vortex flowmeters are used when low conductivity is reached because it is not possible to use electromagnetic flowmeter.

- **Rotameters**

A Variable-area flowmeter is one where the fluid must pass through a restriction whose area increases with flow rate. The simplest example of a variable-area flowmeter is the rotameter, which uses a solid object (called a plummet or float) as a flow indicator, suspended in the midst of a tapered tube.

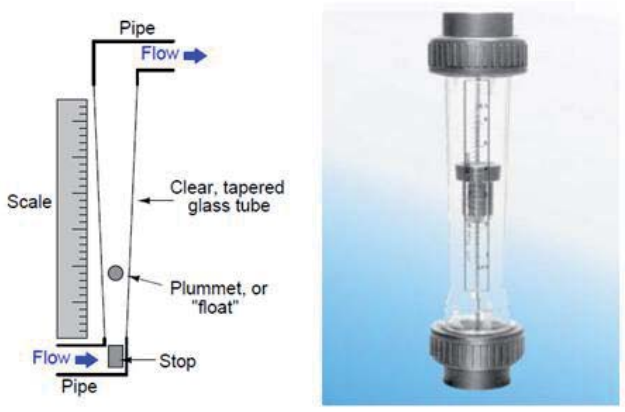


Illustration 19: Rotameter

A rotameter consists of a tapered tube, typically made of glass with a 'float', made either of anodized aluminum or a ceramic, actually a shaped weight, inside that is pushed up by the drag force of the flow and pulled down by gravity. The drag force for a given fluid and float cross section is a function of flow speed squared only.

A higher volumetric flow rate through a given area increases flow speed and drag force, so the float will be pushed upwards. However, as the inside of the rotameter is cone shaped (widens), the area around the float through which the medium flows increases, the flow speed and drag force decrease until there is mechanical equilibrium with the float's weight.

Floats are made in many different shapes, with spheres and ellipsoids being the most common. The float may be diagonally grooved and partially colored so that it rotates axially as the fluid passes. This shows if the float is stuck since it will only rotate if it is free. Readings are usually taken at the top of the widest part of the float; the center for an ellipsoid, or the top for a cylinder. Some manufacturers use a different standard.

The "float" must not float in the fluid: it has to have a higher density than the fluid, otherwise it will float to the top even if there is no flow.

c) Level instruments

A good way to reduce the number of level measurement options is to categorize them into two broad categories: contact and noncontact. Then you can filter choices by the type of material they can measure.

The characteristics of the process material being measured, such as tank size and shape, the pressure and temperature that the process requires, amount of material agitation, available power, etc., must be taken into account when determining if a contact or noncontact approach is the right option. One must consider whether the material is corrosive and could possibly cause damage to the measuring device, whether it is volatile and a contact sensor might create a safety hazard, whether the agitation, temperature, or pressure of the process material could affect the reading of or damage the contact sensor, and any other troublesome possibility.

On the other hand, noncontact solutions may be outside of the budgetary constraints of the project or not provide the necessary level of precision.

Contact Level Sensors

- **Level Sight Gauge**

The first type of level measurement device to be considered is also the simplest. A level sight gauge typically consists of a tube connected at openings near the top and bottom of the tank. The tube has a transparent face so an operator can see the level of the process material.

This method of level measurement may be considered the most reliable because the material level can actually be seen by the operator, pressure or temperature differentials between the tank and the viewing area can have an effect on measurement accuracy. Level sight gauges can only be used when measuring liquids, as granules and slurries cannot move fluidly through the gauge. There is also no way to incorporate any type of automation into the process using this type of measurement device.

In Tuas project is used magnetic level gauges which follow the same measure principle. The difference between these two instruments is how they show the level: magnetic gauge have inside the stand pipe of measure a float containing a permanent magnet which moves up and down following the change of liquid level.

On the outside of the stand pipe a transparent rail with indicator flaps are mounted. The small flaps hold small permanent magnets. The flaps are bi-colour for example red and yellow. When the float passes the flaps, the flaps are rotated 180° by the magnetic field in the float. The indicator shows the red colour up to the liquid level. Above the colour is yellow

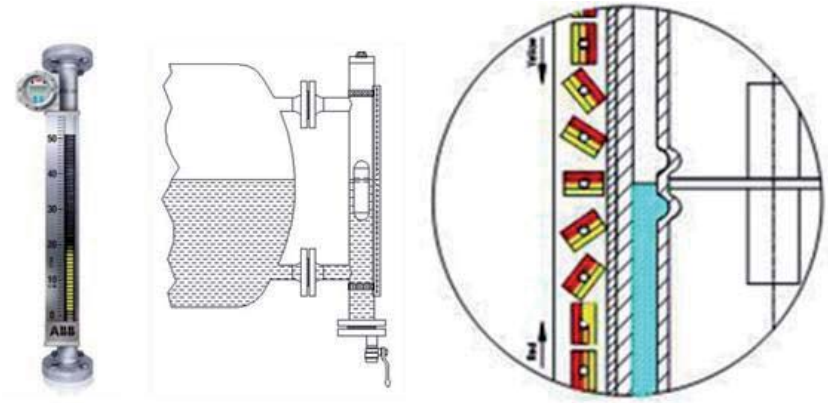


Illustration 20: Magnetic Level gauge

- **Float level switches**

Float level switches rely on the material's specific gravity (density) to measure level. The measurement of this kind of level switches consist on the extension and retraction of a cable connected to the float. This type of sensor, in principle, requires no power to operate but is susceptible to failure if there are mixers, liquid's turbulences or when they are used near to aspiration of submergible pumps.

In desalination industry there are a lot of types and sizes of float and they could be used for many applications, but the most commonly used in Tuas plant is used to indicate low or high level into a tank and then the necessary pumps are stopped or a discharge valve is opened.

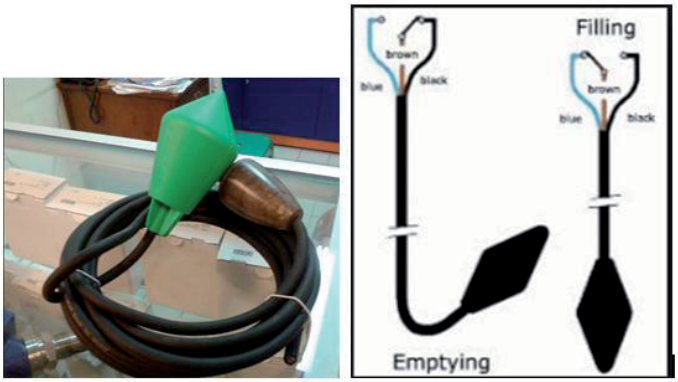


Illustration 21: Float level switch

- **Vibrating level switches**

Vibrating or turning fork level switches work under the principle that the sensor will vibrate at its resonant frequency when not submerged in process fluid. The tuning fork is piezoelectrically energized and vibrates at its mechanical resonance frequency of approximately 1 200 Hz.

The vibration frequency changes when the tuning fork is covered by the medium. This change is detected by the integrated oscillator and converted into a switching command. The integrated electronics evaluate the level signal and output a switching signal, directly operating connected devices. This technique works with liquids, slurries,

and granules, although consideration should be made for coating when corrosive materials.

Vibrating level switches will typically only be used for point level measurement, as opposed to continuous level measurement, and trigger high and/or low alarms. The sensors themselves tend to be fragile because of the level of precision necessary.

These switches are used when is not possible to use float switches for example, when there is a mixer inside the tank or submergible pumps.

Illustration 22: Vibrating fork level switches

Non-Contact Level Sensors

- **Radar level transmitter**

Radar typically works by emitting electromagnetic pulses in the direction of an object, waiting for that pulse to reflect off the object and return to the source, and measuring its time off light.

The distance between the pulse source and the object can be calculated as the product of one half the time off light and the speed of light. For use in level measurement, a radar transceiver is suspended from the top of the tank and measures the distance to the top of the process material. The overall length of the tank body can then be used to calculate the level. As a noncontact sensor, radar has the distinct advantage of not being affected by the process material's state, such as agitation, corrosiveness, tackiness, temperature, pressure, etc. Radar can be used to measure liquids, slurries, and granular solids. However, materials with high conductivity tend to be better candidate for radar level measurement because they reflect more of the emitted radio signal.

The distance to the surface is measured by short radar pulses. When a radar pulse reaches a media, part of the energy is reflected back to the level transmitter. Based on the time difference between the transmitted and the reflected pulse; level, volume, and level rate are calculated. Applications with, for example, turbulence, foam and long measuring ranges can reduce the reflected energy.

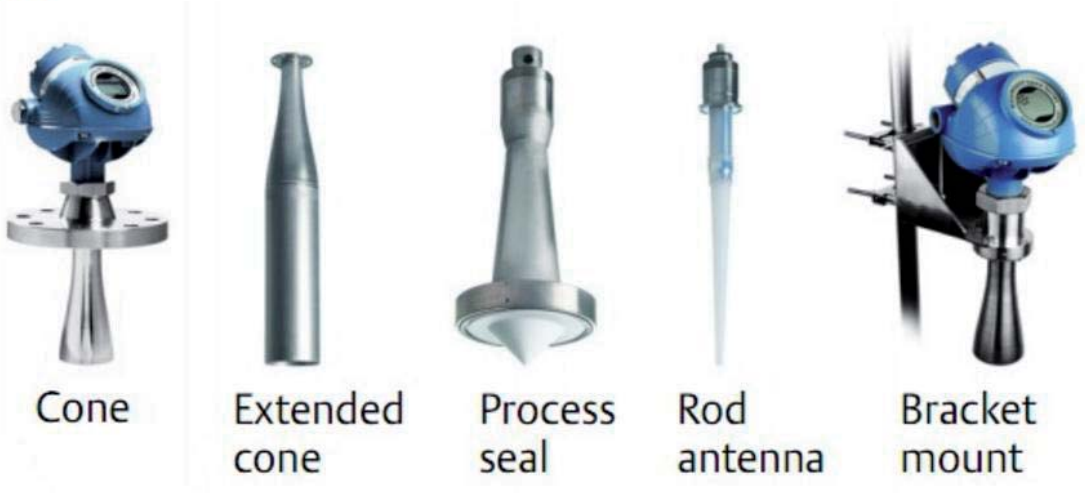


Illustration 23: Types of radar level transmitter antennas

This is only one type of radar level transmitter, but there are two basic type of radar level transmitters guided-wave radar and non-contact wave radar. Guided wave radar instruments use wave guide “probes” to guide the radio waves into the process fluid while non-contact radar instruments (explained before) are used in applications where the dielectric of process liquid in quite low. All radar level instruments use an antenna to broadcast or send radio signals to the process liquid whose level is to be determined.

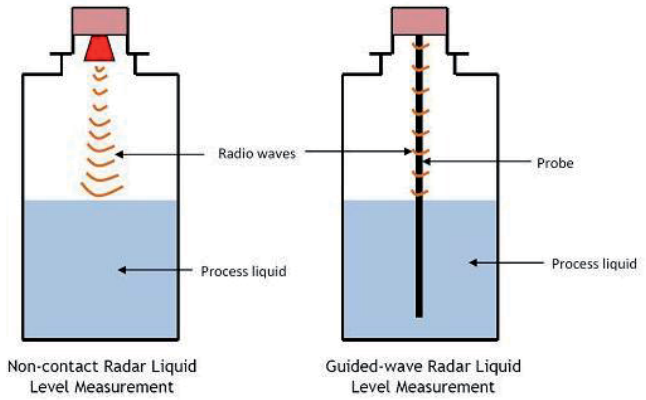


Illustration 24: Radar level transmitter type

- **Ultrasonic level transmitters**

Ultrasonic level sensors use a very similar method as radar sensors to measure level. However, instead of using radio waves they use sound waves and the distance is calculated as the product of one half the flight time and the speed of sound. Unlike the speed of light, the speed of sound is temperature dependent, so the temperature of the tank must also be measured and taken into account. Like radar, they can also be used to measure liquids, slurries, and granular solids. Process materials that produce a stronger sonic reflection are more applicable to this type of measurement.

Condensation, dust buildup, and presence of additional objects within the tank can all cause measurement inaccuracies.

An ultrasonic level transmitter is mounted on the top of the tank and transmits an ultrasonic pulse down into the tank. This pulse, travelling at speed of sound, is reflected back to the transmitter from liquid surface. The transmitter measures the time delay between the transmitted and received echo signal and the on-board microprocessor calculates the distance to the liquid surface.

Illustration 25: Ultrasonic level transmitter

The fundamental difference between a radar instrument and an ultrasonic instrument is the type of wave used: radio waves instead of sound waves. Radio waves are electromagnetic in nature (comprised of alternating electric and magnetic fields), and very high frequency (in the microwave frequency range – GHz). Sound waves are mechanical vibrations (transmitted from molecule to molecule in a fluid or solid substance) and of much lower frequency (tens or hundreds of kilohertz – still too high for a human being to detect as a tone) than radio waves.

- **Proximity switches**

A proximity sensor is a sensor able to detect the presence of nearby objects without any physical contact.

Proximity switches provide better alternative to the conventional electromechanical limit switches for position sensing. It is a best solution to all linear / rotary counting applications.

A critical element of sensing, automation & control, proximity switches are available in Inductive, Capacitive and Optical types based on the object sensing principle.

- Inductive limit switch: the sensing principle using to this switch type is damping of oscillations by conductive materials. These switches sense only metallic objects and is used for counting position sensing.
- Capacitive limit switch: this switch is able to detect dielectric properties, is used for non metallic, metallic or liquids but only for low counting speeds.

- Optical limit switch: this switch senses any object using infra-red reflection. It can be used for long distances, medium counting speeds and has a big accuracy. This switch type is used for many industries like robotics, automobile or pharma between others, but it is too many expensive for desalination.

d) Temperature instruments

Temperature is the measure of average molecular kinetic energy within a substance. The concept is easiest to understand for gases under low pressure, where gas molecules randomly shuffle about. The average kinetic (motional) energy of these gas molecules defines temperature for that quantity of gas.

Thermal energy is a different concept: the quantity of total kinetic energy for this random molecular motion.

Heat is defined as the exchange of thermal energy from one sample to another, by way of conduction (direct contact), convection (transfer via a moving fluid), or radiation (emitted energy); although you will often find the terms thermal energy and heat used interchangeably.

There are many types of temperature sensor, but industries commonly use like temperature sensors these four types: Thermostat, Thermistor, Resistive Temperature Detector and Thermocouple.

- **Thermostat**

The thermostat is a contact type electro-mechanical temperature sensor or switch that basically consists of two different metals that are bounded together like a bimetallic strip.

Two dissimilar metals are bonded together into what is called a bimetallic strip. One of them has smaller coefficient of thermal expansion than the other. As temperature increases, the metal with bigger coefficient expands more than the other causing the bimetallic strip to curl upwards as sketched in Illustration 26.

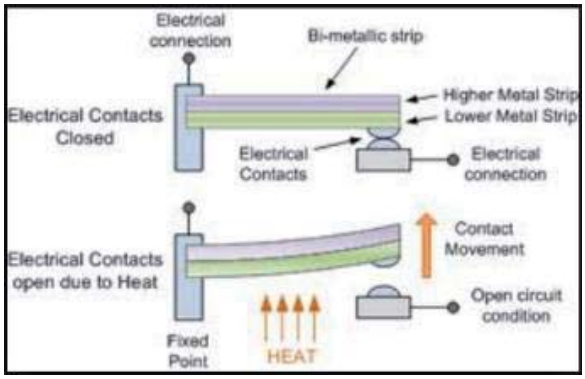


Illustration 26: Bimetal temperature sensor

When the bimetallic sensor of the thermostat experiences a temperature changes, its responsive movements produce pressure that either presses against the electric contact or pulls away from the electric contact. The device is calibrated to perform the requisite movement at just the correct temperature to press down on the contact.

- **Thermistor**

The thermistor is another type of temperature sensor, whose name is a combination of the words THERM-ally sensitive res-ISTOR.

A thermistor is temperature sensitive semiconductor that exhibits a large change in resistance over a relatively small range of temperature. There are two main types of thermistors, positive temperature coefficient (PTC) and negative temperature coefficient (NTC). NTC thermistors have the characteristics of resistance falling with increasing temperature. These are most commonly used for temperature measurement.

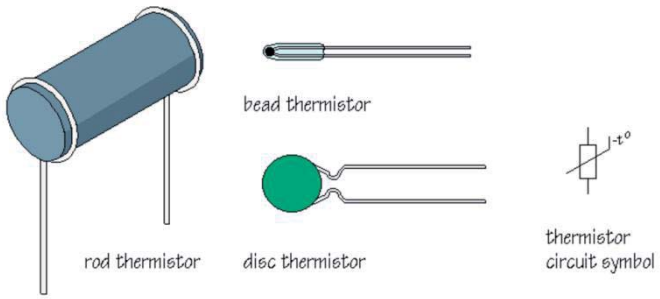


Illustration 27: Thermistors types and circuit symbol

The device is manufactured from materials like sintered mixtures of oxides of metals such as manganese, nickel, cobalt, and iron. Their resistances range from 0.4 ohms to 75 megaohms and they may be fabricated in wide variety of shapes and sizes. Smaller thermistors are in the form of beads of diameter from 0.15 millimeters to 1.5 millimeters. Such a bead may be sealed in the tip of solid glass rod to form probe which is easier to mount than bead. Alternatively thermistor may be in the form of disks and washers made by pressing thermistor material under high pressure into flat cylindrical shapes with diameter from 3 millimeters to 25 millimeters. Washers may be stacked and placed in series or parallel to increase power disciplining capability. Illustration 27 shows all these types.

- **Resistive Temperature Detector or RTD**

Another type of electrical resistance temperature sensor is the Resistance Temperature Detector or RTD. RTD's are precision temperature sensors made from high-purity conducting metals wound into a coil and whose electrical resistance changes as a function of temperature.

The simplest way to measure the resistance of a RTD is to inject a constant current into the RTD and to measure the voltage that develops across the RTD. A Wheatstone bridge circuit (shown in Illustration 28) is generally used to detect the changes in resistance of a resistance thermometer (RTD).

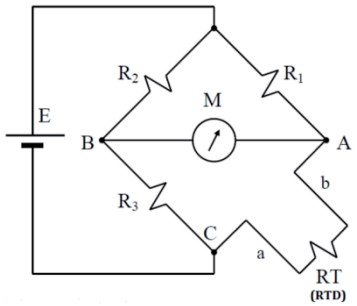


Illustration 28: Wheatstone bridge circuit

The values of resistances “R1”, “R2” and “R3” are very accurately known and “RT” represents the resistance of RTD with leads “a” and “b”. The bridge is said to be in null balance when the voltage across points A and B is zero. This occurs when RT=R3x(R1/R2), causing VAC=VBC, resulting in the reading on Multimeter M, to become zero.

The zero condition would correspond to the zero point or set point of the resistance thermometer output. As the temperature increases, the resistance of the resistance thermometer (RTD) will increase, causing the bridge to become unbalanced, and meter M to show a reading.

The most common metals used for temperature sensing are platinum, nickel, copper and molybdenum. RTDs cannot generally be used in their basic sensing element form, as they are too delicate. They are usually built into some type of assembly, which will enable them to withstand the various environmental conditions to which they will be exposed when used. Most commonly this is a stainless steel tube with a heat conducting grease (that also dampens vibration).

Typical Sheath Mounted RTD Probe

Illustration 29: RTD probe

The most common RTD material used is Platinum, primarily because of its long-term stability in air. There are two standard Platinum sensor types, each with a different doping level of ‘impurities’. To a large extent there has been a convergence in platinum RTD standards, with most international standards bodies.

The most common Platinum RTD used is Pt100 which indicates a platinum resistance and 100 ohms of resistance.

- **Thermocouple or TC**

The thermocouple is by far the most commonly used type of all the temperature sensing devices due to its simplicity, ease of use, their speed of response to changes in temperature and their small size.

A thermocouple consists of two pieces of dissimilar metals with their ends joined together (by twisting, soldering or welding). When heat is applied to the junction, a voltage, in the range of millivolts (mV), is generated. A thermocouple is therefore said to be self-powered. Shown in Illustration 30 is a completed thermocouple circuit.

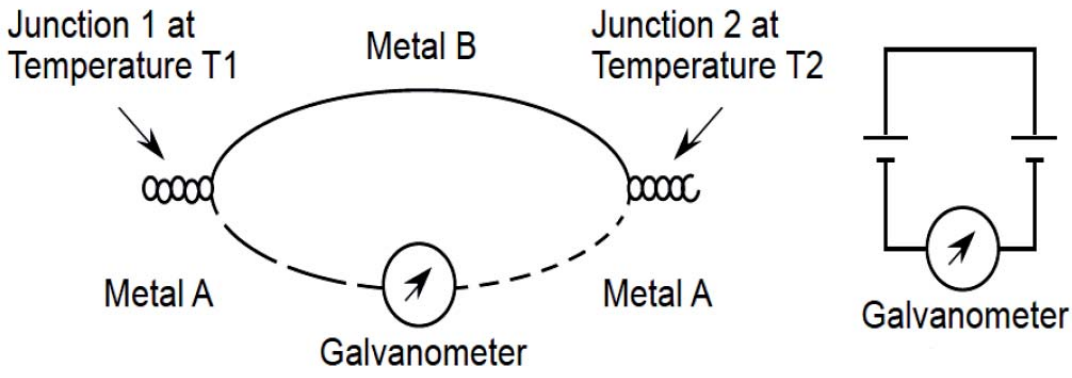


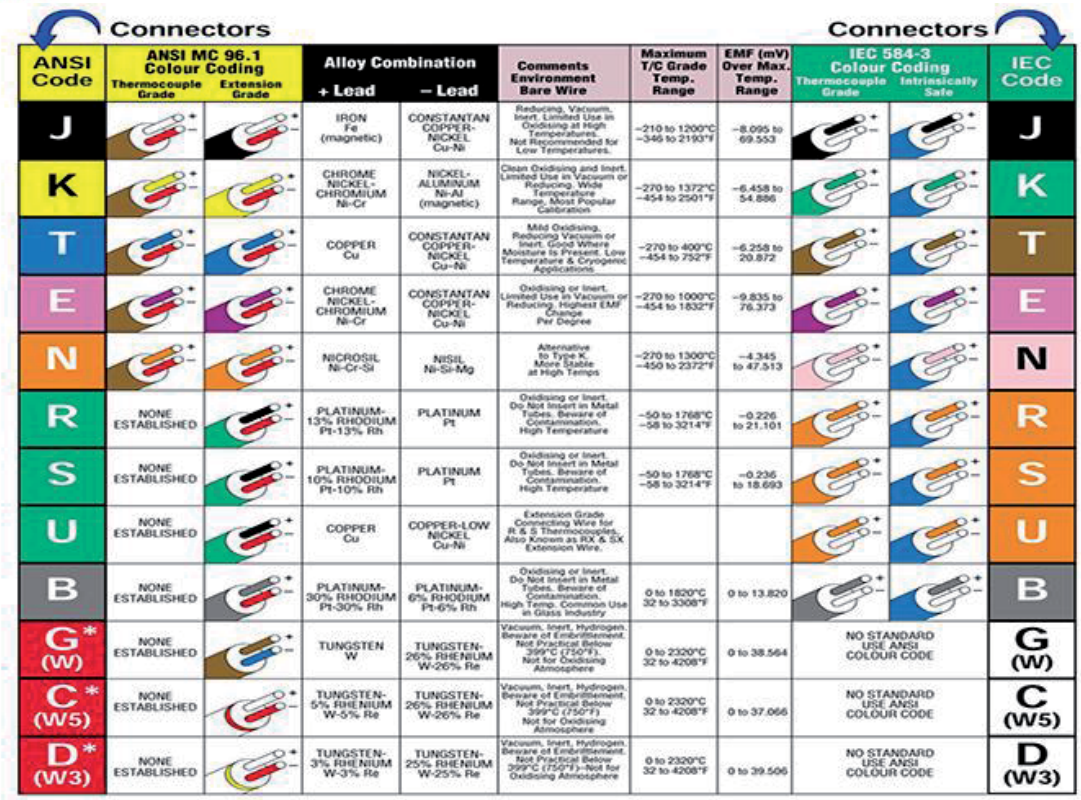
Illustration 30: Thermocouple circuit

The voltage generated at each junction depends on junction temperature. If temperature T1 is higher than T2, then the voltage generated at Junction 1 will be higher than that at Junction 2. In the above circuit, the loop current shown on the galvanometer depends on the relative magnitude of the voltages at the two junctions.

In order to use a thermocouple to measure process temperature, one end of the thermocouple has to be kept in contact with the process while the other end has to be kept at a constant temperature. The end that is in contact with the process is called the hot or measurement junction. The one that is kept at constant temperature is called cold or reference junction. The relationship between total circuit voltage (emf) and the emf at the junctions is:

Circuit emf = Measurement emf – Reference emf

There are many types of thermocouples depending on material used. All the types are shown in Illustration 31.



ANSI Code	ANSI MC 96.1 Colour Coding: Thermocouple Grade	ANSI MC 96.1 Colour Coding: Extension Grade	Alloy Combination: + Lead	Alloy Combination: – Lead	Comments Environment Bare Wire	Maximum T/C Grade Temp. Range	EMF (mV) Over Max. Temp. Range	IEC 584-3 Colour Coding: Thermocouple Grade	IEC 584-3 Colour Coding: Intrinsically Safe	IEC Code
J			IRON Fe (magnetic)	CONSTANTAN COPPER-NICKEL Cu-Ni	Reducing, Vacuum, Inert, Limited Use in Oxidising at High Temperatures. Not Recommended for Low Temperatures.	-210 to 1200°C -346 to 2193°F	-8.095 to 69.553			J
K			CHROME NICKEL-CHROMIUM Ni-Cr	NICKEL-ALUMINUM Ni-Al (magnetic)	Clean Oxidising and Inert, Limited Use in Vacuum or Reducing. Wide Temperature Range, Most Popular Calibration	-270 to 1372°C -454 to 2501°F	-6.458 to 54.886			K
T			COPPER Cu	CONSTANTAN COPPER-NICKEL Cu-Ni	Mild Oxidising, Reducing Vacuum or Inert, Good Where Moisture Is Present, Low Temperature & Cryogenic Applications	-270 to 400°C -454 to 752°F	-6.258 to 20.872			T
E			CHROME NICKEL-CHROMIUM Ni-Cr	CONSTANTAN COPPER-NICKEL Cu-Ni	Oxidising or Inert, Limited Use in Vacuum or Reducing, Highest EMF Change Per Degree	-270 to 1000°C -454 to 1832°F	-9.835 to 76.373			E
N			NICROSIL Ni-Cr-Si	NISIL Ni-Si-Mg	Alternative to Type K, More Stable at High Temps	-270 to 1300°C -450 to 2372°F	-4.345 to 47.513			N
R	NONE ESTABLISHED		PLATINUM-13% RHODIUM Pt-13% Rh	PLATINUM Pt	Oxidising or Inert, Do Not Insert in Metal Tubes, Beware of Contamination, High Temperature	-50 to 1768°C -58 to 3214°F	-0.226 to 21.101			R
S	NONE ESTABLISHED		PLATINUM-10% RHODIUM Pt-10% Rh	PLATINUM Pt	Oxidising or Inert, Do Not Insert in Metal Tubes, Beware of Contamination, High Temperature	-50 to 1768°C -58 to 3214°F	-0.236 to 18.693			S
U	NONE ESTABLISHED		COPPER Cu	COPPER-LOW NICKEL Cu-Ni	Extension Grade Connecting Wire for R & S Thermocouples, Also Known as RX & SX Extension Wire.					U
B	NONE ESTABLISHED		PLATINUM-30% RHODIUM Pt-30% Rh	PLATINUM-6% RHODIUM Pt-6% Rh	Oxidising or Inert, Do Not Insert in Metal Tubes, Beware of Contamination, High Temp. Common Use in Glass Industry	0 to 1820°C 32 to 3308°F	0 to 13.820			B
G* (W)	NONE ESTABLISHED		TUNGSTEN W	TUNGSTEN-26% RHENIUM W-26% Re	Vacuum, Inert, Hydrogen. Beware of Embrittlement. Not Practical Below 399°C (750°F). Not for Oxidising Atmosphere	0 to 2320°C 32 to 4208°F	0 to 38.564	NO STANDARD USE ANSI COLOUR CODE		G (W)
C* (W5)	NONE ESTABLISHED		TUNGSTEN-5% RHENIUM W-5% Re	TUNGSTEN-26% RHENIUM W-26% Re	Vacuum, Inert, Hydrogen. Beware of Embrittlement. Not Practical Below 399°C (750°F) Not for Oxidising Atmosphere	0 to 2320°C 32 to 4208°F	0 to 37.066	NO STANDARD USE ANSI COLOUR CODE		C (W5)
D* (W3)	NONE ESTABLISHED		TUNGSTEN-3% RHENIUM W-3% Re	TUNGSTEN-25% RHENIUM W-25% Re	Vacuum, Inert, Hydrogen. Beware of Embrittlement. Not Practical Below 399°C (750°F)-Not for Oxidising Atmosphere	0 to 2320°C 32 to 4208°F	0 to 39.506	NO STANDARD USE ANSI COLOUR CODE		D (W3)

Illustration 31: Thermocouples type according to materials

- **Thermo wells**

The process environment where temperature monitoring is required is often not only hot, but also pressurized and possibly chemically corrosive or radioactive. To facilitate removal of the temperature sensors (RTD and TC), for examination or replacement and to provide mechanical protection, the sensors are usually mounted inside thermal wells (Illustration 32).

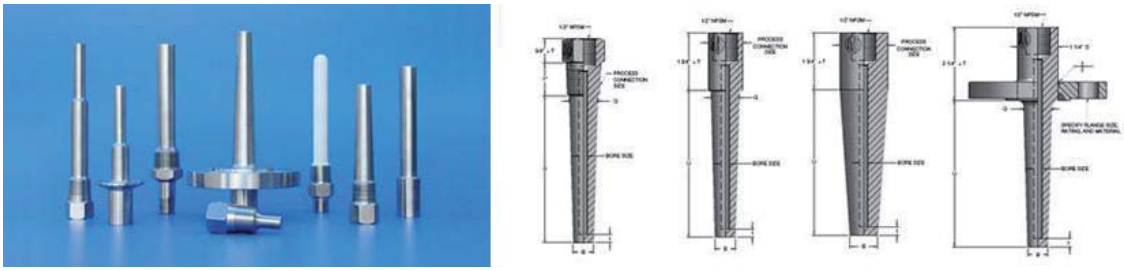


Illustration 32: Thermowells types

A thermo well is basically a hollow metal tube with one end sealed. It is usually mounted permanently in the pipe work. The sensor is inserted into it and makes contact with the sealed end.

A drawback to thermal wells is their long response time because heat must be transferred through the well to the sensor. Minimizing the air space between the sensor and the well, however, can decrease this thermal lag.

e) Analyzers

Analyzers are used to measure specific fluid properties such conductivity, pH, turbidity, ORP… which are critical in some part of the process. In Tuas desalination plant project there are a lot of analyzers (ORP, O2, Turbidity, Conductivity, pH, Particle counter, TOC, Chlorine, Hydrocarbon, Algae, Fluoride and Ammonia) but due to high variety of them, the three most commonly used, are explained in this project: conductivity, pH and turbidity.

- **Conductivity**

Electrical conductivity in liquids is the free move of its ions. Ions are electrically imbalanced atoms or molecules that are free to drift because they are not “locked” into a lattice structure. The degree of electrical conductivity of any liquid is therefore dependent on the ion density of the solution (how many ions freely exist per unit volume of liquid). When a voltage is applied across two points of a liquid solution, negative ions will drift toward the positive pole (anode) and positive ions will drift toward the negative pole (cathode). In honor of this directional drifting, negative ions are sometimes called anions (attracted to the anode), while positive ions are sometimes called cations (attracted to the cathode).

Inductive conductivity sensors induce a low current in a closed loop of solution, and then measure the magnitude of this current to determine the solution’s conductivity.

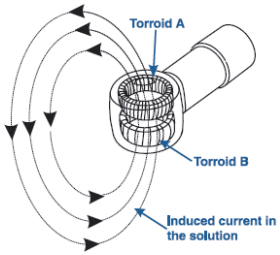


Illustration 33: Inductive conductivity sensor

The conductivity analyzer drives Torroid A, inducing an alternating current in the solution. This current signal flows in a closed loop through the sensor bore and surrounding solution. Torroid B senses the magnitude of the induced current which is proportional to the conductance of the solution. The analyzer processes this signal and displays the corresponding reading.

It is important to note that raw seawater is highly conductivity (55000 µS/cm), but not osmotic water (3-5 µS/cm) for that reason is used two different conductivity meters in order to adjust the measure range of them.

- **pH**

The pH value is a measure of the acid or base character of a medium which are determinate by the concentration of hydrogen ions (H^+) in the solution. Water has the

molecular formula of H_2O and almost always exists in the stable molecular state of H_2O. However, a small portion also exists in the form of ions known as hydrogen ions (H^+) and hydroxyl ions (OH^-), and the balance between these hydrogen ions and hydroxyl ions determinates the pH. The solution becomes acidic if there are many hydrogen ions, while it is alkaline if there are many hydroxyl ions.

Several methods of measuring pH have been developed and upgraded. Currently, the glass electrode method is most often used in various fields.

(1) Indicator method:

The indicator method uses litmus papers or reagents such as methyl orange and phenolphthalein solutions and is old and simple way of measuring pH.

This method has a long history and is easy to use. However, there are various errors and inaccuracies.

(2) Hydrogen electrode method:

A platinum electrode, on which hydrogen gas is adequately adsorbed, is called a hydrogen electrode. Placing this electrode in a test solution generates a potential corresponding to the hydrogen ion concentration (to be precise, the hydrogen ion activity) of the solution, and thus the pH of the test solution can be determined. This hydrogen electrode method is to directly measure the hydrogen ion activity and is used as one of the standard pH measurement methods today. However, it is not used as an industrial standard because it requires hydrogen gas that has an explosion risk, its operation is troublesome, and furthermore, it may involve a sodium ion error and other errors.

(3) Antimony electrode method:

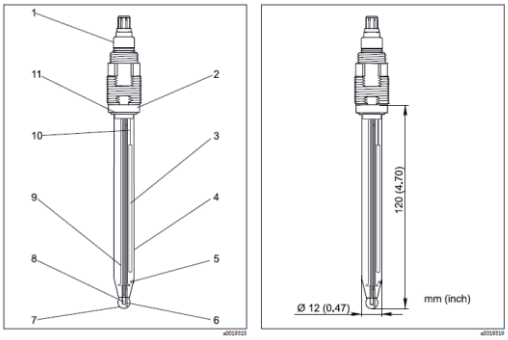
In the antimony electrode method, an antimony rod with a polished tip is immersed into a test solution together with the reference electrode to obtain pH based on the potential difference between the antimony rod and reference electrode. This method is no longer used often with the exception of certain applications (where accuracy is not required when measuring a solution containing fluorine) because the reading varies depending on the condition of the polished electrode and reproducibility is poor.

(4) Glass electrode method:

If two solutions with different pH exist separately on two sides of a thin glass membrane, a potential difference develops between the two sides, which are proportional to the difference in pH of the two solutions. This method of measuring pH is often used due to advantages such as the potential quickly reaches equilibrium, good reproducibility, and little effects of an oxidizing or reducing substance.

Depending on the pH value of the medium, the electrode's membrane glass provides an electrochemical potential. This is the result of H+ ions selectively penetrating the outer layer of the membrane. As a result, an electrochemical boundary layer forms here with an electric potential. An integrated Ag/AgCl reference system forms the required reference electrode.

It is one of the most common forms of analytical measurement in industry, because pH has a great effect on the outcome of many chemical processes. Water treatment is one of the industries making extensive use of pH measurement (and control). The pH value is also a significant factor in the corrosion of metal pipes and vessels carrying aqueous (water-based) solutions, so pH measurement and control are important in the life-extension of these capital investments.



CPS31 with ESA plug-in head

1 ESA electrode plug-in head, Pg 13.5
2 Pressure ring
3 Capillaries
4 Shaft tube
5 Diaphragm
6 Ag/AgCl internal reference lead

CPS31 with ESA plug-in head

7 pH membrane glass
8 Temperature probe
9 Internal tube
10 Leads, external
11 O-ring

Illustration 34: pH electrode

- **Turbidity**

The turbidity method is nephelometric method which is based upon a comparison of intensity of light scattered by a sample under defined conditions with the intensity of light scattered by a standard reference suspension.

The nephelometric or light-scattering principle of turbidity measurement in a liquid often is considered applicable only to measurement of low turbidities, such as in filtered water. This is because of upper range limitations that can be measured without dilution and the natural tendency of turbid samples to coat optical surfaces. Also there is a problem with loss of sensitivity due to sample matrix or particulate absorption of both the incident and scattered light on high turbidity samples.

The turbidimeter measures turbidity by directing a laser into a sample to scatter off suspended particles. The light that is scattered at a 90° angle from the incident beam is reflected through a conical mirror in a 360° ring around the sample before it is captured by a detector. The amount of light scattered is proportional to the turbidity of the sample. If the turbidity of the sample is negligible, little light will be scattered and detected by the photocell and the turbidity reading will be low. High turbidity, on the other hand, will cause a high level of light scattering and result in a high reading.

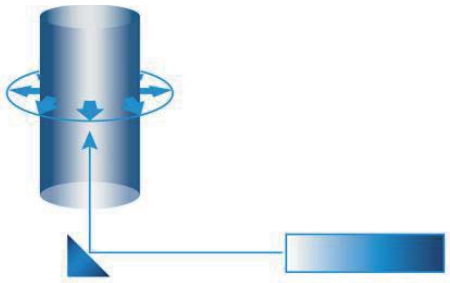


Illustration 35: Nephelometric method sketched

All the instruments used in Tuas III desalination plant are made in two different materials depending on conductivity of the medium. In case of high conductivity, super duplex or hastelloy are used due to these materials are able to high conductivity, however when low conductivity stainless steel 316L is used. This material is cheaper than super duplex or hastelloy. When is used each material is specified in Annex IV in wetted parts column and in Annex II.

2.3. Process and instrumentation diagrams (P&ID).

First of all, the term P&ID refers to Piping and Instrumentation Diagram. So the P&ID is like a "map" which shows all the instruments installed in the plant. Literately it is a diagram in the process industry which shows the piping of the process flow together with the installed equipment and instrumentation. P&ID is used to understand how the process works.

One area of P&IDs that is standardized are the instrumentation symbols, the key to being able to understand P&IDs. Instrumentation symbols appearing on diagrams adhere to ANSI/ISA's S5.1-1984 (R 1992) standards. Sticking to the Instrumentation, Systems, and Automation Society (ISA) S5.1 "Instrumentation Symbols and Identification" standard ensures a consistent, system independent means of communicating instrumentation, control, and automation intent so everyone understands.

a) ISA Standard

Each instrument or function to be identified is designated by an alphanumeric code or tag number. Each instrument may be represented on diagrams by a symbol. The symbol may be accompanied by a tag number.

The functional identification of an instrument or its functional equivalent consists of letters from Table 1 and includes one first-letter (designating the measured or initiating variable) and one or more succeeding-letters (identifying the functions performed).

	FIRST-LETTER (4)		SUCCEEDING-LETTERS (3)		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	Analysis (5,19)		Alarm		
B	Burner, Combustion		User's Choice (1)	User's Choice (1)	User's Choice (1)
C	User's Choice (1)			Control (13)	
D	User's Choice (1)	Differential (4)			
E	Voltage		Sensor (Primary Element)		
F	Flow Rate	Ratio (Fraction) (4)			
G	User's Choice (1)		Glass, Viewing Device (9)		
H	Hand				High (7, 15, 16)
I	Current (Electrical)		Indicate (10)		
J	Power	Scan (7)			
K	Time, Time Schedule	Time Rate of Change (4, 21)		Control Station (22)	
L	Level		Light (11)		Low (7, 15, 16)
M	User's Choice (1)	Momentary (4)			Middle, Intermediate (7,15)
N	User's Choice (1)		User's Choice (1)	User's Choice (1)	User's Choice (1)
O	User's Choice (1)		Orifice, Restriction		
P	Pressure, Vacuum		Point (Test) Connection		
Q	Quantity	Integrate, Totalize (4)			
R	Radiation		Record (17)		
S	Speed, Frequency	Safety (8)		Switch (13)	
T	Temperature			Transmit (18)	
U	Multivariable (6)		Multifunction (12)	Multifunction (12)	Multifunction (12)
V	Vibration, Mechanical Analysis (19)			Valve, Damper, Louver (13)	
W	Weight, Force		Well		
X	Unclassified (2)	X Axis	Unclassified (2)	Unclassified (2)	Unclassified (2)
Y	Event, State or Presence (20)	Y Axis		Relay, Compute, Convert (13, 14, 18)	
Z	Position, Dimension	Z Axis		Driver, Actuator, Unclassified Final Control Element	

Table 1: Identification letters

The functional identification of an instrument is made according to the function and not according to the construction. Thus, a differential-pressure recorder used for flow measurement is identified by FR; a pressure indicator and a pressure-actuated switch connected to the output of a pneumatic level transmitter are identified by LI and LS, respectively.

The succeeding-letters of the functional identification designate one or more readout or passive functions and/or output functions. A modifying-letter may be used, if required, in addition to one or more other succeeding-letters. Modifying-letters may modify either a first-letter or succeeding-letters, as applicable. Thus, TDAL contains two modifiers. The letter D changes the measured variable T into a new variable, "differential temperature." The letter L restricts the readout function A, alarm, to represent a low alarm only.

The sequence of identification letters begins with a first-letter selected according to Table 1. Readout or passive functional letters follow in any order, and output functional letters follow these in any sequence, except that output letter C (control) precedes output letter V (valve), e.g., PCV, a self-actuated control valve. However, modifying-letters, if used, are interposed so that they are placed immediately following the letters they modify.

A multiple function device may be symbolized on a diagram by as many bubbles as there are measured variables, outputs, and/or functions. Thus, a temperature controller with a switch may be identified by two tangent bubbles — one inscribed TIC-3 and one inscribed TSH-3. The instrument would be designated TIC/TSH-3 for all uses in writing or reference. If desired, however, the abbreviation TIC-3 may serve for general identification or for purchasing, while TSH-3 may be used for electric circuit diagrams.

The number of functional letters grouped for one instrument should be kept to a minimum according to the judgment of the user. The total number of letters within one group should not exceed four. The number within a group may be kept to a minimum by:

1) Arranging the functional letters into subgroups. For instruments having more than one measured variable or input, but it may also be used for other instruments.

2) Omitting the I (indicate) if an instrument both indicates and records the same measured variable.

All letters of the functional identification are uppercase.

First-Letters	Initiating or Measured Variable	Controllers				Readout Devices		Switches and Alarm Devices*			Transmitters			Solenoids, Relays, Computing Devices	Primary Element	Test Point	Well or Probe	Viewing Device, Glass	Safety Device	Final Element
		Recording	Indicating	Blind	Self-Actuated Control Valves	Recording	Indicating	High**	Low	Comb	Recording	Indicating	Blind							
A	Analysis	ARC	AIC	AC		AR	AI	ASH	ASL	ASHL	ART	AIT	AT	AY	AE	AP	AW			AV
B	Burner/Combustion	BRC	BIC	BC		BR	BI	BSH	BSL	BSHL	BRT	BIT	BT	BY	BE		BW	BG		BZ
C	User's Choice																			
D	User's Choice																			
E	Voltage	ERC	EIC	EC		ER	EI	ESH	ESL	ESHL	ERT	EIT	ET	EY	EE					EZ
F	Flow Rate	FRC	FIC	FC	FCV, FICV	FR	FI	FSH	FSL	FSHL	FRT	FIT	FT	FY	FE	FP		FG		FV
FQ	Flow Quantity	FQRC	FQIC			FQR	FQI	FQSH	FQSL			FQIT	FQT	FQY	FQE					FQV
FF	Flow Ratio	FFRC	FFIC	FFC		FFR	FFI	FFSH	FFSL						FE					FFV
G	User's Choice																			
H	Hand		HIC	HC						HS										HV
I	Current	IRC	IIC			IR	II	ISH	ISL	ISHL	IRT	IIT	IT	IY	IE					IZ
J	Power	JRC	JIC			JR	JI	JSH	JSL	JSHL	JRT	JIT	JT	JY	JE					JV
K	Time	KRC	KIC	KC	KCV	KR	KI	KSH	KSL	KSHL	KRT	KIT	KT	KY	KE					KV
L	Level	LRC	LIC	LC	LCV	LR	LI	LSH	LSL	LSHL	LRT	LIT	LT	LY	LE		LW	LG		LV
M	User's Choice																			
N	User's Choice																			
O	User's Choice																			
P	Pressure/ Vacuum	PRC	PIC	PC	PCV	PR	PI	PSH	PSL	PSHL	PRT	PIT	PT	PY	PE	PP			PSV, PSE	PV
PD	Pressure, Differential	PDRC	PDIC	PDC	PDCV	PDR	PDI	PDSH	PDSL		PDRT	PDIT	PDT	PDY	PE	PP				PDV
Q	Quantity	QRC	QIC			QR	QI	QSH	QSL	QSHL	QRT	QIT	QT	QY	QE					QZ
R	Radiation	RRC	RIC	RC		RR	RI	RSH	RSL	RSHL	RRT	RIT	RT	RY	RE		RW			RZ
S	Speed/Frequency	SRC	SIC	SC	SCV	SR	SI	SSH	SSL	SSHL	SRT	SIT	ST	SY	SE					SV
T	Temperature	TRC	TIC	TC	TCV	TR	TI	TSH	TSL	TSHL	TRT	TIT	TT	TY	TE	TP	TW		TSE	TV
TD	Temperature, Differential	TDRC	TDIC	TDC	TDCV	TDR	TDI	TDSH	TDSL		TDRT	TDIT	TDT	TDY	TE	TP	TW			TDV
U	Multivariable					UR	UI							UY						UV
V	Vibration/Machinery Analysis					VR	VI	VSH	VSL	VSHL	VRT	VIT	VT	VY	VE					VZ
W	Weight/Force	WRC	WIC	WC	WCV	WR	WI	WSH	WSL	WSHL	WRT	WIT	WT	WY	WE					WZ
WD	Weight/Force, Differential	WDRC	WDIC	WDC	WDCV	WDR	WDI	WDSH	WDSL		WDRT	WDIT	WDT	WDY	WE					WDZ
X	Unclassified																			
Y	Event/State/Presence		YIC	YC		YR	YI	YSH	YSL				YT	YY	YE					YZ
Z	Position/Dimension	ZRC	ZIC	ZC	ZCV	ZR	ZI	ZSH	ZSL	ZSHL	ZRT	ZIT	ZT	ZY	ZE					ZV
ZD	Gauging/Deviation	ZDRC	ZDIC	ZDC	ZDCV	ZDR	ZDI	ZDSH	ZDSL		ZDRT	ZDIT	ZDT	ZDY	ZDE					ZDV

Note: This table is not all-inclusive.
*A, alarm, the annunciating device, may be used in the same fashion as S, switch, the actuating device.
**The letters H and L may be omitted in the undefined case.

Other Possible Combinations:

FO	(Restriction Orifice)	PFR	(Ratio)
FRK, HIK	(Control Stations)	KQI	(Running Time Indicator)
FX	(Accessories)	QQI	(Indicating Counter)
TJR	(Scanning Recorder)	WKIC	(Rate-of-Weight-Loss Controller)
LLH	(Pilot Light)	HMS	(Hand Momentary Switch)

Table 2: Typical letter combinations

Symbols

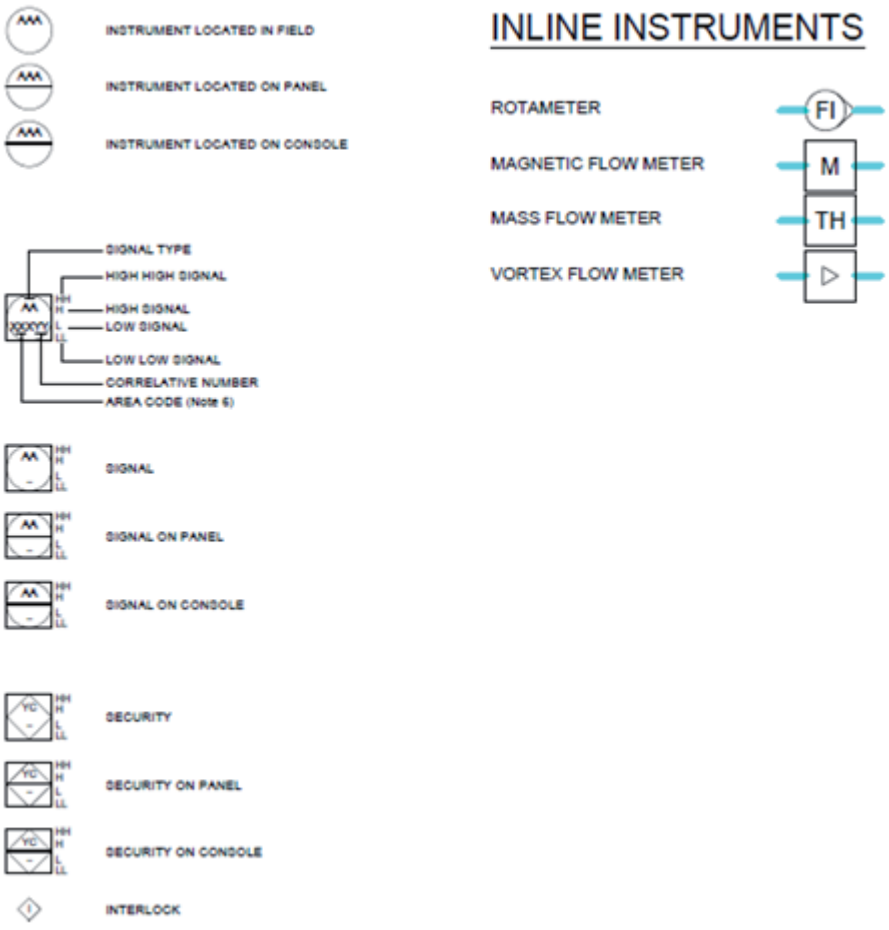


Illustration 36: Symbols used to represent the instruments in a P&ID

Symbols represented in Illustration 36 are commonly used for all instruments represented in P&ID.

As explained before, instruments are named with alphanumeric combination. Letter combination has already been explained previously and it is standard but numeric combination depends on project tenders.

In Tuas III desalination plant is used numeric code as explained below these lines. First number after letter tag is 1 and it is used to make uniform all instrument tags. The two following numbers indicate PID number where instrument is placed and the last two numbers is a correlative numeration for all instruments with the same previous letter and digit.

Now an example tag using for that plant is going to be explain:

FIT-14802

F: This letter indicates that this instrument is used for measuring FLOW

I: The instrument has **indication** like a display that shows the measure of flow in this case.

T: This instrument is a **Transmitter** and has an output signal to the Distributed Control System.

1: Digit used to make uniform the tag

48: P&ID number, in this case is referred to 2nd pass RO rack 1 named as PUB-WSP-JDD-0**48.** All P&ID's are included in Annex 1.

02: This number shows that there are at least 2 FIT in this P&ID.

It is important to note that the tag is just a name of the instrument but it doesn't indicate the type like magnetic, ultrasonic, vortex… this is shown by the symbol used.

All the instruments that would be purchased to Tuas III desalination plant are included in Annex 4. This Annex 4 shows all the instruments with their tags, ranges, location, service and more important data.

b) Equipments representation

The equipment has also its own symbol and tag for representing them into the P&ID. Due to the dimension of the table which contains these symbols it is impossible to draw that table in this project, but all the symbols are available in Annex 1 pages 1, 2 and 3.

3. INSTRUMENTATION SYSTEM DESIGN FOR TUAS III

3.1. Basic engineering

The basic engineering is the previous step on the engineering process for a project development. For that reason a process flow diagram is explained at this point to understand the process.

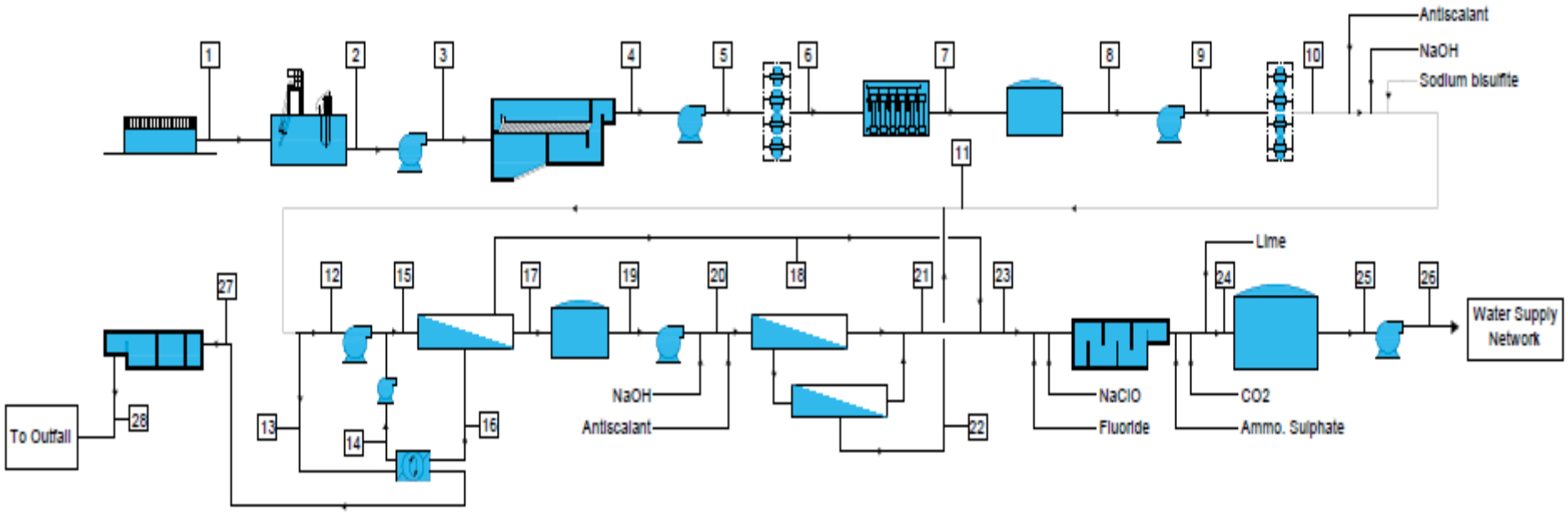


Illustration 37: Process flow diagram of Tuas III

1 First of all raw seawater goes into the plant through the intake screens which avoid the fishes and gross matter go into the plant. The next step is to remove the big solids which go through the intake screen and the trash are collected by a straight trash rake and the last part of screening intake is to remove the fine debris, for that reason a travelling band screen are installed. All this matter removed is pumping into the waste water tank.

2 When water goes through the screen system ends into the intake tank where is pumped towards the DAF system. When water goes into the DAF 3 some chemical processes take place in it which clarifies water by the removal of suspended matter which is pumped to the waste water tank. Then water is pumped (4 and 5) trough the disc filters that protects the UF membranes. Ultrafiltration membranes (UF 6) system retains suspended solids and solutes of high molecular weight and water is sent (7) to the filtered water tank. Then water is pumped (8 and 9) to others disc filters which protect the most important part of the plant, the reverse osmosis system or RO.

Once the water pass though the disc filters 10, some chemicals are added to the water pipe in order to prevent the scale form (antiscalant), to pH control (NaOH) and to neutralize agent for chlorine (sodium bisulfite).

Before getting into the first pass RO membranes 11 water flux is divided in two currents, one goes to the energy recovery system 13 (where water is pressurized by using the pressure which brine has after the RO membrane 16) and the second current is high pressurized to get into the RO membranes. When water is high pressurized, gets into the RO membrane 15 which has two outputs, the first one is brine which is sent trough the recovery energy system to outfall tank 27 and when the brine is quality enough, this water is sent to the sea. The second output 17 goes to the flushing tank, but if water is permeated enough, all the next steps could be bypassed and the water is sent to the product water tank 18.

After the flushing tank 19, the water is pumped to the second RO pass and chemicals are added again 20. The send pass RO consist of two steps after them, the water is totally permeated and has very low conductivity. This RO pass has two outputs, one of them is back to UF entry 22 and the other is permeated water 21 which is mixed with UF bypass 23 and adding chemicals this water goes into the chlorination contact chamber when is disinfected.

After this tank, chemicals are added to water to eliminate all free residual chlorine which is detrimental for human health. Finally water entry to the water product tank 24 from where is pumped (25 and 26) to water supply network.

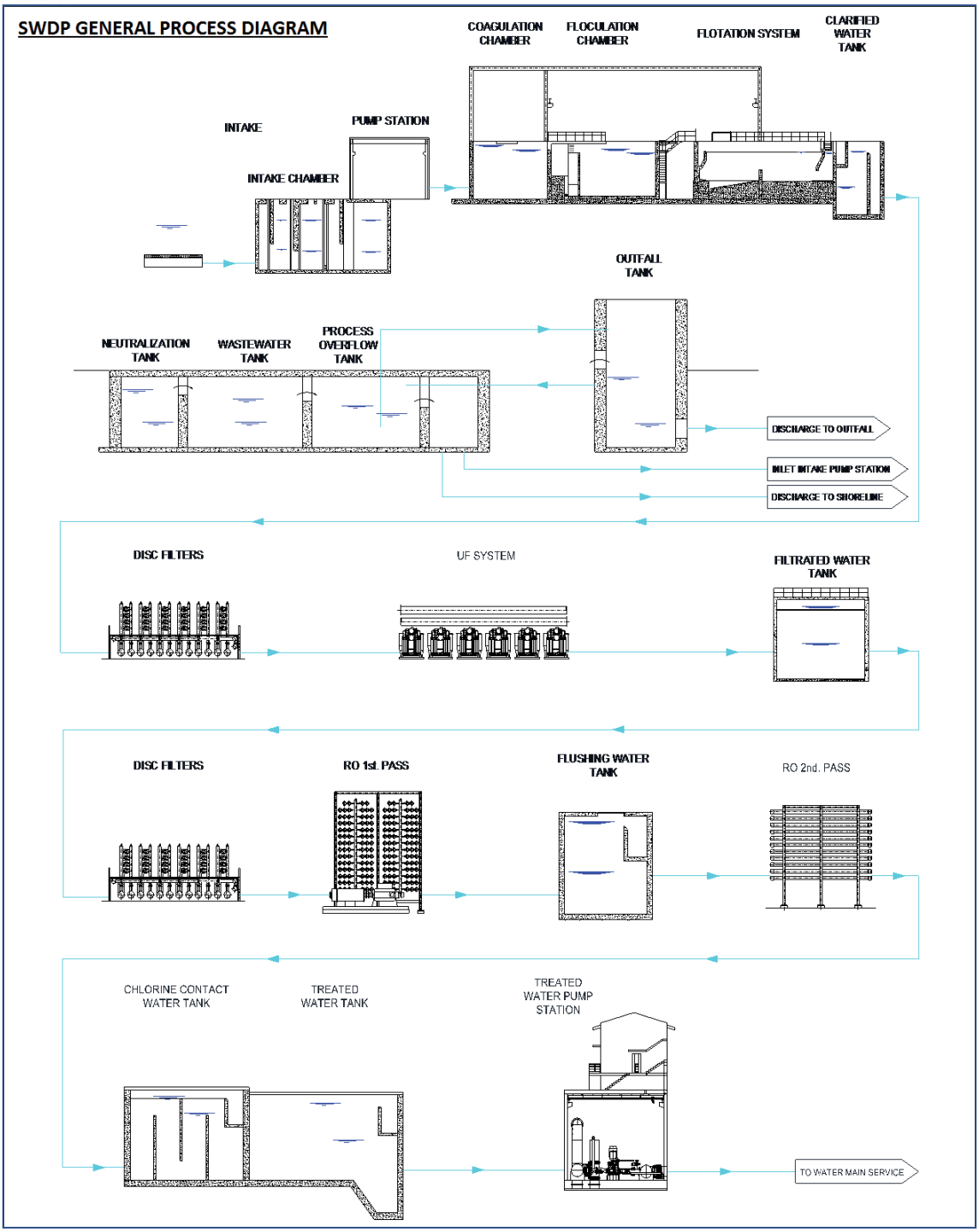


Illustration 38: Tuas III desalination plant general process diagram

Illustration 38 shows all the tanks which are made with concrete. This illustration could be used to explain the process diagram as well as Illustration 37 but due to this one shows the pumps and chemicals added, I preferred to use Illustration 37 instead of Illustration 38.

3.2. Detailed engineering

Detailed engineering follows basic engineering and it contains in detailed diagrams and drawing for construction between others documents. As point of view of instrumentation, this means to know how the plant works in detail. For that reason below these lines an overview of Tuas III desalination plant is explained.

The general Layout shown in Illustration 39 is important to understand the detailed description that is then explained.

In order to explain a general overview of the desalination plant, the plant is divided in the following subsystem according to process flow and following the P&ID's (Annex 1).

1. Intake
2. Intake screening
3. Intake Pump Station
4. DAF (Dissolved Air Flotation)
5. Ultrafiltration feed pump
6. Ultrafiltration Protection Disc Filter
7. Ultrafiltration system
8. UF Clean in place (CIP)
9. Filtered Water Tanks and RO Feed Pump
10. RO Protection Disc Filter
11. RO 1st Pass
12. RO Flushing tank
13. RO 2nd Pass
14. Chlorine Contact
15. Remineralisation
16. Treated water tank and pump station
17. Neutralization
18. Outfall
19. Ancillary systems

Below each subsystem shall be defined from the point of view of process operation.

Illustration 39: General Layout at Tuas III desalination plant

3.2.1. Intake

The feed water source will be seawater extracted from the Straits of Johor approximately 50m from the shoreline. The seawater is drawn into the intake structure through a single pipe.

Sodium hypochlorite dosing shall be added for biological control at intake structure and to the intake screening inlet pipe, in order to control the water quality parameter.

Two sample pumps will take seawater from intake structure to laboratory and intake seawater analysers. These pumps may also take water from intake pipe. Operator will decide what water will be analysed: water from intake structure or water from intake pipe.

The analysers measure the followings parameters: hydrocarbon, oxygen, algae-watch, pH, conductivities, redox, turbidity and free residual chlorine. When out of range values are detected an alarm appears in SCADA panel and if values remain out of range a defined time downstream process should be stopped.

3.2.2. Intake Screening

The seawater is delivered into the intake chamber where is distributed in three lines, each line is composed by one bar screen and one travelling band screen to prevent large and fine solids matter pass into the plant respectively, then sea water is conducted to intake pump chamber.

Bar screens are equipped with rakes that throw captured solids to waterway pit. Travelling band screens have an auto cleaning system by water spray. The sewage water from cleaning bar screen is collected in sump basin from where it is sent to waste water tank.

Sea water to wash the bar screens collecting channel and travelling band screen is controlled by pneumatic valves that are commanded by DCS. A flow switch is installed in each water service line to trip the travelling band screen, if cleaning water is not detected in the pipe when pneumatic valve is opened.

The seawater level is monitored in SCADA by a set of six level transmitters, two level transmitters measure the level in the inlet chamber (redundant measurement), three level transmitters, one in each screening lines, measure the level between bar screens and travelling band screen and the last level measuring in intake pump chamber.

The cleaning of the bar screens collecting channel will be temporized (configurable parameter). When the time between cleanings has been reached, the pneumatic valve will be opened and one spray water pump shall be started-up (if no other cleaning was being executed before). Cleaning time will be temporized too (configurable parameter). After this cleaning time has been reached, working spray pump is stopped (if no other travelling band screen has to be cleaned) and pneumatic valve is closed. Operator can execute a cleaning manually if required.

The cleaning of the travelling bar screens will be developed when a high level difference is detected. Then, the corresponding pneumatic valve shall be opened and one spray water pump shall be started-up (if no other cleaning was being executed before). Cleaning time shall be temporized (configurable parameter). After this cleaning time has been reached, working spray pump is stopped (if no other cleaning has to be executed) and pneumatic valve is closed.

If one cleaning process is required while other is being developed, it shall be executed when the current cleaning process shall be finished.

The wastewater is collected in wastewater tank. Two sump pumps drain wastewater to wastewater outfall tank, where a set of four level switches shall be installed to control the sump pump in auto mode. The switches start up or stop the pump according to level switches status:

- If low level switch is activated, the two sump pumps shall be stopped.
- If high level switch is activated, one sump pumps shall be started.
- If high high level switch is activated, two sump pumps shall be started.

3.2.3. Intake Pump Station

Once the seawater has been screened, it enters in the intake wet well. From here raw seawater can be pumped to dissolve air flotation system (DAF), to clarified water tanks (by-passing DAF system during normal seawater quality) or directly to process overflow tank. Water will be sent to one or another process taking into account the measurements taken by the intake analysers. Depending on these measurements one of the automatic valves will be opened while the other two remain closed sending water to the desired place.

Intake pumps are centrifugal with plunged impeller and dry motor; there are four operating units and one unit more in standby. Depend on plant demand, the control sequence starts or stops intake pumps automatically in order to achieve the adequate flow.

Each pump is powered by variable frequency drive which adapts the flow and pressure according to plant demand.

Two (1+1) submersible sample pumps will take water from intake wet well to redox and free residual chlorine analysers or could be pumped to laboratory and intake seawater analysers

3.2.4. DAF Dissolved Air Flotation

Pre-treatment by dissolved air flotation will prevent suspended solids, algae, oil and grease going into ultrafiltration phase. DAF treatment could be bypassed during normal seawater quality and also must be readily to put on service and started up when process required due to periodic deterioration of seawater quality, for example algal bloom events.

There will be 6 DAF lines. The number of active DAF lines will be defined by the measurement of intake pumping flowmeter FIT10201. DAF system consists on several

steps, first the seawater is mixed with chemicals in a flash chamber where sulfuric acid and ferric chloride are dosed for pH correction and coagulant effect:

Sulfuric acid dosing rate is automatically controlled based on on-line measurement of inlet flow to DAF system by a flow meter.

Ferric chloride dosing rate is automatically controlled based on on-line measurement of flow to DAF system measured by a flow meter and on-line pH downstream of the intake pumps measured by an analyzer.

Then water is divided in six parallel lines, one per DAF unit.

Each DAF line is composed by a flocculation chamber where the polyelectrolyte is added and mixed to conglomerate the particles into bigger clusters; sulphuric acid dosing rate is automatically controlled based on on-line measurement of inlet flow to DAF system measured by a flow meter.

Next water is mixed with air saturated water that coming from ASR (air saturated reactor).

There are 12 ASR, two per DAF unit, in each reactor a portion of clarified effluent water leaving the clarified water tanks is pumped into pressure vessel which compressed air is also introduced. This results in air saturated water.

The saturated water is delivered in low side of flotation tank and bubbles are generated, the bubbles catch particles when lift up into the tank. This causes the suspended matter to float to the surface where it forms a froth layer which is then removed by a skimmer. The froth-free water exits float tank and it is collected in clarify tank.

The floated sludge removal from each DAF is placed in sludge tank where three screw pumps propel the sludge to wastewater tank or rapid mix basin, depend on DAF logic setting a portion of sludge could be recirculate to rapid mix basin to improve coagulation stages.

DAF system could be operated in two modes: Local and remote.

Local mode: The system must be controlled from local control panel, the operator could select in local panel auto or manual. If manual mode is selected, the operator shall control the system manually. The valves, mixers, pumps and motors must regulate from local panel. This mode is designed to start up stage mainly. If auto mode is selected, the DAF runs in automatically according to logic sequence and set point fixed.

Remote mode: The system must be controlled from control room, the operator could select in SCADA console auto or manual. If auto mode is selected, the DAF runs in automatically according to logic sequence and set point fixed. If manual mode is selected, the commands are sent by operator manually from SCADA console.

The velocity of flocculation mixers will be controlled depending on the polyelectrolyte flow to flocculation chamber measured by six flow meters. Controller for these pumps has Proportional plus Integral plus Derivative (PID) action.

Decanted sludge in flotation cells have to be removed periodically by means of three purge valves per DAF. The time between purges will be a configurable parameter.

Two (1+1) submersible sample pumps will take water from DAF intake channel and pumped to laboratory passing by turbidity and pH analysers.

3.2.5. Ultrafiltration Feed Pumps

Clarified water is pumped to ultrafiltration (UF) trains by means UF feed pumps. Four pumps shall be fitted for nominal operation rates and one pump shall be in standby. A variable frequency drive (VFD) is used to adjust pump discharge flow and pressure according to UF flow demand.

Manual mode: The operator shall control the pump VFD manually.

Auto mode: The operator shall select the flow or pressure set point and the pump start up or stop automatically.

The velocity of these pumps will be controlled depending on the total inlet flow to UF system taken by a flow meter, depending on the common pumps discharge pressure measured by a pressure transmitter or depending on the active(s) filtered water tank(s) level measured by two level indicator transmitter. The selection of one of these control parameters can be done manually by the operator in the SCADA screen. Operator will set manually the set point in the SCADA screen too. Controller for these pumps has Proportional plus Integral plus Derivative (PID) action.

Turbidity and pH parameters are measured in pump discharge, two (1+1) clarified water sample pumps shall be installed and will pump clarified water to laboratory.

If measured values by these instruments are out of permitted ranges, active UF lines are shut-down and a butterfly valve is opened to send water to process overflow tank. If these values are out of range during a defined period of time (configurable parameter), UF feed pumps will be stopped.

3.2.6. Ultrafiltration Protection Disc Filter

The previous UF filtration consists on twenty-two (18+4) polymeric disc filter modules rated filtration quality 55 microns and average flow rate per module 584 m^3/h. Each module is composed by four disc filter.

The filter could be operated in manual or auto mode, as required from SCADA by the operator. A set of four pneumatic valves is installed in each module to operate the system properly.

In auto mode the number of working filters will depend on the inlet flow measured by a flow meter. The operator can set the number of UF trains on-line manually.

Disc filter valves sequence:

- Filtration stage: Inlet valve and outlet valve are opened and brine backwash inlet valve and drain valve are closed.

- Backwash stage: Inlet valve and outlet valve are closed and brine backwash inlet valve and drain valve are opened.

Backwash sequence starts to clean module by module, if any of following cases happens (configurable parameters):

1) A pre-set pressure loss is reached.
2) An elapsed time is reached (filter inlet & outlet valves opened).
3) Predetermined quantity of filtered water is reached.
4) Operator select backwash sequence (forced backwash).

Osmotic shock could be done by using brine backwash pumps, osmotic water from RO flushing tank is pumped to disc filter module.

RO brine from brine backwash tanks is used for disc filters backwash. If there is no enough brine in the tanks or brine backwash pumps are not available 1st pass RO permeated water from flushing tanks can be used. The operator can select manually in SCADA the desired way of filters backwash.

The pressure loss is detected by four different pressure transmitters. When high pressure difference is measured by a different pressure transmitter in a defined line, all filters of the line are washed.

The quantity of filtered water is measured by the UF feed flowmeter. When the defined quantity of filtered water is reached, all the filters will be cleaned.

Only two filters (one per line) can be washed at the same time.

In the disc filters outlet pipe, ferric chloride, sodium bisulphite and sulphuric acid are dosed to filtered water in order to neutralize membrane cleaning chemicals. Dosing set points for these chemicals are defined by the operator in SCADA.

In discs outlet pipe, there are two (1+1) sample pumps which pump filtered water to laboratory after a quality water control where following parameters are analysed and monitored in SCADA:

- Total chlorine
- pH
- Turbidity
- Algaewatch
- Hydrocarbon

If any measured value is out of range, an alarm is indicated in SCADA. If these values are not in range after a defined period of time (configurable parameter), UF feed pumps will be stopped.

Disc filters system will be automatically cleaned if high level of algae is detected by algaewatch analyser.

BRINE BACKWASH SYSTEM

Two tanks of brine are designed to feed brine pumps, three pumps are installed and the UF disc filters backwash is operated with one pump normally. Other pump is used for RO disc filters backwash and the third pump is a common stand-by unit.

Each brine tank can be isolated by means two operated valves. Tanks inlet brine continuously overflows in the tanks and returns to the brine pipe.

3.2.7. Ultrafiltration System

Ultrafiltration system is divided in two sub-systems, each sub-system is composed by 12 (11+1) UF skids and each UF skid consist of 56 membrane modules.

Ultrafiltration process filters feed water in inside-out configuration through the UF membrane. Filtration is performed at a preset rate (flux, described as membrane surface loading rate l/m2/h or LMH) and will last for a fixed duration (filtration time), both are configurable parameters. In the filtration direction, raw feed water is pumped into the UF module through the bottom feed inlet.

FILTRATION CYCLE

The filtration sequence starts by opening a UF feed bottom valve and a UF filtrate valve. Feed is then pumped at a fixed rate by means the control valve and the flowmeter. As filtration progresses, a filter cake (fouling layer) build-up on the UF membrane will result in increasing feed pressure requirements to maintain design flow rate. A fixed flow rate can be maintained by either regulating VFD feed pump or a control valve opening position.

BACKWASH (BW) CYCLE

During filtration a fouling layer is being formed on the UF membrane. The fouling layer is then removed during the BW cycle. UF filtrate water is pumped at a high rate into the reverse direction, from the outside of the membrane capillaries through the UF membrane towards the inside. The BW rate is fixed at 230LMH (configurable parameter). BW lasts for a fixed duration (BW time, configurable parameter).

During normal operation, Backwash sequence will be developed automatically. The required initial condition for the backwash sequence to begin automatically is a defined time of operation (configurable parameter). The system will start-up a backup line (if possible) in order to cover the production while the line that must be cleaned is shut down.

Although the operation is automatically developed when it is necessary, exists the possibility of manually trigger a backwash for a defined line, which must be inactive at the moment when backwash is triggered.

The BW sequence of events starts by isolating the UF train.

The backwash outlet top valve is now opened and the backwash outlet bottom valve is simultaneously closed. The pump is kept at the backwash flow rate until expiration of the backwash (from) bottom timer (configurable parameter). After timer expires, the BW

pump is ramped down (ramp down time), all BW valves are closed, and finally feed and filtrate valves are opened (back to filtration cycle).

FORWARD FLUSH CYCLE

A forward flush can be performed before backwash or after completion of the backwash in order to assist removal of solids from the UF capillaries. Here, UF feed water is pumped into the UF system at the same rate as during the filtration sequence. In forward flush bottom, feed water is pumped into feed bottom valve and then through UF capillaries out through the backwash outlet top valve to drain. Forward flushes are typically not used during regular operation, however in some cases they may need to be implemented to improve solids removal before and/or after UF backwash cycles.

CHEMICALLY ENHANCED BACKWASH (CEB) CYCLE

During the course of operation, UF Membranes will slowly loose permeability due to build-up of a hard to remove fouling layer on the membranes. Fouling layers consist of water impurities and can either be of organic nature or inorganic. The latter is also referred to as scaling due to the buildup of salt crystals, such as CaCO3. Hence, UF membranes must be chemically cleaned in certain intervals to maintain design filtration performance.

There are three individual chemically enhanced backwash (CEB) procedures integrated into the UF process:

- CEB 1: First step CEB1.1 (Caustic NaOH & Chlorine NaOCl) and second step CEB 1.2 acid CEB (sulfuric acid H_2SO_4).
- CEB 2: Acid CEB (H_2SO_4)
- CEB 3: Disinfection (NaOCl)

CEB1 is the UF standard CEB, CEB1 comprises of two steps, a caustic CEB step followed by and acidic CEB step. CEB1.2 must always be performed after CEB1.1.

CEB2 is a separate acidic cleaning step, essentially the same as CEB1.2 but performed as a standalone clean.

CEB3 is used as a separate sanitary disinfection step.

During normal operation CEB Backwash sequence will be developed automatically. The required initial condition for a CEB backwash sequence to begin automatically is a defined number of Backwash sequences for each UF rack (configurable parameter). Only one CEB backwash type can be executed for each rack. If a CEB backwash is required while other type of CEB backwash is being executed in the rack, it only will be executed after the first is finished.

The duration of each CEB backwash will be T1, T2 & T3 depending on the chemical CEB that is being developed. These times must be configurable for the operator.

After CEB backwashing a UF line, it will remain in stand-by (if no needed). In case of various lines inactive the line recently backwashed must enter in operation before the others.

3.2.8. UF Clean In Place (CIP)

The CIP system could be capable of automatic and manual operation depending on selected option in SCADA.

Clean-in-place (CIP) is an effective method of restoring membrane performance by tackling the kind of fouling and scaling that is difficult to remove using conventional backwashes or chemically enhanced backwashes (CEBs).

A CIP is performed by introducing a chemical solution into the modules and shutting down the membrane system for a longer period of time (configurable parameter) than is required for conventional cleaning methods.

One of the major differences to a CEB is that a CIP is characterized by a forward flux with the circulation of different chemicals using a CIP tank on the feed side and an extended soak time (configurable parameter).

A CIP should be performed if the permeability of the system falls below 100 - 150 LMH/bar and if this drop cannot be reversed by performing a CEB. A CIP is rated as successful if the permeability of the system subsequent to the CIP is restored to a value of at least 70 - 80% of the reference value recorded after the commissioning of the ultrafiltration system.

The water used to prepare the CIP cleaning solution will be 1st pass reverse osmosis permeate. The CIP solution must be fed into the system from the feed side of the membranes/modules.

The frequency of the CIP cleanings should not exceed four applications a year.

The overall duration of the circulation and soak time of a CIP depends on the effectiveness of its cleaning results, though it should not exceed 12 hours.

A conventional backwash should be performed prior to a CIP to ensure that the membrane surface is as clean as possible and to rinse out any foreign particles that may be contained in the piping of the modules or racks.

When performing a CIP, ensure that the modules and racks being cleaned are disconnected from the rest of the water main system.

The CIP solution is heated in the CIP tank to improve the effectiveness of the cleaning process and reduce the soak time. The maximum permitted temperature of 40°C and the maximum permitted rate of temperature change of 1°C/min. A heater with thermostat is supplied in each tank for heating the CIP solution.

When is preparing the chemical solution in a CIP tank (mixing together the cleaning chemical and water), the chemicals must always be added to the tank of water, not the other way around. Adding water to concentrated chemicals could cause a violent reaction.

Preparing the Chemical Solution for a CIP

1. The CIP tank is filled with 1st pass reverse osmosis (RO) permeate: Osmotic shock backwash pumps are started and a butterfly pneumatic valve & CIP tank water inlet valves are opened. When the low level set-point (configurable parameter) is reached in the tank, the pump is stopped and the valves are closed. There will be different set points depending on the selected chemical and the desired concentration.
2. The cleaning chemicals are added to the water-filled CIP tank, not the other way around (see above). Citric acid or sulphuric acid will be added in acid CIP tanks and sodium hydroxide will be added in basic CIP tanks.
3. The chemical solution is homogenized using a mixer.
4. After mixing, the pH value and concentration of the solution are checked and compared to the target values.
5. The heating process may not start until the chemical solution has begun circulating through the modules.

Preparing for a CIP Process

1. For a manual CIP, ensure that the valves are in the correct positions and that the connections are set properly for the cleaning cycle.
2. The cleaning solution may be pumped in filtration mode.

Circulation and Soak Time

1. In the first stage, inlet and top outlet UF rack CIP valves are opened, top inlet and outlet CIP tanks valves are closed and CIP pump is started.
2. If the chemical solution is to be heated, it should be slowly heated to 30-35°C (configurable parameter) while it is circulating through the system. Electric heaters are switched on until temperature set-point (configurable parameter) is reached and temperature switches are activated. If temperature descends until a configurable temperature set-point, heater will be switched on again.
3. Once at least 60 min have passed (configurable parameter) with the solution circulating, the process moves on to a second stage in which UF rack bottom outlet valve is opened & UF rack top outlet valve is closed, bottom inlet CIP tanks valves are opened & top inlet CIP tanks valves are closed. Solution keeps circulating during 60 minutes (configurable parameter).
4. Once the chemical solution has been circulating through the system for approximately 2 hours, the process moves on to a third stage which alternates between soaking periods and circulation through the feed side. In this third stage, the cleaning pump is stopped, the heating element is switched off, and the feed side valves are closed. Just 60 min (configurable time) are enough for the soak time.

INTEGRITY TESTING

Integrity testing can be an effective means of checking the intactness of the membrane fibres in ultrafiltration modules. Two types of test are available for modules: Fully automatic pressure hold tests and semi-automatic bubble tests with visual inspection.

Both tests are based on the phenomenon seen in wetted ultrafiltration membranes whereby water can pass through the pores, but air is prevented from passing through until a certain pressure has been exceeded (the minimum pressure at which air begins to flow is referred to as the “bubble point”).

The bubble point pressure depends on the membrane's pore size and on the surface tension at the air-liquid interface. The bubble point pressure of the pores of membranes is much higher than the applied test pressure (approx. 1 bar) that is required to detect non-intact fibres.

If air is used to displace all the water on one of the two sides of the membrane (feed or filtrate side), the pressure on this side will then continue to increase since the air cannot pass through the wetted pores (this side is referred to in this context as the "high-pressure side").

Once the test pressure has been reached, all the valves are closed on the pressure side. This means that the air can now only escape through defective fibres or faulty valves/pipes on the other side (referred to here as the "low-pressure side") or into the surrounding environment.

A slight pressure drop may be observed due to the natural air diffusion process through the water-filled pores of the membranes. If the pressure differential from the high-pressure side to the low-pressure side is higher than the tolerance limit stipulated by manufacturer, this may indicate a defective fibre.

In the bubble test, air escaping on the low-pressure side due to defects in the system, is visually confirmed by bubbles appearing in the transparent pipes on the feed or filtrate side. In principle, the bubble test can therefore be performed in conjunction with every pressure hold test.

Integrity test shall be performed periodically, approximately once every two weeks in each train.

3.2.9. Reverse Osmosis System (RO)

The primary purpose of the RO system is to remove dissolved solids and minerals including boron from the filtered seawater to produce permeate that can be post treated to meet the product water quality requirements specified.

The RO plant consist on nine (8+1) 1st pass lines and six (4+2) 2nd pass reverse osmosis lines and comprises the following main system.

Each 1st pass RO rack is equipped with an energy recovery system to transfer residual pressure energy into a portion of RO feed water. The system consists of 12 rotary driven pressure exchangers operating in parallel and a booster recirculation pump equipped with variable speed drive.

3.2.10. RO Feed Pumps

Ultrafiltered water is stored in two tanks, each tank is equipped with six motorized butterfly valve for isolation, safety overflow, two level switches, two level transmitters and one motorized butterfly valve for draining system.

RO feed pumps suction water from filtered water tank. There are five (4+1) horizontal centrifugal pumps driven by variable frequency drive (VDF) to feed reverse osmosis system.

These pumps will be started-up when will be required by RO system.

Speed of the active(s) RO feed pump(s) will be regulated depending on the sum of the values measured by the 1st pass RO inlet flow to energy recovery system. This loop will be activated & deactivated during the RO Start-up & Shut-down sequence. When the loop is deactivated the pump will work at a fixed frequency.

Controllers for these pumps have Proportional plus Integral plus Derivative (PID) action. Reverse acting.

When at least one RO feed pump is running, RO disc filter sample pumps must be running.

3.2.11. RO Protection Disc Filter

The purpose of RO disc filter is to act as a safety barrier, in order to protect the reverse osmosis membranes.

Protection disc filter consists on thirty four (34) polymeric disc filter modules rated filtration quality 21 microns and average flow rate per module 402 m^3/h. Each module is composed by four disc filter.

The filter could be operated in manual or auto mode, as required from SCADA. A set of four pneumatic valves is installed in each module to operate the system properly.

In auto mode the number of working filters will depend on the inlet flow measured by a electromagnetic flow meter.

Disc filter valves sequence:

- Filtration stage: Inlet valve and outlet valve are opened and brine backwash inlet valve and drain valve are closed.
- Backwash stage: Inlet valve and outlet valve are closed and brine backwash inlet valve and drain valve are opened.

Backwash sequence starts to clean module by module, if any of following cases happens (configurable parameters):

1) A pre-set pressure loss is reached.
2) An elapsed time is reached (filter inlet & outlet valves opened).
3) Predetermined quantity of filtered water is reached.
4) Operator select backwash sequence (forced backwash).

Osmotic shock could be done by using brine backwash pumps, osmotic water from RO flushing tank is pumped to disc filter module.

RO brine from brine backwash tanks is used for disc filters backwash. If there is no enough brine in the tanks or brine backwash pumps are not available, 1st pass RO permeated water from flushing tanks can be used. The operator can select manually in SCADA the desired way of filters backwash.

The pressure loss is detected by a different pressure transmitter. When a High pressure difference is measured by a different pressure transmitter in a defined line, all filters of the line are washed.

The quantity of filtered water is measured by the UF feed flowmeter. When the defined quantity of filtered water is reached, all the filters will be cleaned.

Only two filters (one per line) can be washed at the same time.

Three chemical products are dosed in three static mixers that are installed in the manifold outlet of RO disc filters:

- Sodium bisulfite to neutralize water oxidants (chlorine)
- Sodium hydroxide to adjust pH
- Antiscalant to prevent the possible precipitation of insoluble salts

To regulate the dosing concertation redox, pH, turbidity, chlorine and conductivity analysers are installed in the two main lines to distribute RO feed water. The water is taken by three (2+1) sample pumps.

If water quality is out of specification, water is sent to neutralization system, for this purpose is installed two motorized valves that are opened and allow water flow to neutralization tank. RO inlet valves are closed. When water quality is adequate, RO inlet valves are opened and reject valves are closed again. If water quality is out of range during a defined time (configurable parameter) RO feed pumps will be stopped.

BRINE BACKWASH SYSTEM

Two tanks of brine are designed to feed brine pumps, three pumps are installed and the RO disc filters backwash is operated with one pump normally. Other pump is used for RO disc filters backwash and the third pump is a common stand-by unit.

Each brine tank can be isolated by means two operated valves. Tanks inlet brine continuously overflows in the tanks and returns to the brine pipe.

3.2.12. RO First Pass

The RO feed pipeline bifurcates in two trains, carrying each branch approximately 50% of the pre-treated flow rate. One of the branches leads to the RO high pressure pump suction and the other branch drives towards the energy recovery system.

Energy recovery system recovers the pressure of the RO concentrate and gives it to the pre-treated water when the pre-treated water leaves the energy recovery system; it

has almost the required RO feed pressure. A booster pump in the energy recovery circuit gives the required pressure increase to account for the system losses.

Finally, the high pressure pump system and energy recovery system flows converge in a common pipeline and feed to the RO skid. First pass permeate could exit via two sides, front and rear, depend on feed water quality and desired osmotic water parameters.

The required trans-membrane pressure increases as the membrane's age, seawater quality and the temperature of the seawater reaching the membranes diminishes. In this case, the inlet pressure is regulated by using variable frequency drives.

To monitor and control the correct operation of the reverse osmosis racks, the needed instrumentation is installed in each of them.

3.2.13. RO Flushing Tank

The 1st pass rear permeate is stored in two (2) tanks with 376 m3 useful volume each one. Each tank is equipped with motorized butterfly valves for isolation, one level transmitter for each tank, one low level switch per tank and emptying system. There is a common overflow vibrating level switch to detect tank overflows.

When a 1st pass RO line is shut down and after a certain time has elapsed (configurable parameter) without operation being resumed, the flushing sequence will start up automatically, proceeding to flush the seawater present from inside the pressure vessels, pipes and pumps of 1st pass RO system:

1) Flushing inlet valves are opened.
2) Rack inlet valves are opened.
3) CIP valves are opened.
4) Brine regulation valve is totally opened.
5) Two flushing pumps are started-up.

This configuration remains during a defined time (configurable parameter). After this time is elapsed, flushing pumps are stopped and opened valves are closed.

Flushing tanks also provide permeate water to:

- Second pass RO feed line train 1 and 2
- Lime dosing preparation
- Osmotic shock backwash for UF and RO disc filter
- RO flushing pumps (RO 1st pass flushing and UF backwash)
- UF CIP preparation
- Service water

3.2.14. RO Second Pass

Each RO second pass line is equipped with two sample pump (1+1) to control dosing and water parameter. One conductivity and two pH analyzers are installed in each line.

Sodium hydroxide and Antiscalant chemical are dosed to adjust pH and to prevent the possible precipitation of very insoluble salts that could block the membranes if the feed water has high contents of them.

2nd pass RO is feed by 1st pass rear permeate stored in flushing tanks. RO second pass is divided in two main lines with three RO rack each one.

Two chemical products are dosed in each line in four chemicals injection lances that are installed in the 2ns pass RO feed pipes:

- Sodium hydroxide to adjust pH
- Antiscalant to prevent the possible precipitation of insoluble salts

To regulate the dosing concentration, one conductivity analyser and two pH analysers are installed in the two main lines to distribute RO feed water. The water is taken by two (1+1) sample pumps.

If any measured value is out of range, an alarm is indicated in SCADA. If these values are not in range after a defined period of time (configurable parameter) 2nd pass RO shut-down sequence will be executed.

Each 2nd pass RO rack consists on two stages with 98 pressure vessels in total with 7 membranes elements per pressure vessel in each rack, 66 at their first stage and 32 at their second stage.

Feed water is pressurized by 2nd pass RO feed pump, firstly the water pass into 1st stage and the no permeate water pass into 2nd stage. Both permeate are collected in a main pipe.

The required trans-membrane pressure increases as the membrane's age, seawater quality and the temperature of the seawater reaching the membranes diminishes. In this case, the inlet pressure is regulated by using variable frequency drives.

To monitor and control the correct operation of the reverse osmosis racks, the needed instrumentation is installed in each of them.

3.2.15. RO Clean In Place (CIP)

Clean-in-place (CIP) is an effective method of restoring membrane performance by tackling the kind of fouling that is difficult to remove using conventional backwashes.

Fouling is progressive, and if not controlled early, will impair the RO membrane element performance in a relatively short time. Cleaning should happen when the RO shows evidence of fouling, just prior to a long-term shutdown, or as a matter of scheduled routine maintenance.

Some fouling is allowed as long as:

- normalized permeate flow decrease is less than 10%
- normalized permeate quality decrease is less than 10%

- normalized pressure drop, as measured between the feed and concentrate headers, increase is less than 15%

RO cleaning frequency due to fouling will vary by site. A rough rule of thumb as to an acceptable cleaning frequency is once every 3 to 12 months.

It is recommended to clean a multi-stage RO one stage at a time to optimize cross-flow cleaning velocity. The source water for chemical solution make-up and rinsing shall be clean RO permeate.

CIP system have been designed to clean the RO systems in a manner that allows the cleaning solution to enter the feed end of the pressure vessels and flow through the RO elements until exiting the pressure vessels at the reject end.

Cleaning in the normal (forward) direction is always recommended if scaling is present. Scaling occurs when sparingly soluble salts precipitate and fall out of solution at the tail end of RO systems. These salts must be removed before doing any reverse direction cleaning. The crystals that form during scaling can have very sharp edges that can damage the membrane surface, and reverse direction cleaning can potentially cause greater damage than normal cleaning if these crystals are not removed first.

When cleaning in the normal direction, the tail end RO elements are supported by a thrust ring which helps prevent the elements from telescoping. But when cleaning in a reverse direction the lead membrane will not be supported by a thrust ring to prevent telescoping. For this reason, we recommend limiting the reverse cleaning flow rates to 2/3 of normal cleaning flow rates.
The cleaning solutions, the pH, and the temperature limits for reverse cleanings are the same as for normal cleanings.

CIP PROCEDURE

CIP must be executed by the operator manually in SCADA.

The operator can select the type of CIP cleaning which will be executed. Operator can choose the chemical to prepare the cleaning solution and the direction of the cleaning.

Level set points in the CIP tank for permeated water and permeate water + chemical (configurable parameters) depends on the selected chemical.

1. First of all, permeate water inlet valve is opened and CIP tank is filled until the desired level set point (configurable parameter), (to fill the CIP tank with permeate water is necessary that at least one 1st pass RO rack is in operation). Then, the valve is closed and a low pressure flush at 60 psi (4 bar) or less (configurable parameter) of the pressure tubes is performed by pumping clean water from the cleaning tank through the pressure tubes to drain for several minutes (configurable parameter) to displace any feed/brine solution from RO membranes.
2. Mix a fresh batch of the selected cleaning solution in the cleaning tank. The dilution water shall be clean water of RO permeate. First, permeate water inlet valve is opened until the permeate water level set point is reached in the tank. After that, a selected chemical is added until permeated water + chemical level set point is reached.

3. Valves forward direction CIP or reverse direction CIP are opened and RO rack CIP valves are opened too. The cleaning solution is circulated through the pressure tubes for the desired period of time (configurable parameter). At the start of circulation, send the displaced water to drain so you don't dilute the cleaning chemical and then divert up to 20% of the most highly fouled cleaning solution to drain before returning the cleaning solution back to the RO Cleaning Tank. For the first 5 minutes (configurable parameter), slowly throttle the flow rate to 1/3 of the maximum design flow rate (configurable parameter). This is to minimize the potential plugging of the feed path with a large amount of dislodged foulant. For the second 5 minutes (configurable parameter), increase the flow rate to 2/3 of the maximum design flow rate (configurable parameter), and then increase the flow rate to the maximum design flow rate. Temperature of cleaning solution should be controlled and kept at maximum allowed value during the whole cleaning cycle for best cleaning efficiency. If required, readjust the pH back to the target when it changes more than 0.5 pH units. For this purpose, the inlet valves are opened and outlet valve is closed. Citric acid or sodium hydroxide is added to the CIP tank until reach the desired pH value. Then, outlet valve is opened and inlet valves are closed again.
4. A soak and recirculation sequence is used during cleaning. The soak time can be from 0.5 to 8 hours. The cleaning consists of 30 minutes (configurable parameter) circulation followed by 30 minutes (configurable parameter) soaking cycles.
5. Once cleaning sequence is finished, CIP pumps are stopped and all CIP valves are closed.
6. Upon completion of the chemical cleaning steps, a low pressure Cleaning Rinse with clean water (RO permeate) is required to remove all traces of chemical from the Cleaning Skid and the RO Skid. For draining and flushing the cleaning tank, the outlet, inlet and drain valves are opened and CIP pumps are started until low level is reached in the CIP tank. Then, the permeated water inlet valve is opened and CIP tank is filled up with permeated water until the desired level. The CIP pumps are started again until the tank is emptied again, after that, the CIP pumps are stopped and valves are closed.
   Then the Cleaning Tank is completely refilled with clean water for the Cleaning Rinse by opening the permeated water valve.
7. The forward direction CIP and reverse direction CIP valves are opened again and CIP pumps are started-up to execute the cleaning rinse during a defined time (configurable parameter), then the pumps are closed and stopped.
8. Once the RO system is fully rinsed of cleaning chemical with clean water from the Cleaning Tank, a Final Low Pressure Clean-up Flush is performed using pretreated feed water. The permeate line should remain open to drain.
9. Once all the stages of a train are cleaned, and the chemicals flushed out, the RO can be restarted and placed into a Service Rinse.

3.2.16. Chlorine Contact Tank (CCT)

Permeated water from RO will pass through the Chlorine Contact Chamber (or Chlorine Contact Tank = CCT) in order to achieve a determined concentration of fluoride as well as be subjected to a disinfection.

For this purpose, the Chlorination system is composed of a civil-works-tank, two set of pumps for analysis (one before, and one after the CCT) and its associated instrumentation:

- Chlorine Contact Tank, 2202,46 m^3 useful volume
- 1 (one) CCT inlet magnetic flowmeter
- 1 (one) level indicator transmitter
- 2 (1+1) pumps for analysis, before the CCT
- Before CCT analysers groups:
    - 2 conductivity
    - 1 free chlorine
    - 2 pH
- 2 (1+1) pumps for analysis, after the CCT
- After CCT analysers group:
    - free chlorine analyser (3 sensors)
    - 1 fluoride
    - 1 pH

All the analyzer groups count with a plastic rotameter with low flow switch for providing the necessary flow for each analyzer.

CCT can be by-passed during maintenance activities.

The chemicals used at CCT are:

- Silicofluoride: in order to achieve a fluoride concentration between 0.25 and 0.6 mg/L in the Treated Water.
- Sodium Hypochlorite: for disinfection.
- Sulphuric Acid: for pH adjustment.

The Chlorination Sequence will work as follows:

- Chemicals are injected to permeated water pipeline depending on the requirements and this water goes into de chlorine contact chamber.
- Firstly the water is analyzed in both sample points placed before and after the CCT; the chemical dosing will be calculated depending on the results.
    - Sodium hypochlorite dosing rate is automatically controlled based on on-line measurement of flow to CCT measured by the inlet flowmeter and on-line free chlorine downstream of the CCT measured by a chlorine analyzer.
    - Sulphuric acid dosing rate is automatically controlled based on on-line measurement of flow to CCT measured by the inlet flowmeter and on-line pH upstream of the CCT measured by two analyzers.
    - Silicofluoride dosing rate is automatically controlled based on on-line measurement of flow to CCT measured by the inlet flowmeter and on-line fluor downstream of the CCT measured by an analyzer.
- If during a defined time (configurable parameter), the water parameters do not comply with quality reference values then the CCT outlet valve will be closed

and the water will flood the CCT until it overflows, the overflow will be lead towards the process overflow tank.

The permeated water could flow directly towards the Treated Water Tank through the bypass line opening the by-pass valves and closing the CCT outlet valve.

3.2.17. Treated Water Tanks (TWT)

Previous to treated water tank, carbon dioxide and lime are dosing to remineralize the water. Sodium hydroxide is dosed for pH adjustment and ammonium sulphate is dosed to convert the remaining free chlorine to monochloramine.

The remineralized and disinfected treated water is conveyed to the water storage system from chlorine contact tank (CCT).

Treated water storage is composed of:

- 2 (two) storage tanks, civil works
- 1 (one) Level Indicator Transmitter per tank
- 1 (one) low level switch per tank
- 1 (one) high level switch per tank
- 2 (1+1) TWT sample pumps
- 2 (1+1) chloramination sample pumps
- 1 (one) TWTs inlet magnetic flowmeter
- 1 (one) chloramination sample magnetic flowmeter

The treated water is analyzed in a point after the chemical dosage points. The following parameters are analyzed in order to chemical dosing addition, water quality and chloramination control:

Analysers for water quality control:

- Turbidity
- Conductivity
- Two pH

Analysers for water chloramination:

- Concentration of Ammonium
- Free Residual Chlorine
- Total Chlorine

At this point of the process these chemicals are dosed:

- CO2 / water dilution (CARBONIC ACID) (CAD): to add alkalinity.
- Lime (CAC): for pH adjustment.
- Sodium Hydroxide (SMH): for pH adjustment.
- Ammonium Sulphate (ASP): to convert free chlorine to monochloramine.

Treated water is stored in two tanks before it enters the distribution system to develop an adjustment of its quality parameters via chemical dosing if necessary.

Each tank is provided with a motor driven penstock which lets the water go through the overflow channel and eventually to the process overflow tank.

If during a defined time (configurable parameter), the quality parameters are not within a defined range, then a chemical dosing will be done in order to adjust the water parameters, meanwhile the motor driven butterfly valves at the outlet will remain closed and the motorized penstocks opened sending the tank overflow to the process overflow tank.

If the water parameters are within a defined range then treat water tank outlet valves will open and motorized penstocks will be closed to let the water go towards the distribution system.

Each tank can be isolated for maintenance purposes by closing the inlet valves.

3.2.18. Product Water Pumps

Water from treated water tanks are delivered to distribution net by product water pumps, the product pumping station is composed of:

- Product water pumps, vertical centrifugal type (4+1) equipped with VFD
- Static Mixers
- Anti-water hammer system (2+1)
- Recirculation Pumps (1+1)
- Sample Pumps
- Multiple Valves and Instruments

Product water could be conveyed to following areas:

- Water distribution pipelines
- Treated water tanks (recirculation)
- Process overflow tank
- Yard piping potable water supply loop
- Admin building
- Non potable water supply
- Fire protection water supply

Product water pumps are equipped with a variable speed drive. Speed of the active(s) product water pump(s) will be regulated depending on the sum of the values measured by the product water magnetic flowmeters. Controllers for these pumps have Proportional plus Integral plus Derivative (PID) action. Reverse acting.

Two (1+1) recirculation pumps take water from the treated water pumps common inlet pipe and send it to the treated water tanks again. Sodium hypochlorite is dosed in the recirculation pumps common suction pipe.

Downstream the product water pump, ammonium sulphate is dosed to convert the remaining free chlorine to monochloramine.

Upstream or downstream treated water pumps, water is taken by two sample pumps and the following parameters are analysed in order to chemical dosing addition, water quality and chloramination control:

- 2 fluoride
- 2 free residual chlorine
- 3 total chlorine
- 2 turbidity
- 2 concentration of ammonium
- 2 conductivity
- 1 Total organical carbon
- 2 pH/temperature

Ammonium sulphate dosing rate is automatically controlled based on on-line measurement of treated water flow, measured by four treat water flowmeters and on-line measurement of NH4 measured by two analyzers.

Sodium hypochlorite dosing rate is automatically controlled based on on-line measurement of treated water recirculation flow measured by outlet flowmeter and on-line measurement of total chlorine, measured by a chlorine analyzer.

Water is pumped by two sample pumps and analysed. If total chlorine is out of parameters (detected by two analyzers), treated water pumps are stopped and treated water tanks overflow penstocks are opened. TWT recirculation pump is started and sodium hypochlorite is dosed until the water quality measured by a free chlorine analyzer is into parameters again.

After sodium hypochlorite dosing, treated water pumps are started-up again, treated water tanks overflow penstocks are closed and ammonium sulphate is dosed if needed to reduce the remaining free chlorine.

3.2.19. Water Distribution System

Drainage of product water systems will lead flow towards the drainage tank where two drainage pumps will lead flow towards the process overflow tank closing the circuit.

When High level is measured in the tank by a level transmitter, two drain pumps are started until Low level is reached again.

3.2.20. Neutralization System

In the neutralization tank, water with chemicals from UF and RO cleanings and lime saturators sludge are collected.

Neutralization will be implemented dosing several chemicals according to the values registered at the outlet of the neutralization basin.

The neutralization system is composed of:

- Neutralization Tank, buried tank , 280 m^3
- Neutralization Pumps (350 m^3/h, 15 wcm)

- Motorized Butterfly Valves
- Static mixer
- Associated Instrumentation for measuring:
    - Two pH analyzers.
    - Two Redox analyzers.
    - Two Total Chlorine analyzers.
    - Pressure Indicators and Flow Switch in pumps discharge pipes.
    - One Magnetic Flowmeter in common discharge pipe.
    - One level indicator transmitter in neutralization tank.
    - High/Low level switches in neutralization tank.

The following chemicals will be dosed if necessary:

- SAH: Sulphuric Acid (H_2SO_4)
- SMH: Sodium Hydroxide (NaOH)
- SOB: Sodium Bisulphite ($NaHSO_3$)

The following liquid effluents from different points of the SWRO will be neutralized in order to comply with quality parameters and environmental protection prior to its discharge:

- UF membrane chemical enhanced backwashing (CEB) and CIP.
- RO membrane chemical cleaning.
- Lime saturators sludge purges.

These effluents may be classified according to their source and its pH:

- Acids: from RO and UF acid cleanings .
- Basics: from RO and UF membrane alkaline cleanings.
- Oxidants [hypochlorite-(OCl^-) and bisulphite ($HSO3^-$) mainly]: from UF membrane alkaline cleanings.

NEUTRALIZATION SEQUENCE

On completion of a backwashing or cleaning of either a RO or a UF train, the effluents discharged in the Neutralization Tank shall be subjected to neutralization in order to comply with environmental-friendly quality parameters. For this purpose sodium hydroxide, sulphuric acid or sodium bisulphite will be added in the Neutralization tank as needed in order to neutralize the involved chemicals.

The sequence for neutralization will keep monitoring three parameters by means of redundant analyzers sensors which will measure pH, Redox Potential and Total Chlorine Residual in the recirculation stream.

System will keep recirculation through a recirculation valve while one of the parameters is out of range (configurable parameters) by means of the recirculation pumps to achieve correct homogenization and neutralization. During the recirculation, the needed chemical (sulfuric acid, sodium hydroxide or sodium bisulphite) is dosed until the water quality is into the required parameters.

The neutralization and disposal operations will be automatically carried out from control room.

Finally, when the neutralized water complies with the quality parameters, the same recirculation pumps will lead water through a butterfly valve towards Process Overflow Tank and, eventually, the Outfall Tank.

3.2.21. Wastewater Disposal

The effluents produced in the SWRO plant are homogenized to prevent the peak outflow of pollutants.

This Wastewater system receives water from different systems:

- Wastewater from Intake
- Floated Sludge from DAF
- UF and RO Disc Filters backwash
- UF backwash (without chemicals)

Wastewater system is comprised of:

- 1 (one) wastewater homogenization tank, 400 m³
- 5 Pumps
  - submersible centrifugal type
  - in configuration (4+1 in standby)
  - 300 m^3/h
  - 15 wcm
- 1 magnetic flowmeter
- 1 level transmitter in tank
- 1 High level switch in tank
- 1 Low level switch in tank

Waste water from this tank is pumped to the outfall tank.

When a High level (configurable parameter) is reached and measured by the level transmitte, one wastewater pump is started. If after a defined time (configurable parameter) the level in the tank continues going up, a second pump is started, and so on until all pumps are running. When Low level is reached in the tank all running pumps are stopped.

Wastewater tank overflow enters directly in process overflow tank.

3.2.22. Process Overflow

The process overflows and drainages produced all along the SWRO plant shall be sent to the Process Overflow Tank. In case the system has not enough capacity for high flow rates, then the overflow shall be discharged in the shoreline (if the water complies with a minimum quality parameters) or returned to head of plant (to the intake).

The Process Overflow Tanks will receive water from different systems:

- Clarified Water from Clarified Water Tanks

- Drainage Water from UF disc Filters (either cleaning water or rejected)
- Filtered Water from Filtered Water Tanks
- Treated Water from CCT
- Treated Water from Treated Water Tanks (either overflow or rejected)
- From Drainage Tank
- Treated Water from Flushing Tank
- Raw Seawater from Intake Structure
- Permeated water from RO 1st Pass and RO 2nd Pass (permeate)

The Process Overflow System is comprised of:

- 1 (one) Process Oerflow tank, 495 m³
- 4 (four) pumps
  - Submersible centrifugal type
  - 2200 m^3/h
  - 8 wcm
- 2 (two) sample pumps
- 2 electric operated penstocks
- 1 redox transmitter
- 1 flow indicator transmitter
- 1 level transmitter in tank
- 1 High level switch in tank
- 1 Low level switch in tank

Overflows and drainages pumping to outfall tank will be carried out by means of four submergible centrifugal pumps in configuration 3+1 in standby.

When a High level (configurable parameter) is reached and measured by level transmitter, one wastewater pump is started. If after a defined time (configurable parameter) the level in the tank continues going up, a second pump is started, and so on until all pumps are running. When Low level is reached in the tank all running pumps are stopped.

Also, if necessary, it has been implemented a chemical dosage of Sodium Bisulphite to Process Overflow Tank in order to correct the quality parameters.

Quality parameters will be monitored by the following instrumentation:

- Redox analyzer

Sample Pumps will take samples from Process Overflow Tank. Depending on the measurement results Sodium Bisulphite may be added.

One of these pumps is always running if there is enough level in the tank.

Once water quality is into parameters, it can be pumped to outfall tank.

If tank overflow is detected by an ultrasonic flowmeter, the penstocks are opened and overflow is sent to inlet intake pump station or shoreline.

3.2.23. Outfall Tank

The brine and effluents produced in the SWRO plant and that comply with the minimum required quality parameters will be discharged in the sea.

The Outfall System is comprised of:

- 1(one) Outfall Tank, 324 m³
  - 2 (two) sample pumps
  - Submersible centrifugal type
  - 5 m^3/h
  - 20 wcm
- 1 (one) Brine and effluents discharge GRP pipe of diameter 1,600 mm.
- 1 level transmitter in tank
- 1 High level switch in tank
- 1 Low level switch in tank
- Associated Instrumentation for measuring:
  - total chlorine analyzer
  - redox potential analyzer
  - pH analyzer
  - conductivity analyzer
  - turbidity analyzer
  - O2 analyzer

Outlet water quality is analysed before being sent to the sea. Sodium bisulphate can be added if needed.

Quality parameters will be monitored by the following instrumentation:

- Measure of total chlorine
- Measure of ORP
- Measure of pH
- Measure of conductivity
- Measure of turbidity
- Measure of O2

Sample Pumps will take samples from Process Overflow Tank. One of these pumps is always running.

Overflow from this tank is returned to process overflow tank.

3.3. Technical approvals

The instruments are being purchased, but the previous step is to compare all the offers that the suppliers make. When that comparison is done for proving that all tenders and technical specification are fulfilled, is called a technical comparison.

When technical comparison is being done, it is important to understand how the instruments work and which the process conditions are.

For example, after the RO water has low salinity, so the flowmeter that it is needed has to be available for low conductivity measurement. In case of electromagnetic flowmeter, this process condition implies high costs associated because low conductivity water is not electrically conductive. So, if the instrument offered is not available to that low conductivity, this supplier will not get the technical approval.

Each supplier has its own instruments, which are different to the others by some characteristic, but most of characteristics are the same. To know the differences and similarities between the instruments offered, the best way is meeting with or calling to the commercial of this brand, because he or she knows all the characteristics of this instrument.

To get the technical approval the instruments must comply with the technical comparison and, after that, they should pass the commercial approval. Therefore, many suppliers could get the technical approval, but just one will get the commercial approval.

4. ASSEMBLY AND IMPLEMENTATION

Instruments shall be assembled using some rules and the most important diagram to show how they are assembled is hook up document which is included in annex 5.

This document is usually done by instrumentation engineers when all the process characteristics which affect to assembly instruments are known as flanges connection, vessels height or tubing diameter.

The plant will be working by May 2017.

5. VALUATION OF THE PROPOSED SOLUTION

In this project there are two different solutions which shall be evaluated; the first one is about instrumentation used to this project and the second one is about desalination as drinking water solution.

Instrumentation solution

Some years ago the instrumentation was basically manual and it cost a lot of accidents and even lives. As the instrumentation was more automatic, there were less human mistakes and consequently, less human lives were lost.

The instrumentation used in this project has been carefully designed, because all the instruments shall control the entire plant. In case of failure of one instrument, always there is another one which can be placed in this position and moreover, there is an alarm which switches on when the instrument is broken or it does not work well or the process measurement is out of the range.

The instrumentation design has been developed to be the most efficient, safe, productive and environment friendly as possible.

The most efficiently is referred to the power is correctly used and like example; the energy recovery system is controlled by two differential pressure transmitter, four pressure transmitter and three pressure transmitter.

The safest is referred to control all the process values like pressure and make sure that an alarm is switch on when the pressure is out of range.

The most productive is referred to the production is controlled by a flowmeter (FIT-15601) which measure the flow sent to the network.

The most environmental friendly is referred to control the quality of brine which is sent back to the sea; this part of the plant is controlled by six analyzers.

Desalination plant solution

In order to make a more informed decision about the valuation of using a desalinated plant is important to make a list of pros and cons of desalination. Due to all the desalination plants have the same problems and benefits (more or less) this list has been done like a general plant, so all the specific data given are not the real data for Tuas III desalination plant. The reason of not provide the real data is the confidentiality of the project.

- **List of pros**

1. *It is proven and effective.* The method of reverse osmosis to remove salt from seawater has been proven to be effective in creating a fresh source of drinking water that is needed to increase the health benefits to people who has not other water source. In fact desalination plants can create water that is good quality and drinkable.
2. *It has the massive ocean water as source.* Even if all water would come from desalination plants, seawater can serve as almost inexhaustible source. This implies that people would have sufficient access to freshwater needed for growing crops, for everyday living and other needs, even in times of drought.
3. *Its method is highly understood.* The desalination method is backed up by scientific data and is highly understood. The technology used is so reliable that it allows for high-quality water, which means that using such method should allow for great results and could help eliminate water shortage crisis that the world might face in the future.
4. *Its plants are built in safe locations.* Desalination plants are and will be located away from large residential communities. Some of those already existing today are located in industrial facilities, which mean that people are not put at risk. Companies that are planning to construct desalination plants have plans in place to make the projects safer in the long run.

- **List of cons**

1. *It can be a very costly process***.** For the average desalination plant these days, it takes 2 kWh of energy in order to produce 1 cubic meter of fresh water. Though this would translate to a cost of just under 2 dollars on a lot of power grids, the

real production cost comes from the expenditure of fossil fuels that are needed to create electricity for its process.

2. *Its plants are expensive to build.* Though most plants have operations cost reasonably, building them is not always available for a country or a community. The cost is so very high that some authorities prevented the technology to be developed because they just cannot afford its initial investment.
3. *It demands high energy costs.* One big problem with desalination is the enormous amount of energy it consumes. The process includes reverse osmosis which demands a high amount of energy to reverse. This plant has been designed with a energy recovery system to reduce the energy consumption but this consumption is still a big problem.

In conclusion, I think that the costs of desalination are worth the gains because desalination means an alternative to fresh water. All we need to survive is fresh water and desalination is a good method to do it possible.

6. QUOTATION

At this part of the project, I would like to remember that this project has been done based on a real project and I have developed the work in a company. For this reason, only personal costs are included on the table shows below these lines.

Table 4 shows the Gantt diagram of this project.

	Office time (h)	Weekend time (h)	Edition time (h)	Total (h)	Costs (€/h)	Costs (€)
Student	1056	224	85	1365	10	13650
University Tutor				130	30	3900
Company tutor				300	30	9000
			Total (€)			26550

Table 3: Quotation

	Nombre de tarea	Duración	Comienzo	Fin	Predecesoras
✓	Search information	109 días	lun 01/02/16	jue 30/06/16	
✓	Consult the tender	109 días	lun 01/02/16	jue 30/06/16	
✓	P&ID revision	98 días	jue 11/02/16	lun 27/06/16	
✓	Instrument list	100 días	vie 12/02/16	jue 30/06/16	3CC
✓	Datasheet realization	70 días	vie 25/03/16	jue 30/06/16	2CC+15 días;4FF
✓	Instrument specification	10 días	mié 15/06/16	mar 28/06/16	2FF
✓	Hook up revision	10 días	vie 01/07/16	jue 14/07/16	
✓	Project writting	35 días	jue 14/07/16	mié 31/08/16	1FF;2FF;3FF;4FF

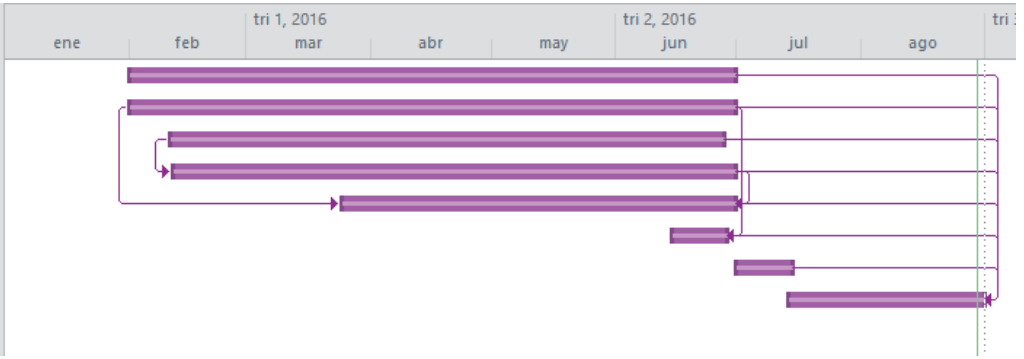


Table 4: Gantt diagram

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ANNEX I: P&ID

REPRESENTATION OF LINES

- MAIN LINE
- SECONDARY LINE
- SLUDGE LINE
- CHEMICALS LINE
- VENT AND DRAINAGES
- PROCESS AIR LINE
- ELECTRICAL SIGNAL LINE
- COMMUNICATION LINE
- PNEUMATIC LINE
- MECHANICAL LATCHING LINE

LINES CODING

WSP-YYYY-BBB-XXX-YYYZZ-C

- MAIN SUBJECT CODE(NOT SHOWN)
- PIPE DIAMETER
- FLUID
- MATERIAL SPECIFICATION
- AREA CODE (Note 6)
- CORRELATIVE ORDER NUMBER OF LINE
- PIPE ISOLATION TYPE

MATERIALS SPECIFICATION

XaY

- CLASS
- MATERIAL
- MATERIAL TYPE

X: CLASS		
1	150#	PN10
2		PN16
3	300#	PN25
4		PN40
6	600#	PN6
9	900#	

a: MATERIAL	
A	CARBON STEEL
C	STAINLESS STEEL
G	GALVANIZED STEEL
F	CAST IRON
P	NON METALLIC

Y: MATERIAL TYPE		
A: CARBON STEEL	1	BS EN 10216
	2	BS EN 10029
B: BRONZE	1	BS EN 1982
C: STAINLESS STEEL	1	A312-TP304
	2	A312-TP316
	3	A790 Gr. S32750 or S32205
G: GALVANIZED STEEL	1	A53 Type E Gr. B
F: CAST IRON	1	BS EN 545
P: NON METALLIC	1	HDPE PE 100
	2	PPH
	3	u-PVC
	4	GRP ISOPHTHALIC RESINE SN2500
	5	GRP ISOPHTHALIC RESINE SN5000
	6	GRP VYNILESTER RESINE SN2500
	7	PVDF
	8	c-PVC

FLUIDS DEFINITIONS

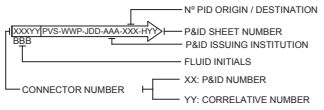
FLUID WATER
- BRN.- BRINE
- BRR.- BRINE RETURN
- BRS.- BRINE SUPPLY
- CLW.- CLARIFIED WATER
- CWC.- CLEAN WATER CHEMISTRY
- DRW.- DRAIN WATER
- EFW.- EFFLUENT WATER
- FIW.- FIRE WATER
- FTW.- FILTERED WATER
- MIW.- MICROFILTRATED WATER
- PMW.- PERMEATED WATER
- PWR.- POTABLE WATER
- PRW.-PRODUCT WATER
- PTW.-PERMEATED WATER
- RMW.- REMINERALIZED WATER
- RSW.- RAW SEAWATER
- SEW.- SERVICE WATER
- STW.- STREAKING WATER
- TRW.-TREATED WATER
- UFW.- ULTRAFILTRATED WATER
- WAW.- WASH WATER
- WNW.- WATER NETWORK
- WSW.- WASHING WATER

FLUID AIR/GAS
- AIW.- WASHING AIR
- DEZ.- DEODORIZING
- FRE.-FREON
- INA.- INSTRUMENTS AIR
- SEA.- SERVICE AIR

FLUID SLUDGE
- DES.- DEWATERED SLUDGE
- FLS.- FLOATED SLUDGE
- THS.- THICKENED SLUDGE

CHEMICALS REAGENTS
- ASP.-AMMONIUM SULPHATE
- CAC.-CALCIUM CARBONATE
- CAD.- CARBON DIOXIDE
- CAH.- CALCIUM HYDROXIDE
- CAU.- CAUSTIC SODA
- CHC.- CHEMICAL CLEANING
- CHD.- CHEMICAL DRAIN
- CIA.-CITRIC ACID
- DIS.- DISPERSANT
- FEC.- FERRIC CHLORIDE
- HYA.- HYDROCHLORIC ACID
- POL.- POLYELECTROLYTE
- SAH.- SULPHURIC ACID
- SFL.-SILICOFLUORIDE
- SMH.- SODIUM HYDROXIDE
- SOB.- SODIUM BISULPHITE
- SOH.- SODIUM HYPOCHLORITE

LINE CONNECTORS



EQUIPMENTS CODING

WSP-XX-AAABB

- MAIN SUBJECT CODE(NOT SHOWN)
- EQUIPMENT INITIALS
- AREA CODE (Note 6)
- CORRELATIVE ORDER NUMBER OF EQUIPMENT (2 DIGITS)

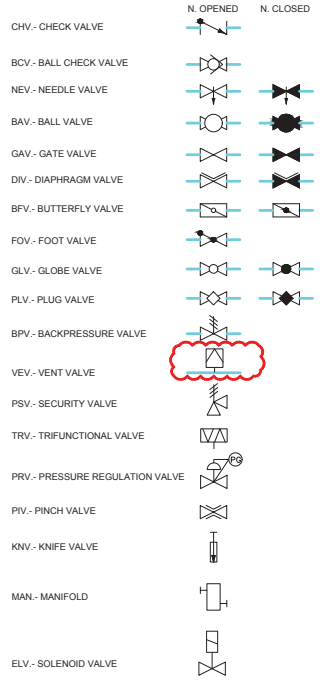
EQUIPMENTS DEFINITION

- AC.- AIR COMPRESSOR
- AD.- AIR DRYER
- AW.- AUTOMATIC WATER DRAINAGE
- BA.- BASSIN
- BC.- BRIDGE CRANE
- BR.- SCRAPER BRIDGE
- BS.-BAR SCREEN
- BW.-BLOWER
- BWT.-BACKWASH TANK
- CB.- CALCITE BED
- CC.- CALIBRATION COLUMN
- CF.- CARTRIDGE FILTER
- CH.- CHAMBER
- CL.- CLARIFIER
- CN.- CHANNEL
- CP.- HORIZONTAL CENTRIFUGAL PUMP
- CWT.-CLARIFIED WATER TANK
- DC.- DEWATERING CENTRIFUGUE
- DE.- DEODORIZATION
- DF.- DISSOLVED AIR FLOTATION
- DSF.-DISC FILTER
- EB.-EDUCTOR SYSTEM
- EP.- ELECTRIC DRIVE PENSTOCK
- ES.- EYEWASHING SHOWER
- FB.-FLOCULATION BASIN
- FI.- SELF CLEANING FILTER
- FST.-FLUSHING TANK
- FWT.-FILTERED WATER TANK
- GC.- GANTRY BRIDGE CRANE
- HO.- HOIST
- HR.- HEATING RESISTANCE
- IC.-INTAKE CHAMBER
- IL.- CHEMICAL INJECTION LANCE
- IP.- INTAKE PASIVE SCREW
- IS.-INTAKE SCREENEING CHAMBER
- LS.- LIME SATURATOR
- LT.- LIME TANK
- MA.- MACERATOR
- MC.- MANUAL PENSTOCK
- MM.- MEMBRANE METERING PUMP
- MP.- PLUG METERIMG PUMP
- MT.- MOTOR
- NT.- NEUTRALIZATION TANK
- OP.- ORIFICE PLATE
- OS.- OIL SEPARATION
- PC.- PNEUMATIC PENSTOCK
- PD.- PULSATION DAMPENER
- PE.- PRESSURE EXCHANGER
- PP.- PERISTALTIC METERING PUMP
- PR.- PRESSURIZATION REACTOR
- PU.- POLYELECTROLYTE COMPACT UNIT
- PV.- PRESSURE VESSEL
- PWT.-PRODUCT WATER TANK
- RD.- RUPTURE DISC
- SB.- SUBMERSIBLE MIXER
- SC.- SCREW CONVEYOR
- SF.- SAND FILTER
- SG.-SILICA GEL SYSTEM
- SK.- SKID
- SL.- STOP LOG PENSTOCK
- SM.- STATIC MIXER
- SS.- SLUDGE SCRAPER
- SP.- SCREW PUMP
- ST.- SLUDGE THICKENER
- SU.- SUMERSIBLE CENTRIFUGAL PUMP
- SV.- SURGE VESSEL
- TA.- TANK
- TB.-TRAVELLING BAND SCREEN
- TWT.-TREATED WATER TANK
- TK.- STORAGE TANK
- UF.- UF MODULES
- VC.- VACUUM PUMP
- VM.- VERTICAL MIXER
- VP.- VERTICAL CENTRIFUGAL PUMP
- VT.- VERTICAL TURBINE
- WE.- WEIR
- YF.- Y FILTER

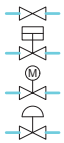
VALVES CODING

- VALVE'S ACTUATOR TYPE
- VALVE TYPE
- MAIN SUBJECT CODE(NOT SHOWN) / VALVE DIAMETER — WSP BBBC XXX YYYZZ
- AREA CODE (Nota 6)
- CORRELATIVE ORDER NUMBER OF EQUIPMENT (2 DIGITS)

VALVES DEFINITION



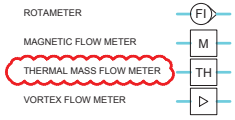
ACTUATORS



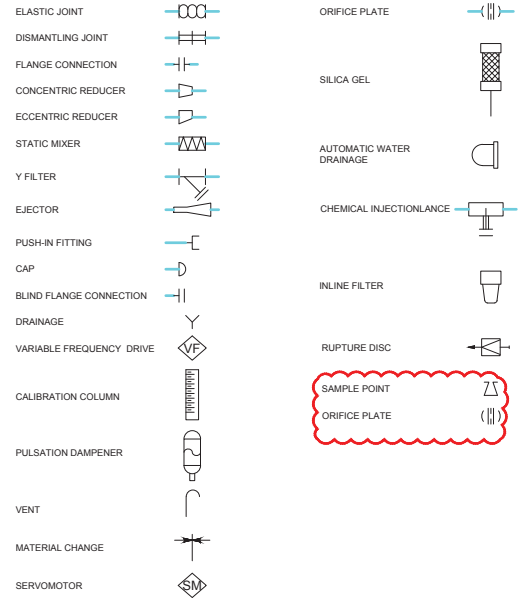
VALVES FAIL ACTION

- F.O. FAIL OPEN
- F.C. FAIL CLOSED

INLINE INSTRUMENTS



FITTINGS



PIPE DIAMETERS			
DN	INCHES (")	STEEL PIPE mm OUTSIDEDIAMETER(ANSI B36.19)	PLASTIC PIPE OUTSIDE DIAMETER mm (d)
6	1/8"	10,3	10
8	1/4"	13,7	12
10	3/8"	17,1	16
15	1/2"	21,3	20
20	3/4"	26,7	25
25	1"	33,4	32
32	1 1/4"	42,2	40
40	1 1/2"	48,3	50
50	2"	60,3	63
65	2 1/2"	73	75
80	3"	88,9	90
~~90~~	~~3 1/2"~~	~~101,6~~	-
100	4"	114,3	110
~~110~~	~~4 1/2"~~	~~141,3~~	~~125~~
~~125~~	~~5"~~	-	-
150	6"	168,3	160
200	8"	219,1	~~200~~
			225
250	10""	273,1	~~250~~
			280
300	12"	323,9	315
350	14"	355,6	355
400	16"	406,4	400
450	18"	457	450
500	20"	508	500
~~550~~	~~22"~~	~~559~~	~~560~~
600	24"	610	630
700	28"	711,2	710
750	30"	762	-
800	32"	812,8	800
900	36"	914,4	900
1000	40"	1016	1000
1100	44"	-	1100
1200	48"	-	1200
1400	54"	-	1400
1600	64"	-	1600
1800	72"	-	
2000	80"	-	
2200	88"	-	

NOTES :
- THIS SHEET CORREPONSE TO AREA:

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
SYMBOLS I

REFERENCE : TDI-P-15-60

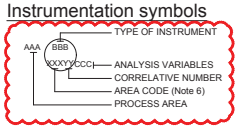
DRAWING Nº : PUB-WSP-JDD-000

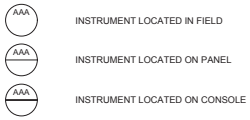
FORMAT A1

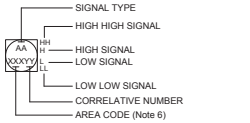
SHEET 1 OF 3

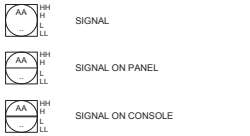
DIN A1 (841 x 594)

Instrumentation symbols









INSTRUMENTS IDENTIFICATION LETTERS (ISA 5.1)

	FIRST LETTERS		SUCCEEDING LETTERS		
	MEASURED / INITIATING VARIABLE	VARIABLE MODIFIER	READOUT / PASIVE FUNCTION	OUTPUT / ACIVE FUNCTION	FUNCTION MODIFIER
A	ANALYSIS		ALARM		
B	BURNER, COMBUSTION		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
C	ELECTRICAL CONDUCTIVITY			CONTROL	
D	DENSITY	DIFFERENCE, DIFFERENTIAL			
E	VOLTAGE		SENSOR PRIMARY ELEMENT		
F	FLOW, FLOW RATE	RATIO			
G	VISION		GLASS, GAUGE, VIEWING DEVICE		
H	HAND				HIGH
I	CURRENT		INDICATE		
J	POWER	CONTINUOUS READING	SCAN		
K	TIME, SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW
M	HUMIDITY	INSTANTANEOUS		CONTROL STATION	MIDDLE, INTERMEDIATE
N	USER'S CHOICE		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
O	USER'S CHOICE		ORIFICE, RESTRICTION		OPEN
P	PRESSURE		POINT (TEST CONNECTION)		
Q	QUANTITY	INTEGRATE, TOTALIZE	INTEGRATE, TOTALIZE		
R	RADIATION		RECORD		RUN
S	SPEED, FRECUENCY	SAFETY		SWITCH	STOP
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER, LOUVER	
W	WEIGHT, FORCE		WELL, PROBE		
X	UNCLASSIFIED	X-AXIS	ACCESORY DEVICES, UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED
Y	EVENT, STATE, PRESENCE	Y-AXIS		AUXILIARY DEVICES	
Z	POSITION, DIMENSION	Z-AXIS, SAFETY INSTRUMENTED SYSTEM		DRIVE, ACTUATOR,UNCLASSIFIED FINAL CONTROL ELEMENT	

TYPICAL LETTER COMBINATIONS

PRESSURE		LEVEL	
PE	PRIMARY ELEMENT PRESSURE	LA	LEVEL ALARM
PI	PRESSURE INDICATOR	LAHH	LEVEL ALARM HIGH HIGH
PRC	PRESSURE RECORDER	LAH	LEVEL ALARM HIGH
PS	PRESSURE SWITCH	LAL	LEVEL ALARM LOW
PSE	RUPTURE DISC	LALL	LEVEL ALARM LOW LOW
PT	PRESSURE TRANSMITTER	LI	LEVEL INDICATOR
PIT	PRESSURE INDICATOR TRANSMITTER	LIC	LEVEL INDICATOR CONTROLER
PDT	PRESSURE DIFFERENTIAL TRANSMITTER	LIT	LEVEL INDICATOR TRANSMITTER
PDIT	PRESSURE DIFFERENTIAL INDICATOR TRANSMITTER	LS	LEVEL SWITCH
PAH	PRESSURE ALARM HIGH	LSHH	LEVEL SWITCH HIGH HIGH
PAL	PRESSURE ALARM LOW	LSH	LEVEL SWITCH HIGH
PSAH	PRESSURE SWITCH AND ALARM HIGH	LSL	LEVEL SWITCH LOW
PSAL	PRESSURE SWITCH AND ALARM LOW	LSLL	LEVEL SWITCH LOW LOW
PSH	PRESSURE SWITCH HIGH	LC	LEVEL CONTROL
PSL	PRESSURE SWITCH LOW	LG	LEVEL GLASS
FLOW		LT	LEVEL TRASMITTER
FE	FLOW PRIMARY ELEMENT	ANALYSIS	
FI	FLOW INDICATOR	AE	ANALYSIS PRIMARY ELEMENT
FS	FLOW SWITCH	AI	ANALYSIS INDICATOR
FT	FLOW TRANSMITTER	AIT	ANALYSIS INDICATOR TRANSMITTER
FIT	FLOW INDICATOR TRANSMITTER	ARC	ANALYSIS RECORDER
FRC	FLOW RECORDER	AAH	ANALYSIS ALARM HIGH
FAH	FLOW ALARM HIGH	AAL	ANALYSIS ALARM LOW
FAL	FLOW ALARM LOW	RADIATION	
FO	FLOW RESTRICTOR	RI	RADIATION INDICATOR
TEMPERATURE		RAH	RADIATION ALARM HIGH
TAH	TEMPERATURE ALARM HIGH	RAL	RADIATION ALARM LOW
TAL	TEMPERATURE ALARM LOW		
TI	TEMPERATURE INDICATOR		
TIT	TEMPERATURE INDICATOR TRANSMITTER		
TT	TEMPERATURE TRANSMITTER		
TSE	TEMPERATURE SAFETY ELEMENT		
TSH	TEMPERATURE SWITCH HIGH		

ANALYSIS VARIABLES

INITIALS	VARIABLE DEFINITION
Cl.	ACTIVE CHLORINE
CO	CARBON MONOXIDE
CO2	CARBON DIOXIDE
Cond.	CONDUCTIVITY
Fluor	FLUORIDE
FRC	FREE CHLORINE
Ct.	TOTAL CHLORINE
H2S	HYDROGEN SULPHIDE
HC	HYDROCARBONS
Hum.	MOISTURE
NaOH	SODIM HYDROXIDE
NH4	AMMONIA
NO3	NITRATES
Nt.	TOTAL NITROGEN
TKN	KELDHAL NITROGEN
O2	DISSOLVED OXYGEN
Oil	OIL
pH	pH
PO4	PHOSPHATE
Pt.	TOTAL PHOSPHORUS
Radar	RADAR
Rx.	REDOX
TCl2	TOTAL CHLORINE RESIDUAL
TOC	TOTAL ORGANICAL CARBON
Turb.	TURBIDITY

NOTES :
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B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
SYMBOLS II

REFERENCE :
TDI-P-15-60

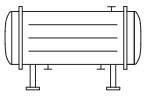
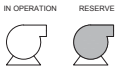
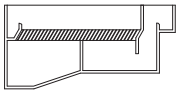
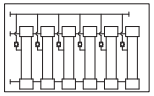
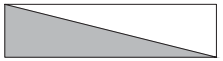
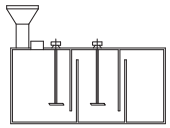
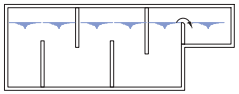
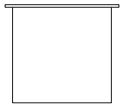
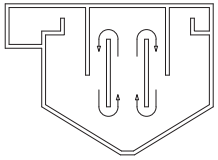
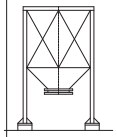
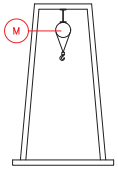
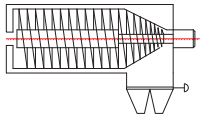
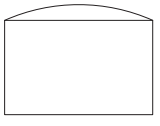
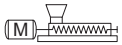
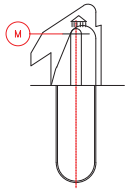
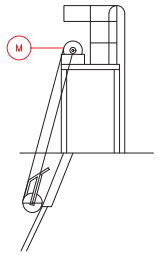
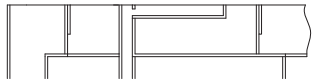
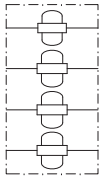
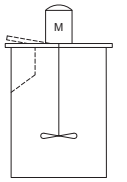
DRAWING N° :
PUB-WSP-JDD-000

FORMAT
A1

SHEET 2 OF 3

DIN A1 (841 x 594)

EQUIPMENT SYMBOLS

											
INTAKE PASIVE SCREW	SURGE VESSEL	AIR COMPRESSOR		STOP LOG PENSTOCK	ELECTRICAL DRIVE PENSTOCK	HEATING RESISTANCE	SUBMERSIBLE MIXER	ANTI WATER HAMMER SYSTEM	PRESSURIZATION REACTOR	CARTRIDGE FILTER	SCREW PUMP
											
HORIZONTAL CENTRIFUGAL PUMP	SUMERSIBLE CENTRIFUGAL PUMP	BLOWER	VERTICAL MIXER	FRECUENTY VARIATOR	MANUAL DRIVE PENSTOCK	ENERGY RECOVERY DEVICE	VERTICAL CENTRIFUGAL	DISSOLVED AIR FLOTATION	UF MODULES	REVERSE OSMOSIS RACK	MEMBRANE METERING PUMP
				 			 	
POLYELECTROLYTE COMPACT UNIT	CHAMBER	CHEMICAL TANK	LIME SATURATOR	STORAGE SILO	GANTRY BRIDGE CRANE	DEWATERING EQUIPMENT	CLOSED TANK	MEMBRANE METERING PUMP HOIST	
		  							
BAR SCREEN	TRAVELLING BAR SCREEN	SCREENING CHANNEL	SELF CLEANING DISC FILTERS	DILUTION TANK	VACUUM LOADER	CRANE FLUSHING TANK			
CHLORINE CONTACT CHAMBER	TREATED WATER TANK	EFLUENT NEUTRALIZATION TANK	CARBON DIOXIDE STORAGE SATURATOR	CATCHPOT	CO2 VAPOR SYSTEM	FILTER AIR DRYER			
SCRAPER BRIDGE	PROCESS OVERFLOW TANK	DAF AIR COMPRESSOR	PERISTALTIC METERING PUMP	SELF CLEANING DISC FILTERS	SLUDGE SCRAPER				

NOTES :
- THIS SHEET CORREPONSE TO AREA:

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

DAF. CLARIFIERS

REVISION 003

PROYECT NAME
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
SYMBOLS III

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-000

FORMAT A1 | SHEET 3 OF 3

DIN A1 (841 x 594)

INTAKE STRUCTURE & SCREEN

GANTRY BRIDGE CRANE
CAPACITY = 10.000 Kg.

GC-10101

CHANNEL STOPS LOGS
Nº UNITS = 3 UNITS

TRASH RAKE
SCREEN TYPE = STRAIGHT TRASH RAKE
SCREEN ANGLE = 90.00°
SCREEN OPENINGS = 20.00 mm
BAR WIDTH = 5.00 mm
CHANNEL WIDTH = 2.00 m
SCREEN HEIGHT = 8.00 m
FITTED SCREENS = 3 UNITS
OPERATING SCREENS = 2 UNITS

TRAVELLING BAND SCREEN
SCREEN TYPE = TRAVELLING BAND SCREEN-DUAL-FLOW
SCREEN ANGLE = 90.00°
VERTICAL WIRE SPACING = 3.00 mm
HORIZONTAL WIRE SPACING = 3.00 mm
FITTED SCREENS = 3 UNITS
OPERATING SCREENS = 2 UNITS

WASTEWATER TANK PUMPS
SUBMERSIBLE CENTRIFUGAL PUMP
FITTED UNITS = 2 UNITS
OPERATING UNITS = 1 UNIT

10205 PUB-WSP-JDD-002 RSW — d90-RSW-1P4-10221-N
16205 PUB-WSP-JDD-062 SOH — d75-SOH-1P3-16233-N
16206 PUB-WSP-JDD-062 SOH — d75-SOH-1P3-16231-N

BFVM DN65 10107 — BFVM DN65 10109
BPV DN65 10102 — BPV DN65 10101
BFVM DN65 10108 — BFVM DN65 10110

IP-10101

d2200-RSW-6P4-10101-N

IL-10101 — IL-10102

BFVM DN65 10104 — BFVM DN65 10105
BPV DN65 10103 — BPV DN65 10104
BFVM DN65 10103 — BFVM DN65 10106

d75-SOH-1P3-16235-N
d75-SOH-1P3-16234-N

16203 PUB-WSP-JDD-062 SOH — d75-SOH-1P3-16235-N
16204 PUB-WSP-JDD-062 SOH — d75-SOH-1P3-16234-N

d63-SOH-1P3-10113-N

d2200-RSW-6P4-10101-N

DN200-DRW-6P4-10105-N

BS-10101 — BFVN DN80 10101 — d90-RSW-1P4-10221-N — BFVN DN80 10102 — FSL 10101 — TB-10101
LIT 10104 / LE 10104 — LIT 10105 / LE 10105 — LIT 10101 / LE 10101
SL-10101 — IS-10101 — SL-10104
10101 PUB-WSP-JDD-002

BS-10102 — BFVN DN80 10103 — d90-RSW-1P4-10221-N — FSL 10102 — TB-10102
LIT 10102 / LE 10102
d90-RSW-1P4-10221-N
SL-10102 — IS-10102 — SL-10105
10102 PUB-WSP-JDD-002

BS-10103 — BFVN DN80 10104 — d90-RSW-1P4-10221-N — FSL 10103 — TB-10103
LIT 10103 / LE 10103
CH-10101
SL-10103 — IS-10103 — SL-10106
10103 PUB-WSP-JDD-002

CONTAINER
FITTED UNITS = 1 UNIT
SCREENING BASKET

d90-DRW-1P3-10107-N — 10104 PUB-WSP-JDD-061 DRW
BFVM DN80 10101 — BFVM DN80 10102
CHV DN80 10101 — CHV DN80 10102
d90-DRW-1P3-10107-N — d90-DRW-1P3-10108-N
LSHH 10101 — LSH 10101 — LSL 10101 — LSLL 10101
DN200-DRW-6P4-10106-N — DN200-DRW-6P4-10105-N
SU-10101 — SU-10102
WASTEWATER TANK

d32-RSW-1P3-10230-N — 10109 PUB-WSP-JDD-002 RSW
d63-SOH-1P3-10113-N — 10107 PUB-WSP-JDD-002 SOH
d63-SOH-1P3-10114-N — 10105 PUB-WSP-JDD-002 SOH
d32-RSW-1P3-10117-N — 10108 PUB-WSP-JDD-002 RSW
d32-RSW-1P3-10112-N — 10106 PUB-WSP-JDD-002 RSW

NOTES :
- THIS SHEET CORREPONSE TO AREA: 81

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

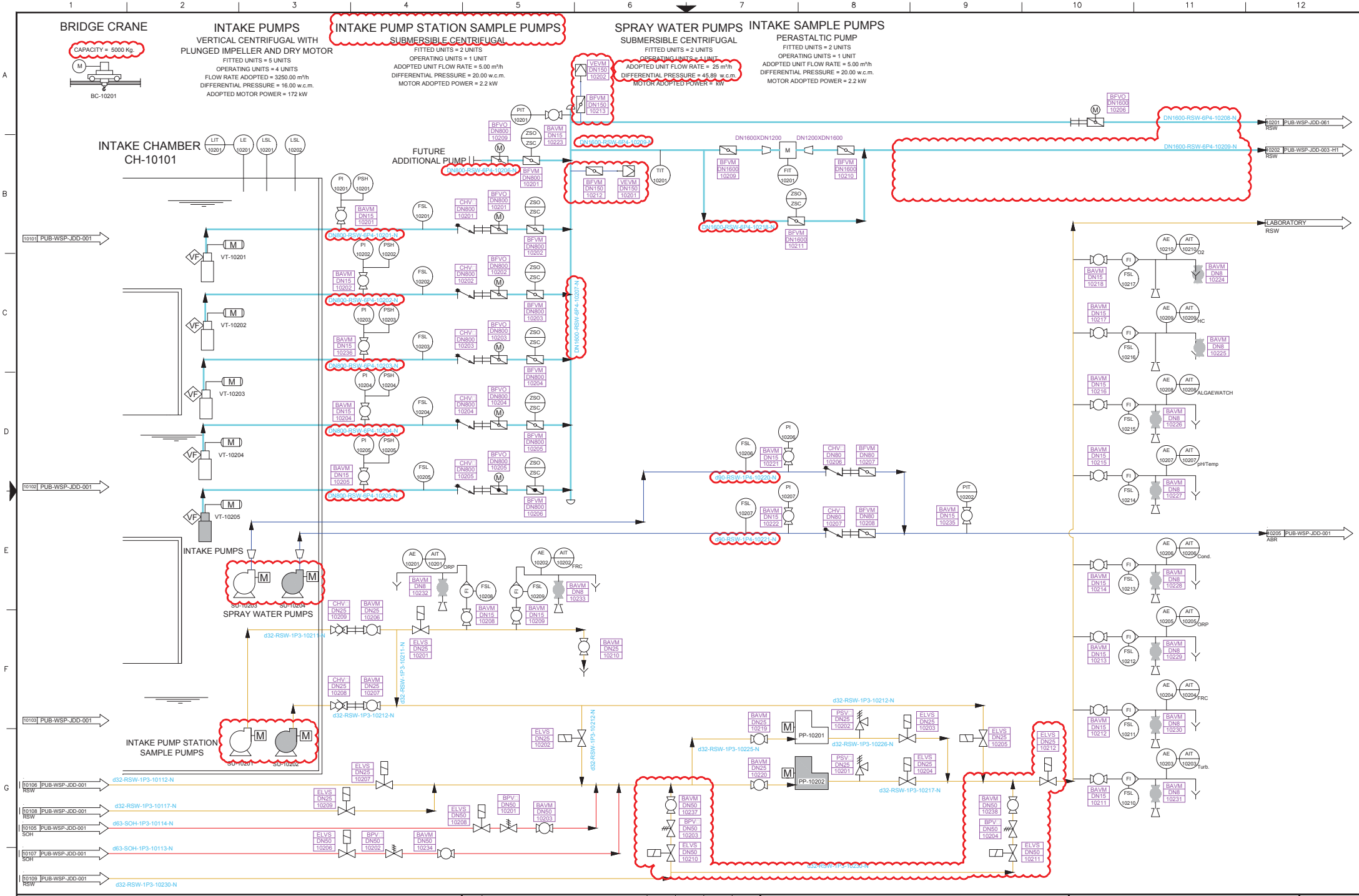
PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
INTAKE SCREENING

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-001

FORMAT A1 — SHEET 1 OF 1

DIN A1 (841 x 594)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 81

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

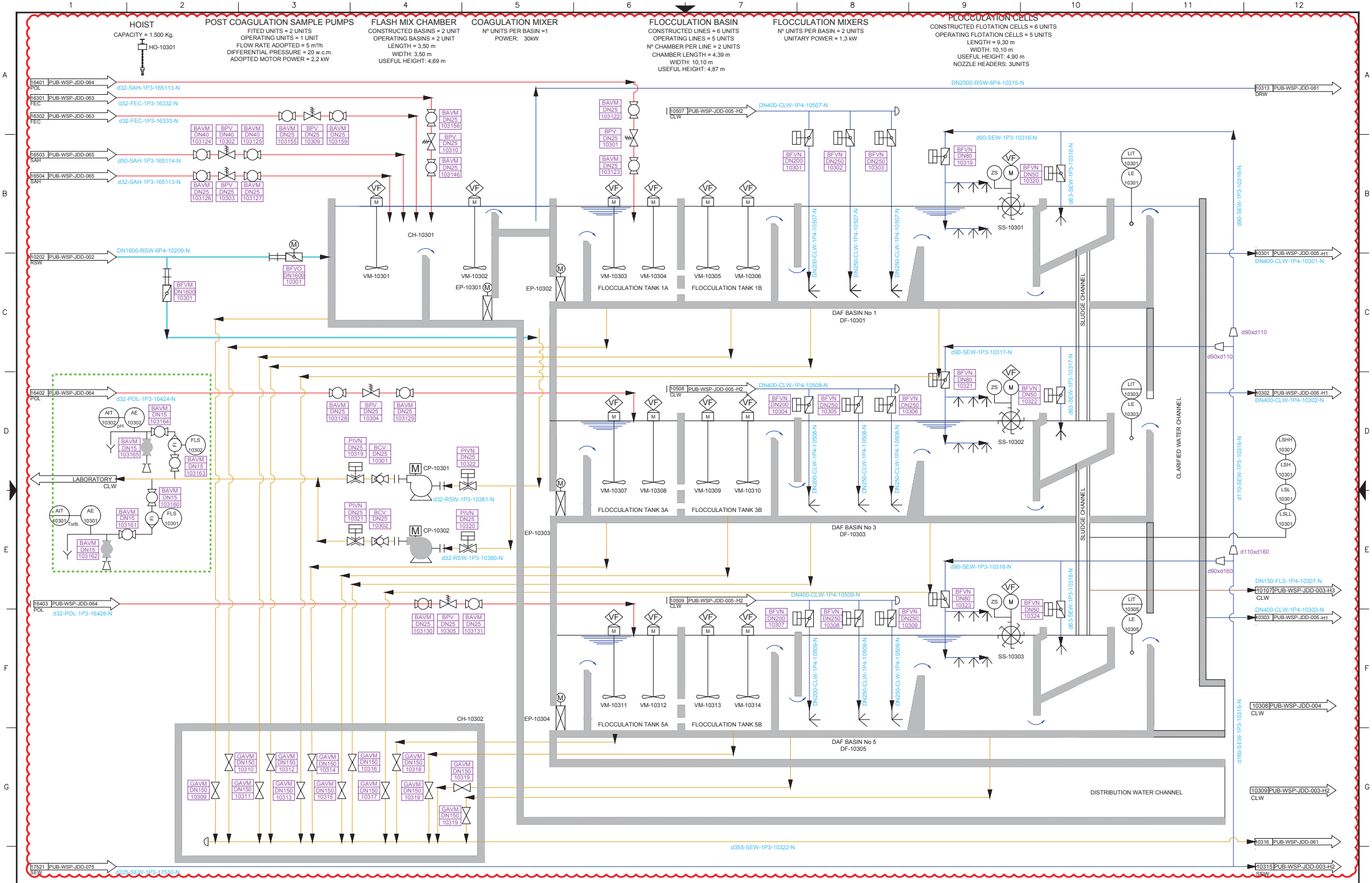
PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
INTAKE PUMP STATION

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-002

FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 21

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

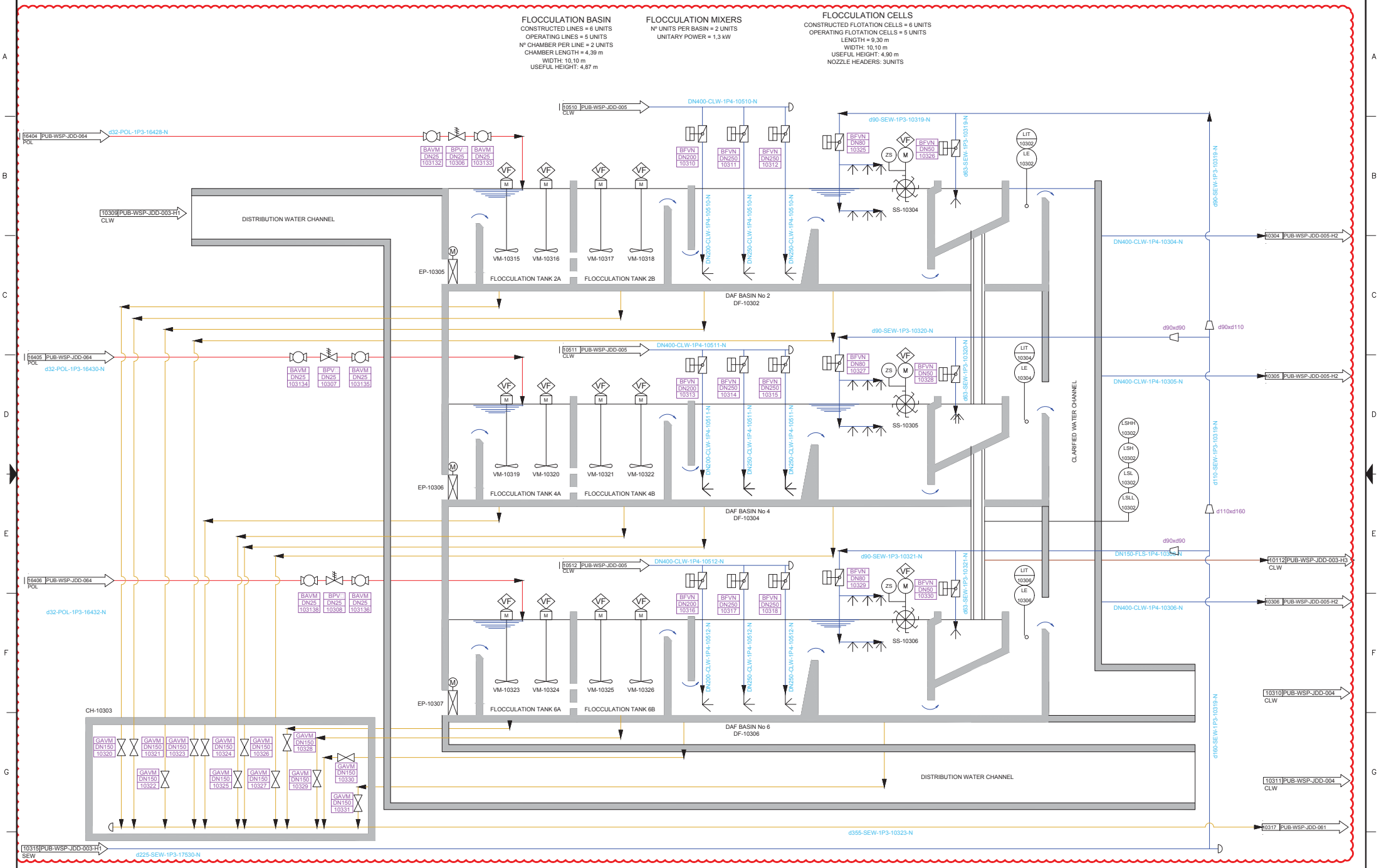
PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
DAF. CLARIFIERS

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-003

FORMAT A1 | SHEET 1 OF 3

DIN A1 (841 x 594)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 21

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE:
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
DAF. CLARIFIERS

REFERENCE: TDI-P-15-60

DRAWING Nº: PUB-WSP-JDD-003

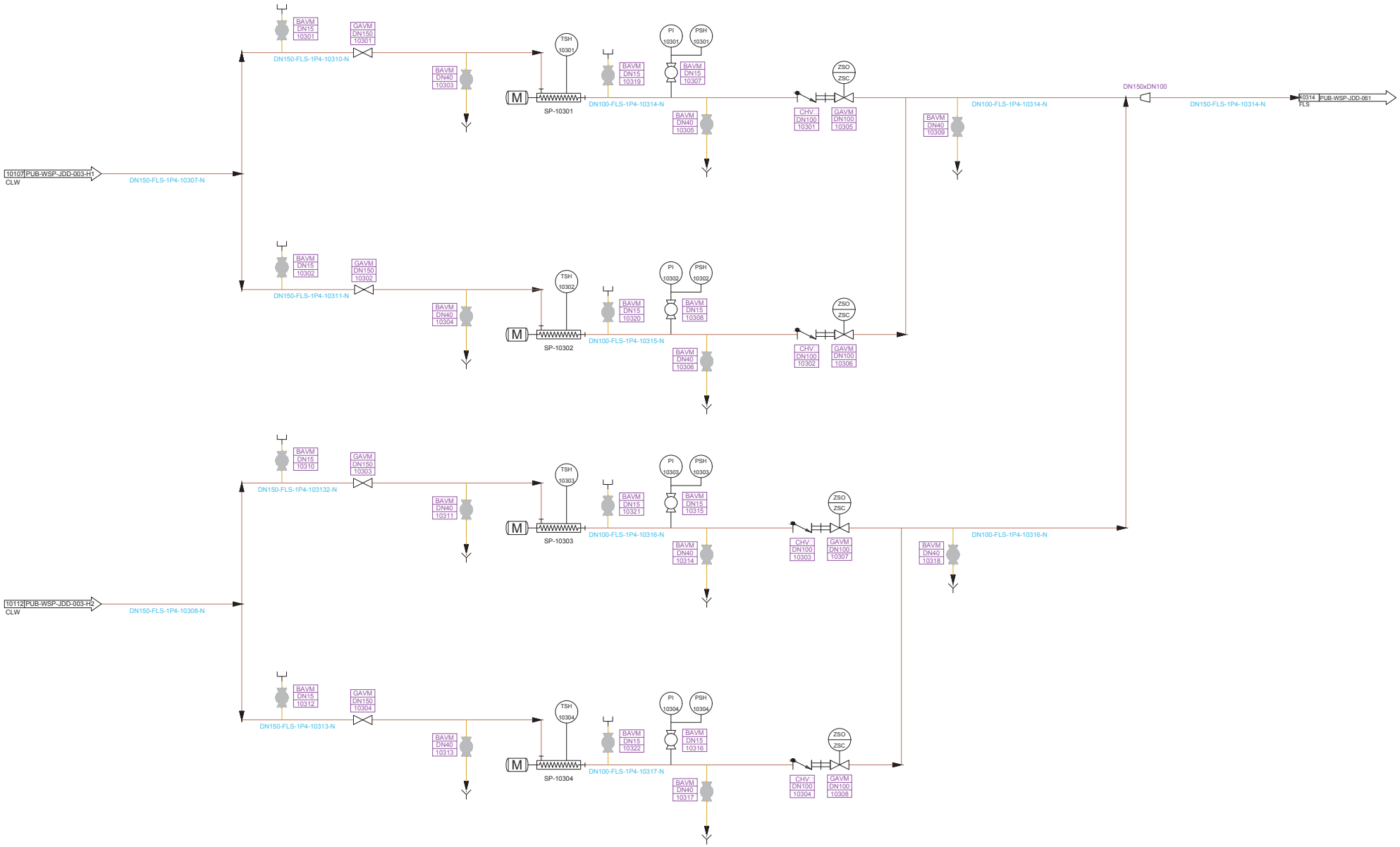
FORMAT: A1

SHEET 2 OF 3

DIN A1 (841 x 594)

SLUDGE PURGE PUMPS

TYPE: SCREW PUMPS
FITED UNITS = 2 + 2 UNITS
OPERATING UNITS = 1 + 1 UNIT
FLOW RATE ADOPTED = 60 m³/h
PRESSURE HEAD = 10 w.c.m.



NOTES :
- THIS SHEET CORREPONSE TO AREA: 21

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
DAF. CLARIFIERS

REFERENCE :
TDI-P-15-60

DRAWING Nº :
PUB-WSP-JDD-003

FORMAT
A1

SHEET 3 OF 3

DIN A1 (841 x 594)

CLARIFIED WATER TANK Nº 1
VOLUME UNIT = 530.26 m³

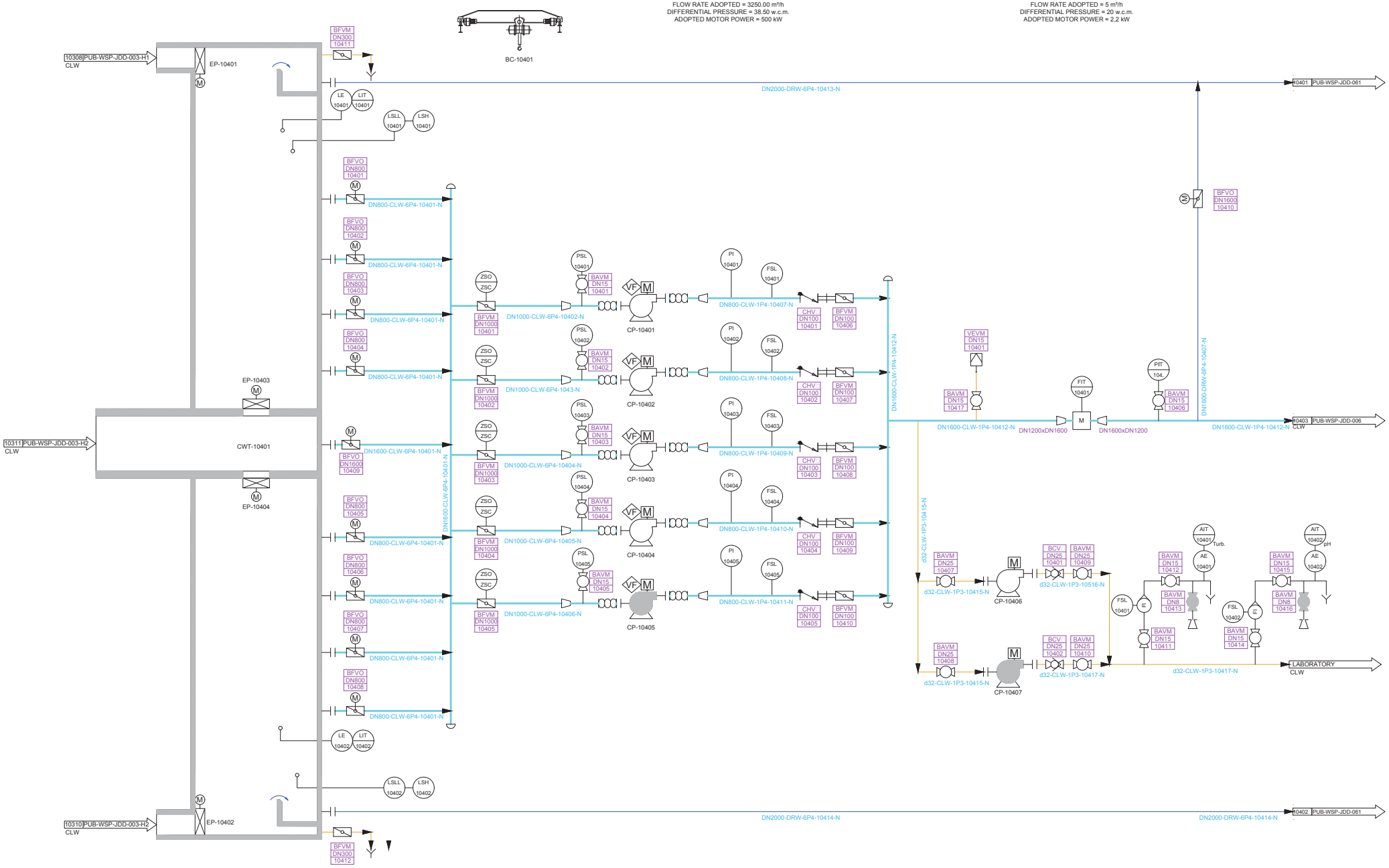
CLARIFIED WATER TANK Nº 2
VOLUME UNIT = 530.26 m³

BRIDGE CRANE
CAPACITY: 10.000 Kg

BC-10401

UF FEED PUMPS
HORIZONTAL CENTRIFUGAL
FITED UNITS = 5 UNITS
OPERATING UNITS = 4 UNITS
FLOW RATE ADOPTED = 3250.00 m³/h
DIFFERENTIAL PRESSURE = 38.50 w.c.m.
ADOPTED MOTOR POWER = 500 kW

UF FEED SAMPLE PUMPS
HORIZONTAL CENTRIFUGAL
FITED UNITS = 2 UNITS
OPERATING UNITS = 1 UNIT
FLOW RATE ADOPTED = 5 m³/h
DIFFERENTIAL PRESSURE = 20 w.c.m.
ADOPTED MOTOR POWER = 2,2 kW



NOTES :
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REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
DAF CLARIFIED WATER TANKS

REFERENCE : TDI-P-15-60

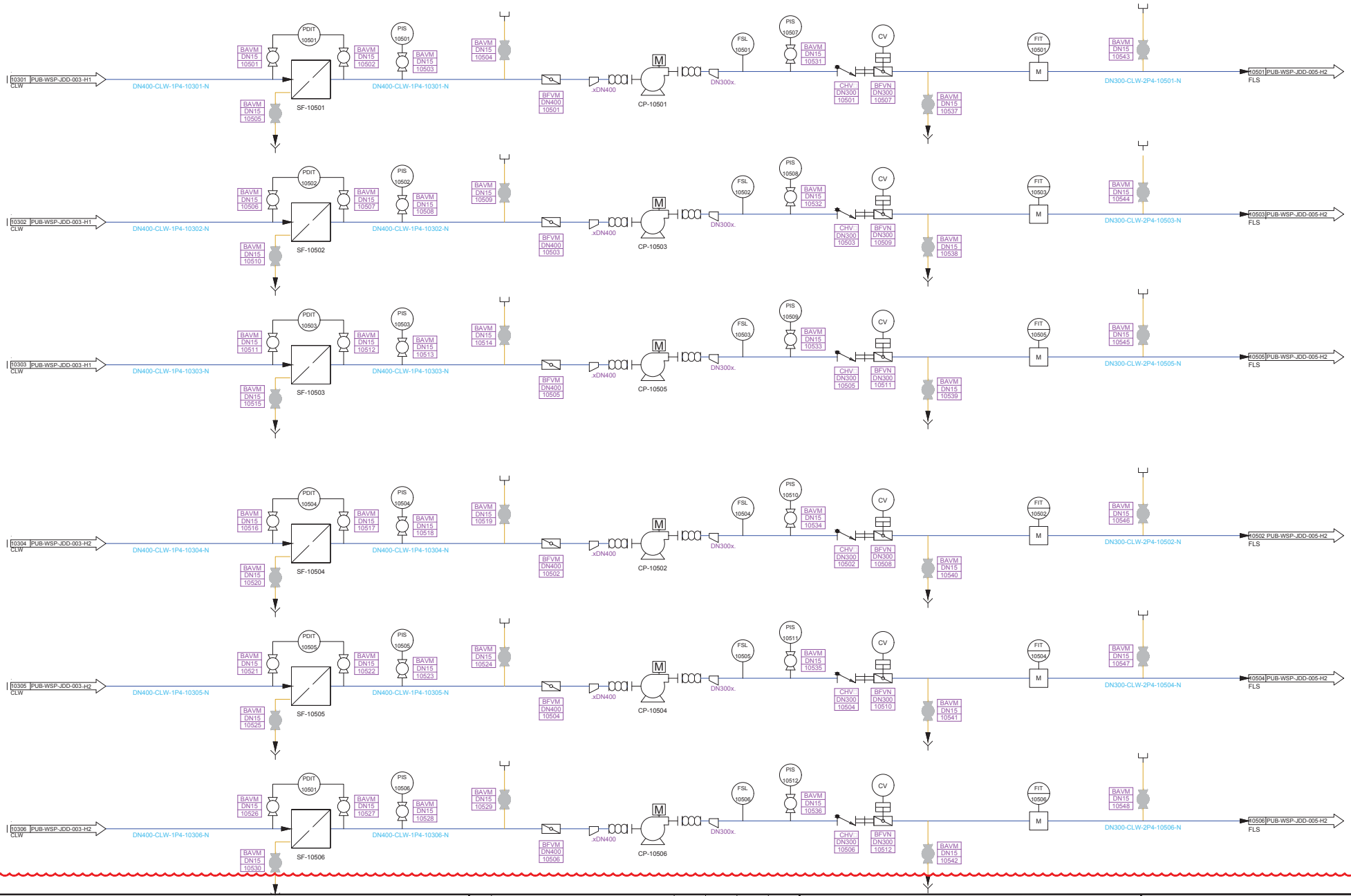
DRAWING Nº : PUB-WSP-JDD-004

FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)

DAF RECYCLE PUMP STRAINERS
TYPE: DOUBLE BASKET
MESH SIZE = 2 mm

DAF RECYCLE PUMPS
HORIZONTAL CENTRIFUGAL
FITTED UNITS = 5 UNITS
OPERATING UNITS = 1 UNIT
FLOW RATE ADOPTED = 490.00 m³/h
DIFFERENTIAL PRESSURE ADOPTED = 7,5 bar



NOTES :
- THIS SHEET CORREPONSE TO AREA: 21

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

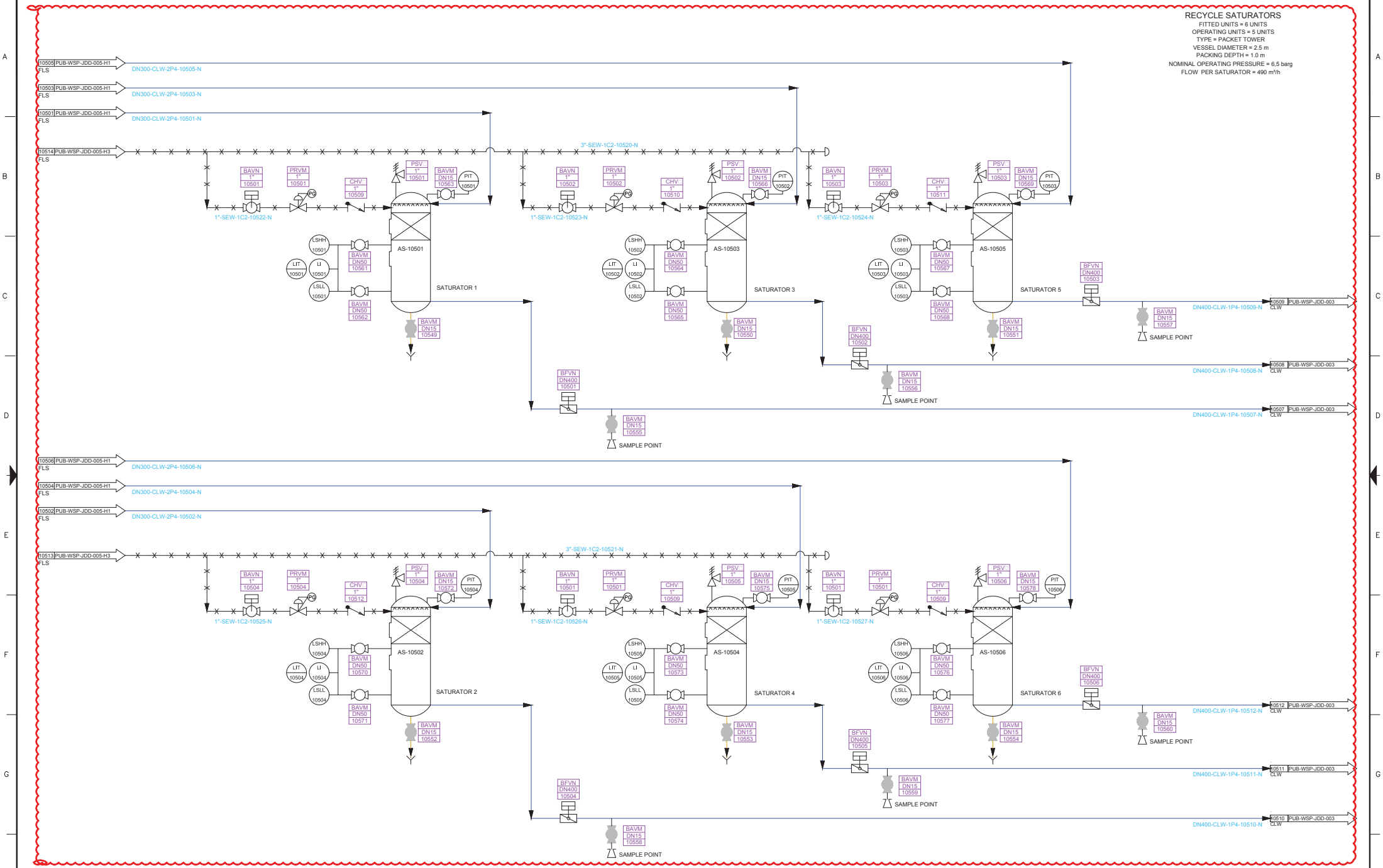
PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
DAF CLARIFIERS. PRESSURIZATION VESSELS

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-005

FORMAT A1 | SHEET 1 OF 3

DIN A1 (841 x 594)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 21

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
DAF CLARIFIERS. PRESSURIZATION VESSELS

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-005

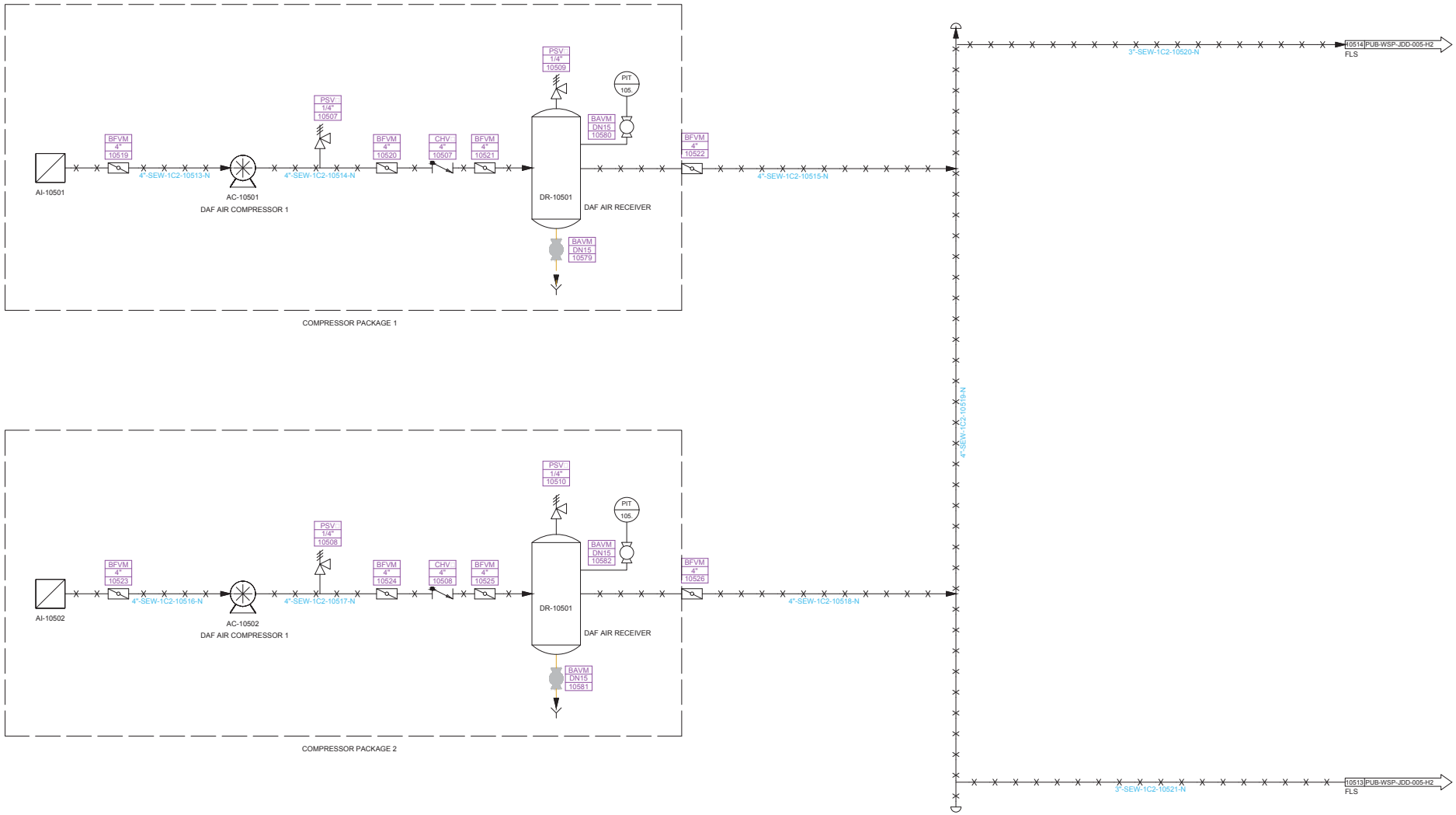
FORMAT A1 | SHEET 2 OF 3

DIN A1 (841 x 594)

FLOTATION COMPRESSORS

TYPE: ROTATORY LOBES (FREE OIL)

FITTED UNITS = 2 UNITS
OPERATING UNITS = 1 UNIT
FLOW RATE ADOPTED = 224.00 Nm³/h (290 kg/hr)
MAX. OPERATING PRESSURE = 8,5 bar



NOTES :
- THIS SHEET CORREPONSE TO AREA: 21

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
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REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
DAF CLARIFIERS. PRESSURIZATION VESSELS

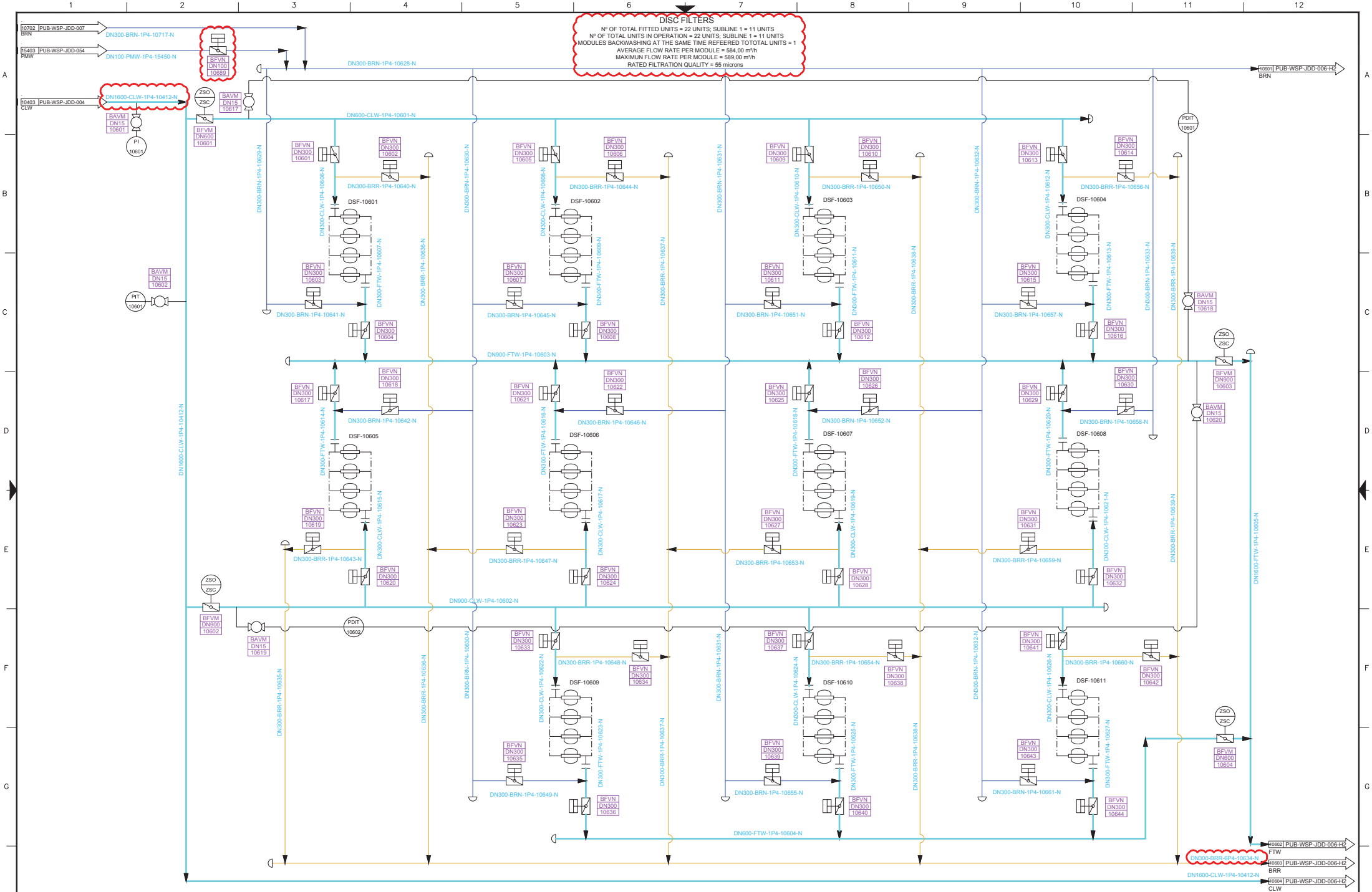
REFERENCE :
TDI-P-15-60

DRAWING Nº :
PUB-WSP-JDD-005

FORMAT
A1

SHEET 3 OF 3

DIN A1 (841 x 594)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 25

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

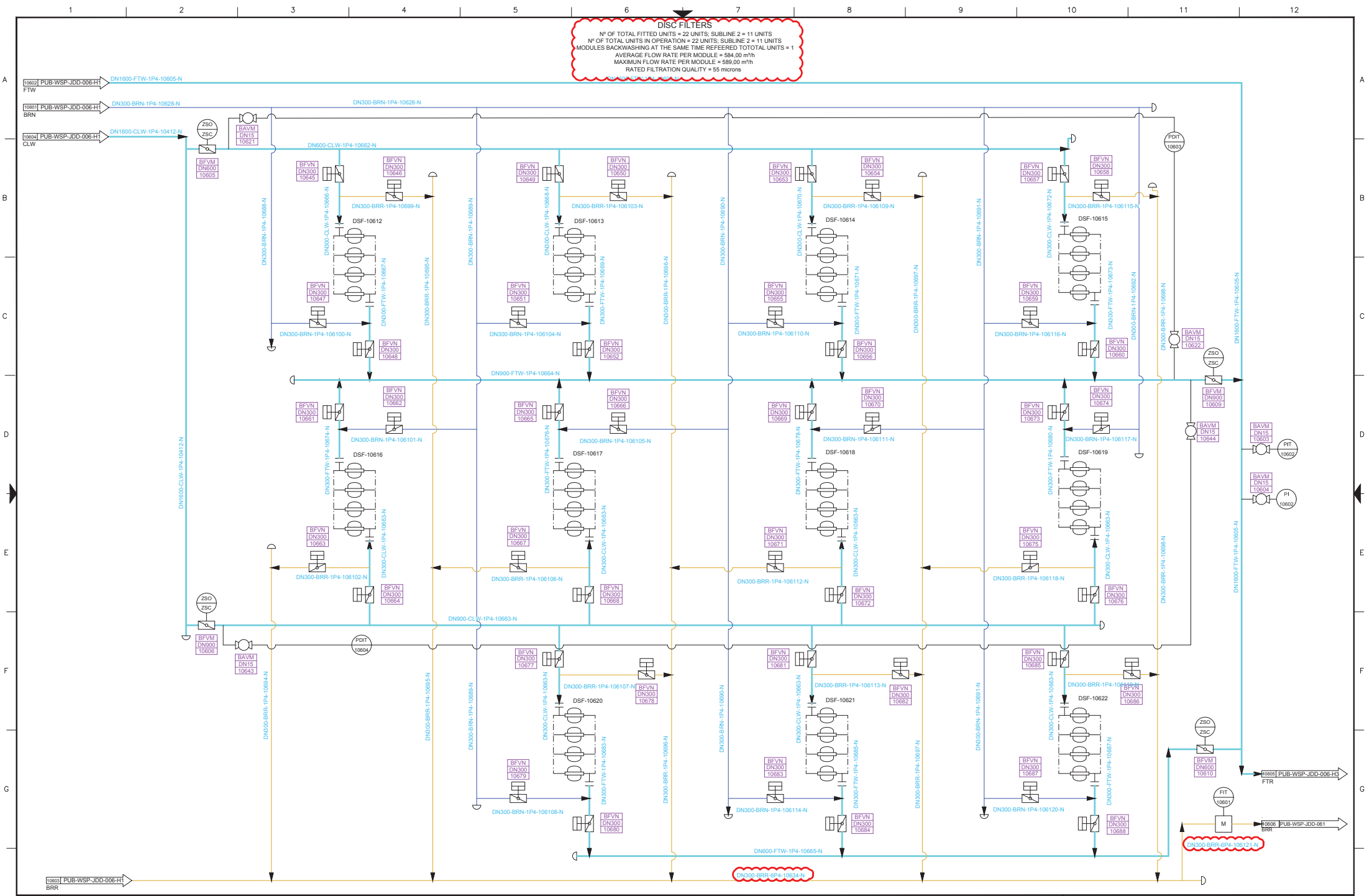
PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
U.F.-DISC FILTERS

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-006

FORMAT A1 | SHEET 1 OF 3

DIN A1 (841 x 594)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 25

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
U.F.-DISC FILTERS

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-006

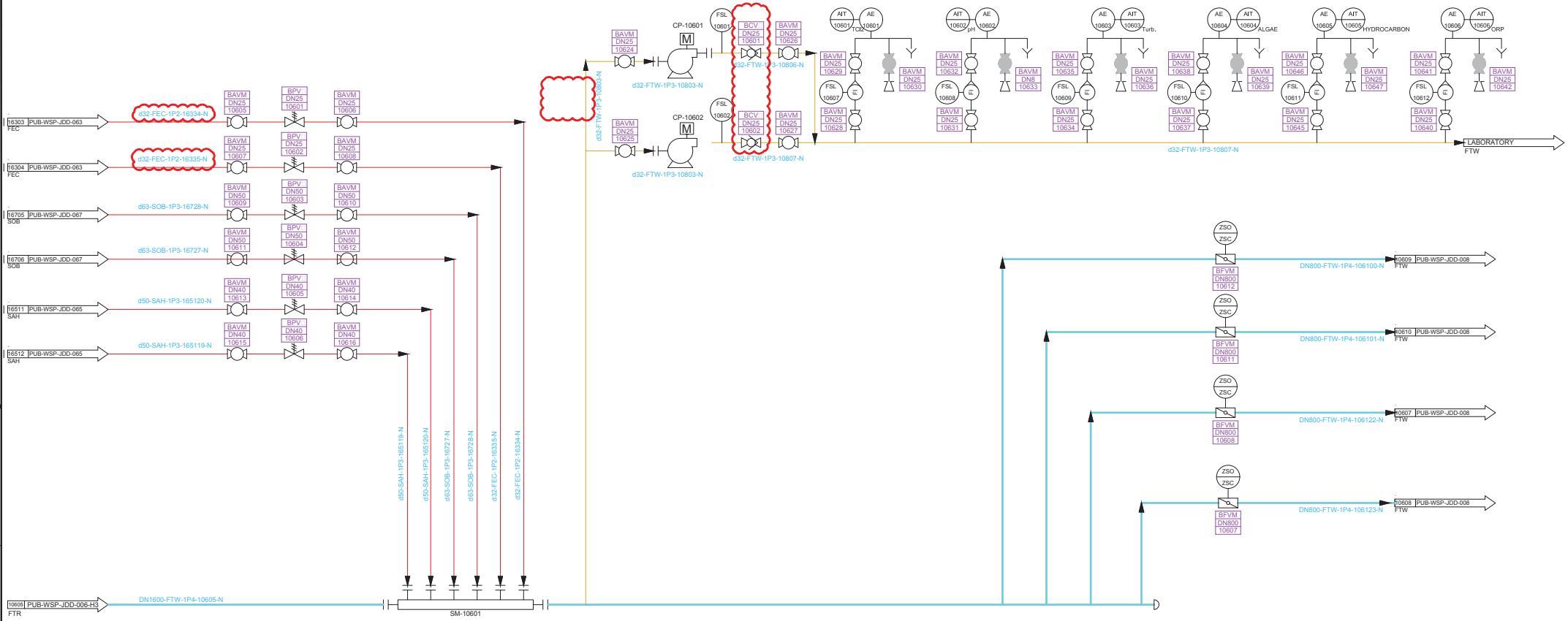
FORMAT A1 | SHEET 2 OF 3

DIN A1 (841 x 594)

UF / MF FEED SAMPLE PUMPS

HORIZONTAL CENTRIFUGAL

FITTED UNITS = 2 UNITS
OPERATING UNITS = 1 UNIT
ADOPTED UNIT FLOW RATE = 5.00 m³/h
DIFFERENTIAL PRESSURE = 20.00 w.c.m.
MOTOR ADOPTED POWER = 2.2 kW



NOTES :
- THIS SHEET CORREPONSE TO AREA: 25

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
U.F.-DISC FILTERS

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-006

FORMAT A1 | SHEET 3 OF 3

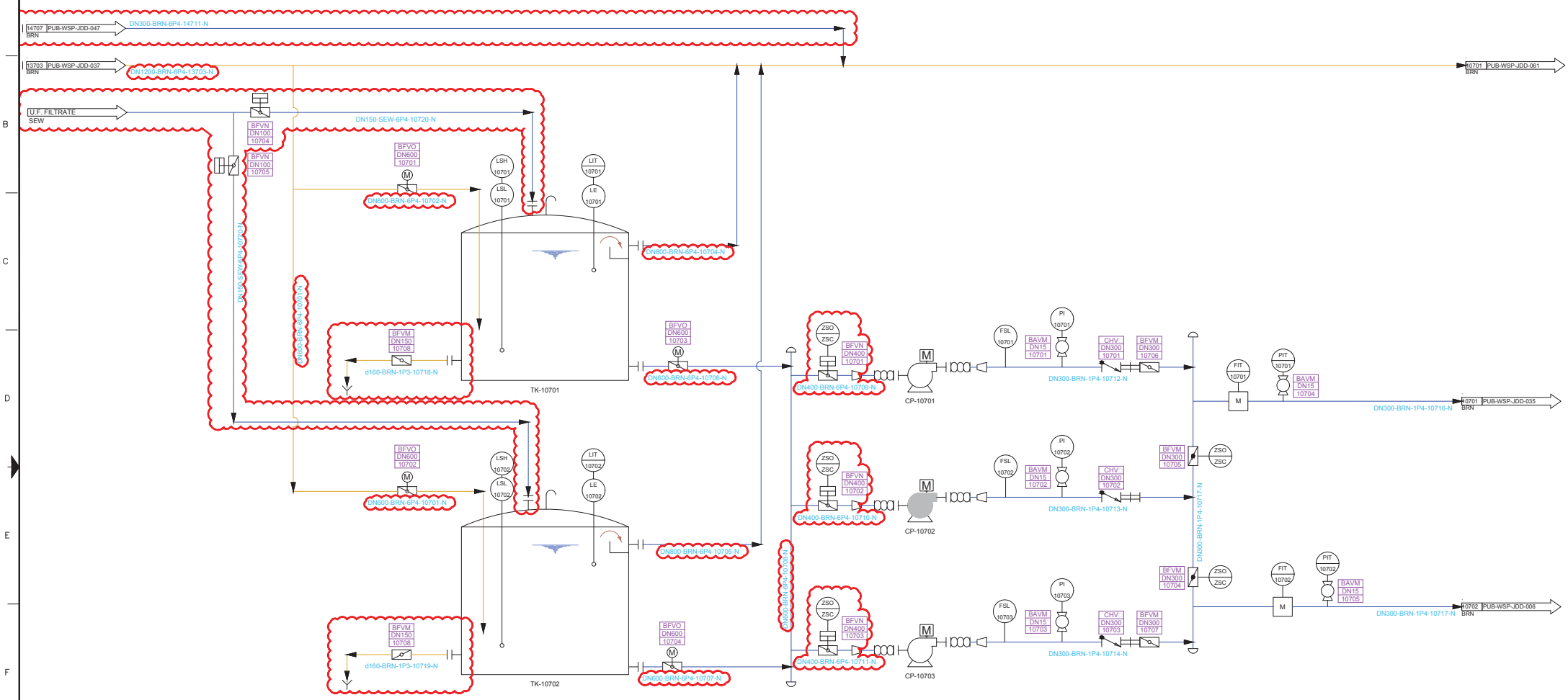
DIN A1 (841 x 594)

BRINE BACKWASH TANKS

FITTED UNITS = 2 UNITS
UNITARY VOLUME = 80 m³

BRINE BACKWASH PUMPS

HORIZONTAL CENTRIFUGAL
FITTED UNITS = 3 UNITS
OPERATING UNITS = 2 UNITS
FLOW RATE ADOPTED = 704.00 Nm/h³
DIFFERENTIAL PRESSURE = 56.08 w.c.m.
ADOPTED MOTOR POWER = 160 kW



NOTES :
- THIS SHEET CORREPONSE TO AREA: 25

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
U.F. FEED BRINE BACKWASH SYSTEM

REFERENCE : TDI-P-15-60

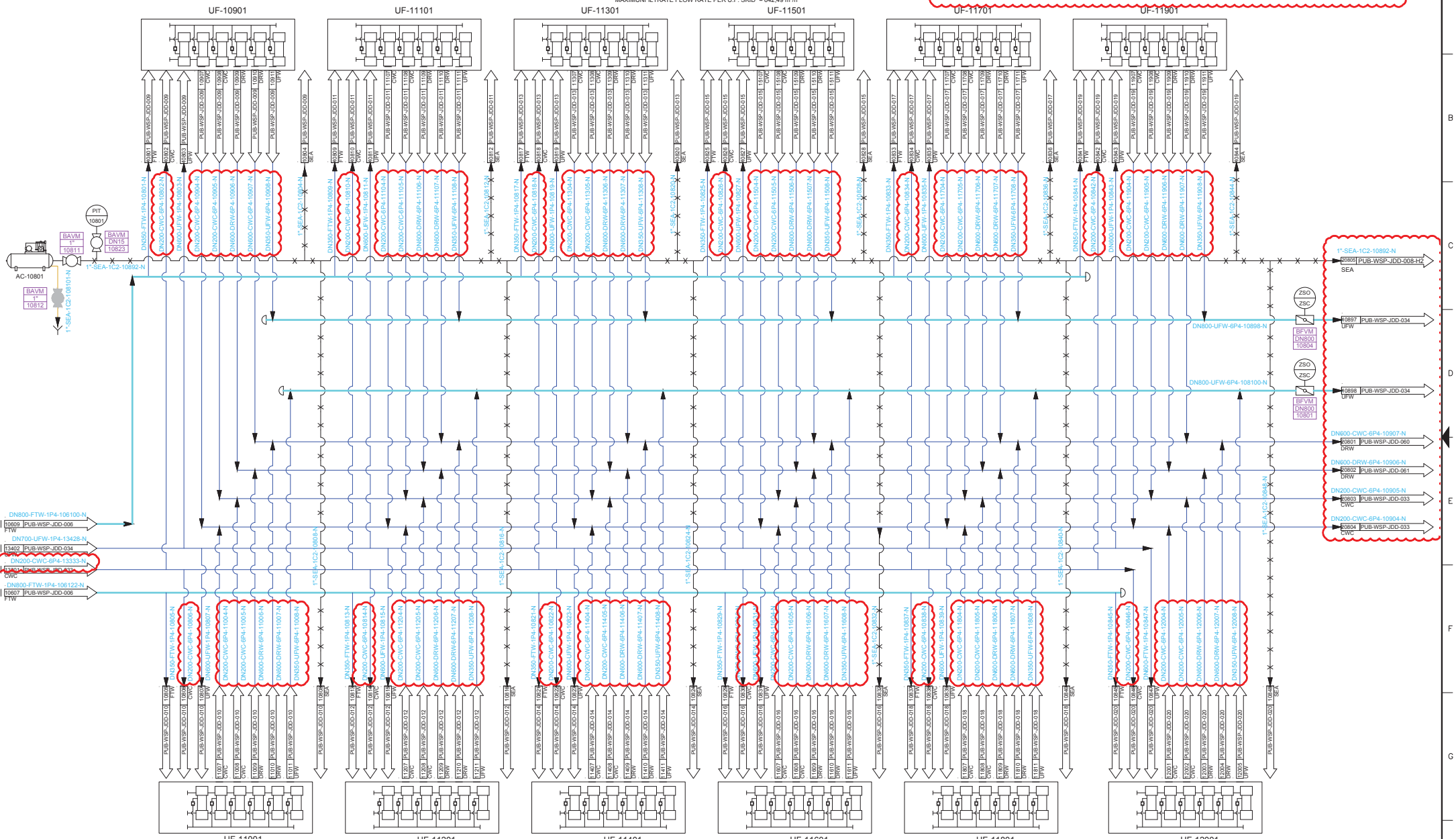
DRAWING Nº : PUB-WSP-JDD-007

FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)

ULTRAFILTRATION UF-10901 - 12001

NUMBER OF FITTED LINES SUBSYSTEMS= 2 UNITS
NUMBER OF FITTED U.F. SKIDS PER LINE = 12 UNITS
NUMBER OF OPERATING U.F. SKIDS PER LINE = 11 UNITS
NUMBER OF FITTED GROUPS PER U.F. UNIT = 2 UNITS
DISPOSITION OF PRESSURE VESSELS = VERTICAL
NUMBER OF HOUSING PER GROUP = 56 UNITS
NUMBER OF POSSIBLE HOUSING PER GROPU = 68 UNITS
NORMAL FILTRATE FLOW RATE PER U.F: SKID AT DESIGN FLOW RATE = 584,08 m³/h
MAXIMUNFILTRATE FLOW RATE PER U.F. SKID = 642,49 m³/h



NOTES :
- THIS SHEET CORREPONSE TO AREA: 25

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
UF/MF SYSTEM - LINE 1

REFERENCE : TDI-P-15-60

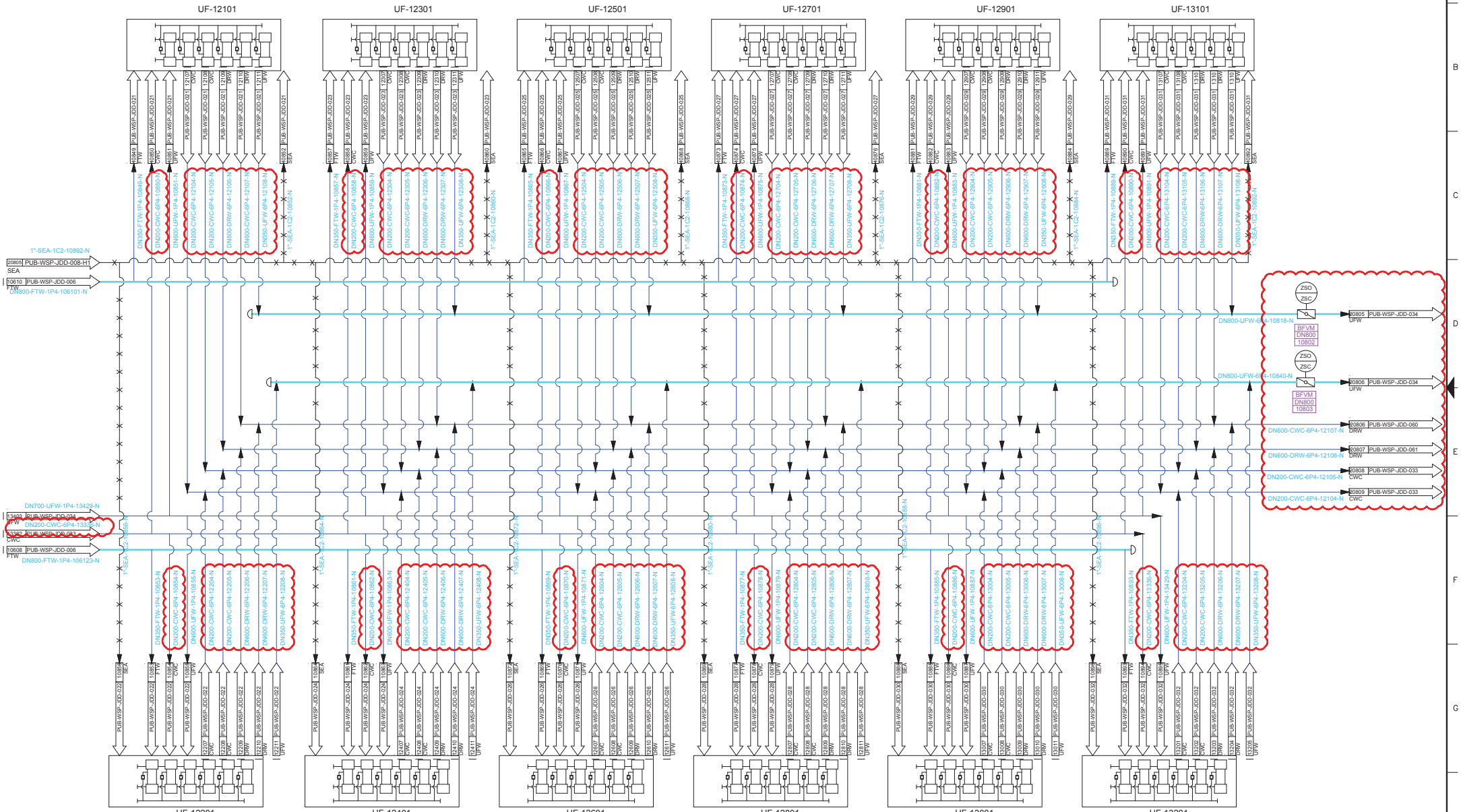
DRAWING Nº : PUB-WSP-JDD-008

FORMAT A1 | SHEET 1 OF 2

DIN A1 (841 x 594)

ULTRAFILTRATION UF-12101 - 13201

NUMBER OF FITTED LINES SUBSYSTEMS= 2 UNITS
NUMBER OF FITTED U.F. SKIDS PER LINE = 12 UNITS
NUMBER OF OPERATING U.F. SKIDS PER LINE = 11 UNITS
NUMBER OF FITTED GROUPS PER U.F. UNIT = 2 UNITS
DISPOSITION OF PRESSURE VESSELS = VERTICAL
NUMBER OF HOUSING PER GROUP = 56 UNITS
NUMBER OF POSSIBLE HOUSING PER GROPU = 68 UNITS
NORMAL FILTRATE FLOW RATE PER U.F. SKID AT DESIGN FLOW RATE = 584,08 m³/h
MAXIMUNFILTRATE FLOW RATE PER U.F. SKID = 642,49 m³/h



NOTES :
- THIS SHEET CORREPONSE TO AREA: 25

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B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

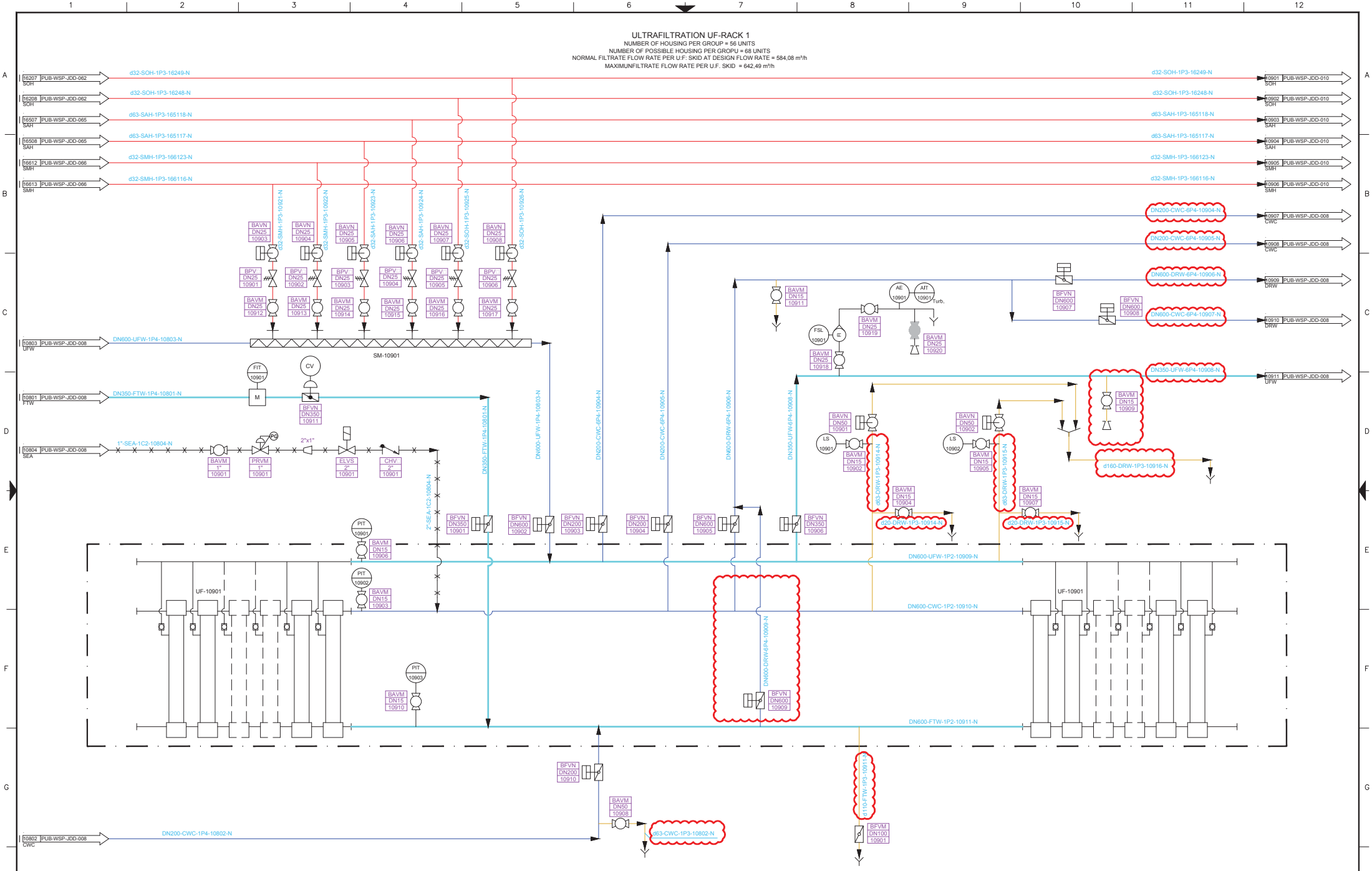
PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
UF/MF SYSTEM - LINE 2

REFERENCE :
TDI-P-15-60

DRAWING Nº :
PUB-WSP-JDD-008

FORMAT A1 | SHEET 2 OF 2

DIN A1 (841 x 594)



NOTES :
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REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
U.F. SYSTEM. DETAIL. RACK 1

REFERENCE : TDI-P-15-60

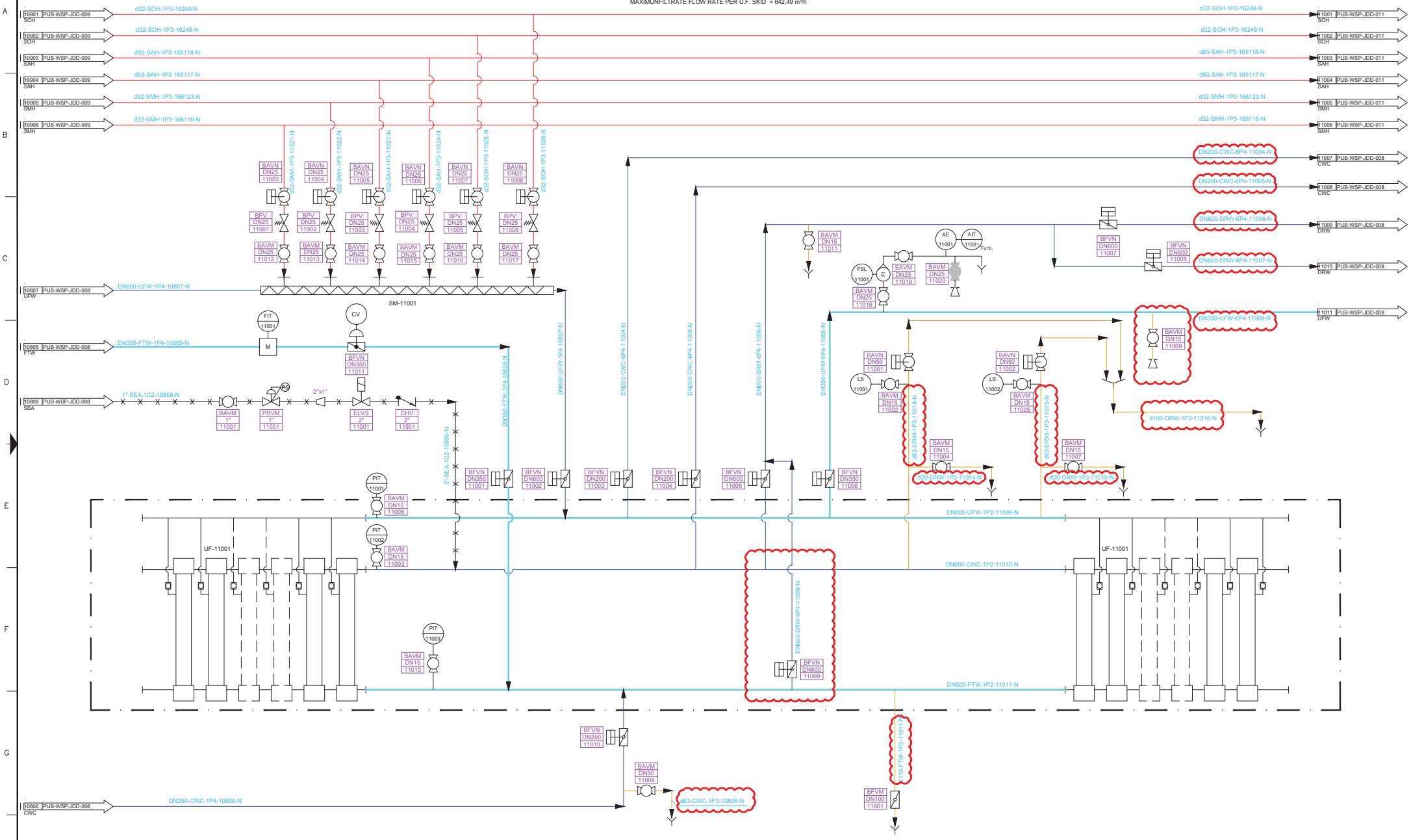
DRAWING Nº : PUB-WSP-JDD-009

FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)

ULTRAFILTRATION UF-RACK 2

NUMBER OF HOUSING PER GROUP = 56 UNITS
NUMBER OF POSSIBLE HOUSING PER GROPU = 68 UNITS
NORMAL FILTRATE FLOW RATE PER U.F: SKID AT DESIGN FLOW RATE = 584,08 m³/h
MAXIMUNFILTRATE FLOW RATE PER U.F. SKID = 642,49 m³/h



NOTES :
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A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
U.F. SYSTEM. DETAIL. RACK 2

REFERENCE : TDI-P-15-60

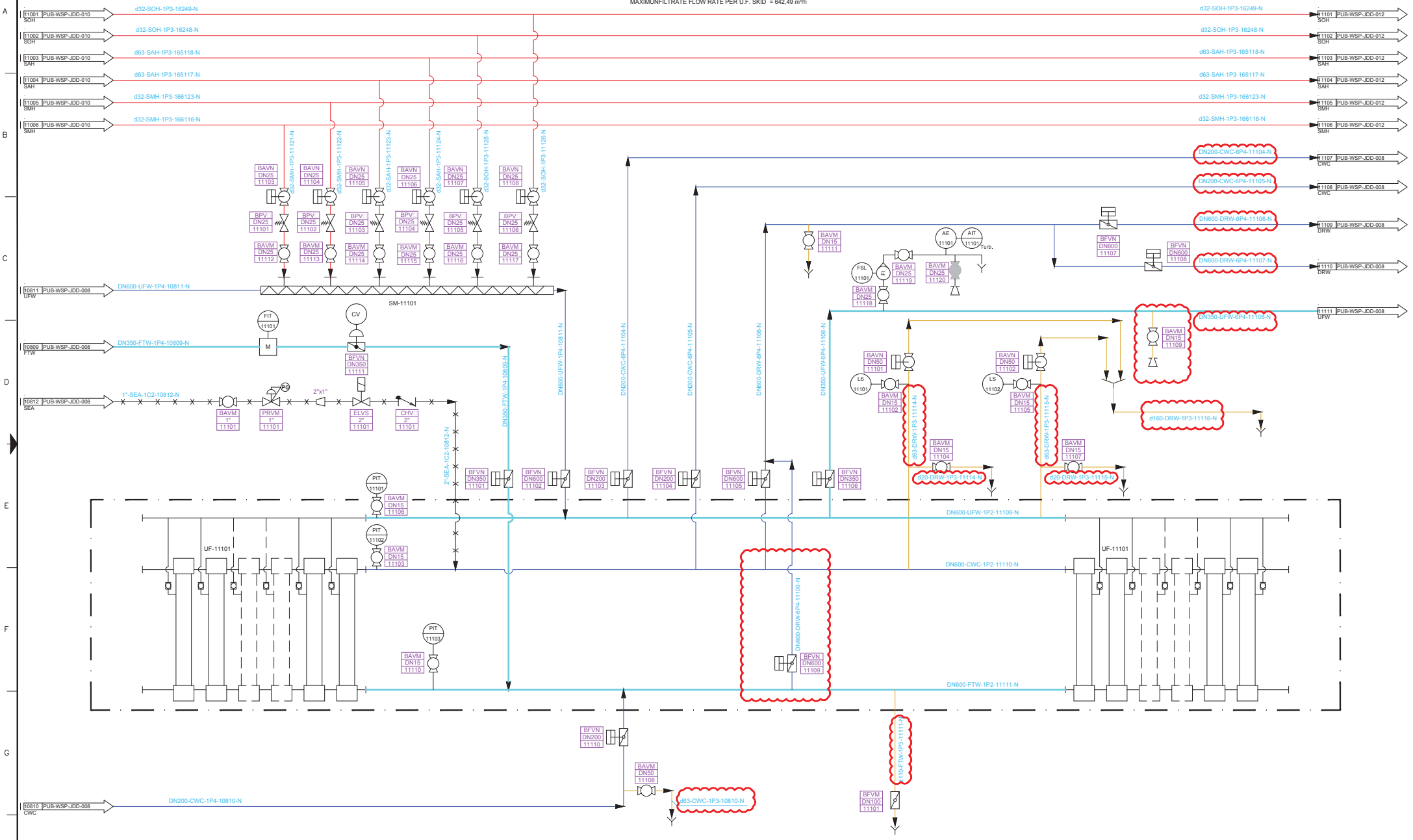
DRAWING Nº : PUB-WSP-JDD-010

FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)

ULTRAFILTRATION UF-RACK 3

NUMBER OF HOUSING PER GROUP = 56 UNITS
NUMBER OF POSSIBLE HOUSING PER GROPU = 68 UNITS
NORMAL FILTRATE FLOW RATE PER U.F: SKID AT DESIGN FLOW RATE = 584,08 m³/h
MAXIMUNFILTRATE FLOW RATE PER U.F. SKID = 642,49 m³/h



NOTES :
- THIS SHEET CORREPONSE TO AREA: 25

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
U.F. SYSTEM. DETAIL. RACK 3

REFERENCE : TDI-P-15-60

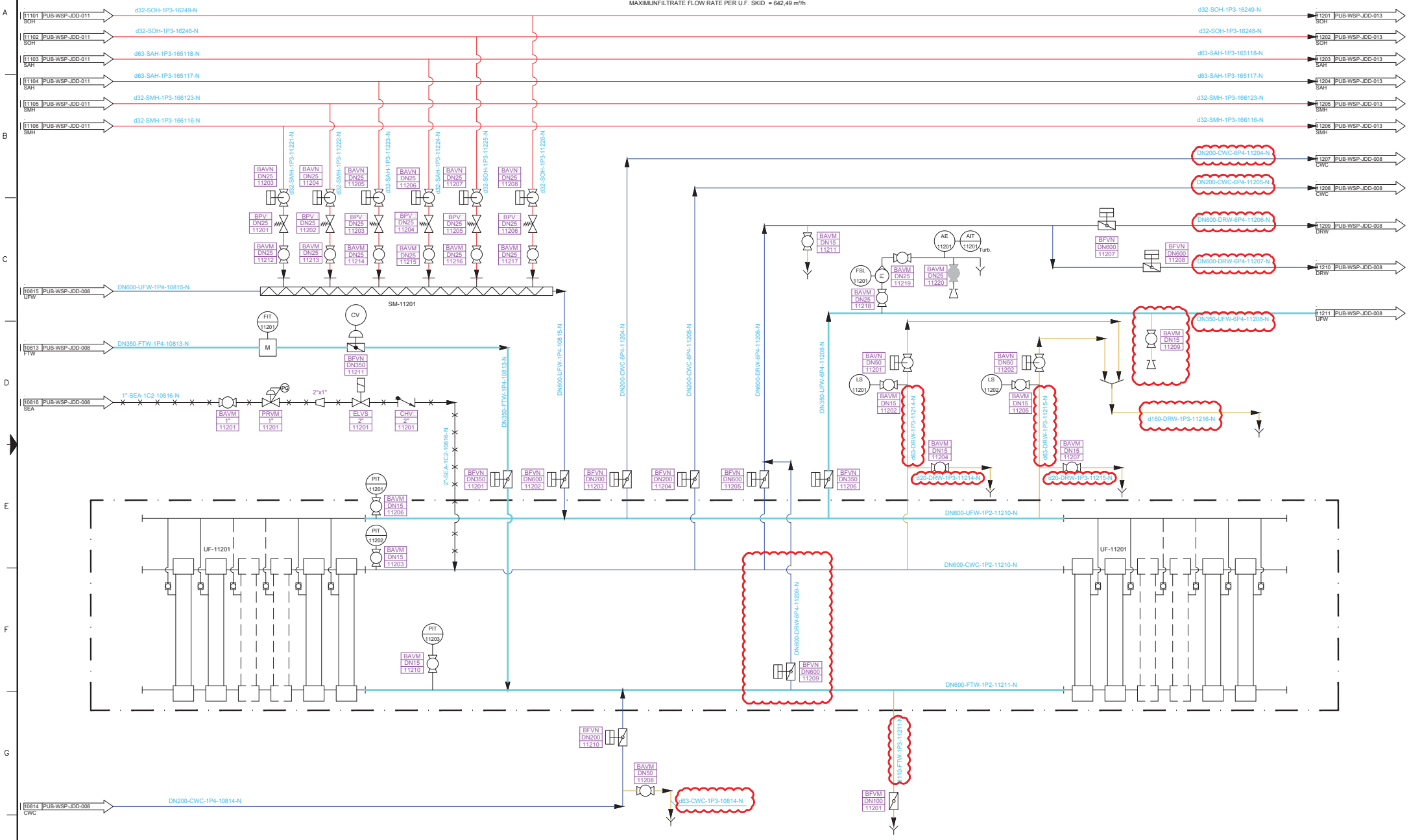
DRAWING Nº : PUB-WSP-JDD-011

FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)

ULTRAFILTRATION UF-RACK 4

NUMBER OF HOUSING PER GROUP = 56 UNITS
NUMBER OF POSSIBLE HOUSING PER GROPU = 68 UNITS
NORMAL FILTRATE FLOW RATE PER U.F: SKID AT DESIGN FLOW RATE = 584,08 m³/h
MAXIMUNFILTRATE FLOW RATE PER U.F. SKID = 642,49 m³/h



NOTES :

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	FOR APPROVAL	16/03/18	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
U.F. SYSTEM. DETAIL. RACK 4

REFERENCE :
TDI-P-15-60

DRAWING Nº :
PUB-WSP-JDD-012

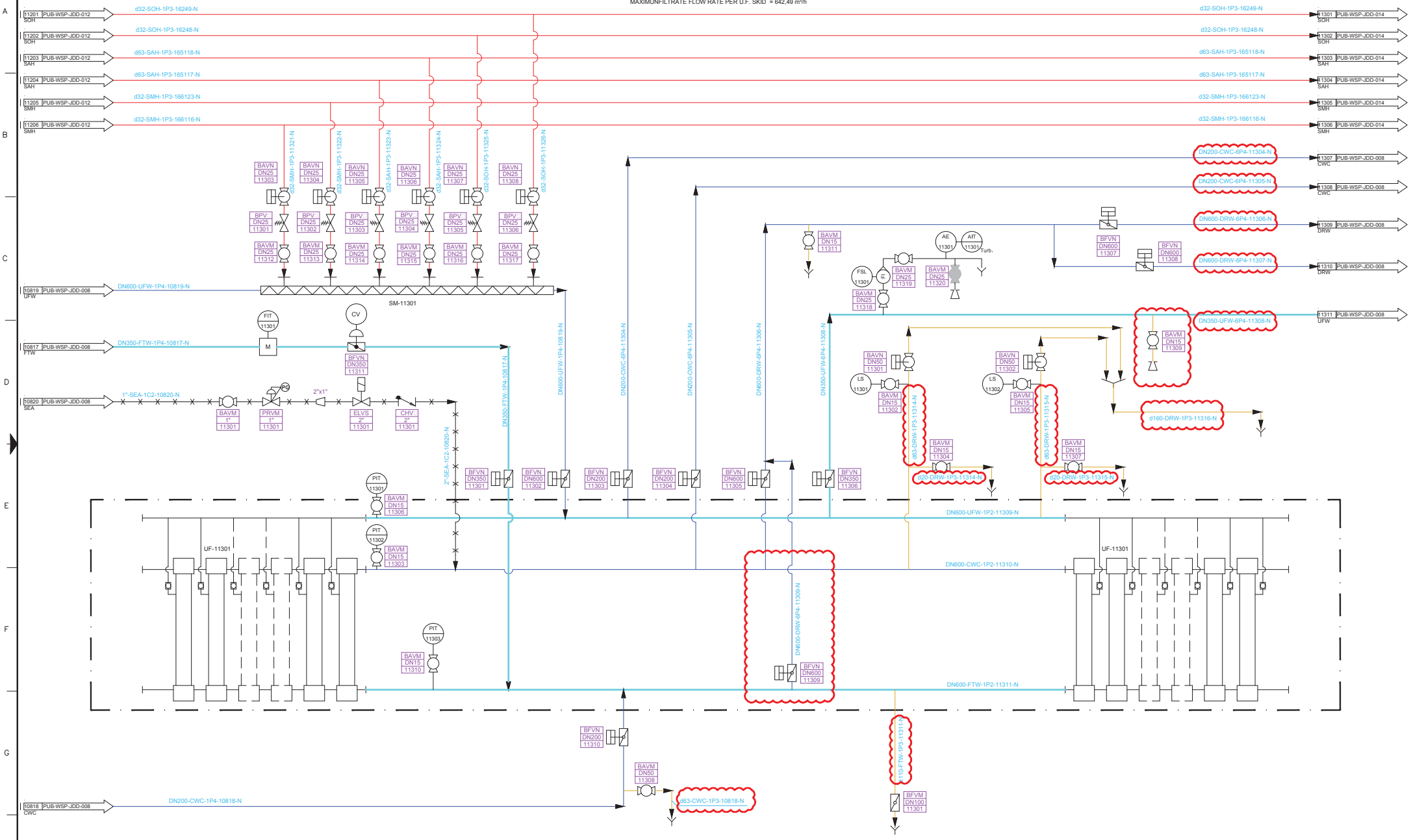
FORMAT
A1

SHEET 1
OF 1

DIN A1 (841 x 594)

ULTRAFILTRATION UF-RACK 5

NUMBER OF HOUSING PER GROUP = 56 UNITS
NUMBER OF POSSIBLE HOUSING PER GROPU = 68 UNITS
NORMAL FILTRATE FLOW RATE PER U.F: SKID AT DESIGN FLOW RATE = 584,08 m³/h
MAXIMUNFILTRATE FLOW RATE PER U.F. SKID = 642,49 m³/h



NOTES :
- THIS SHEET CORREPONSE TO AREA: 25

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
U.F. SYSTEM. DETAIL. RACK 5

REFERENCE : TDI-P-15-60

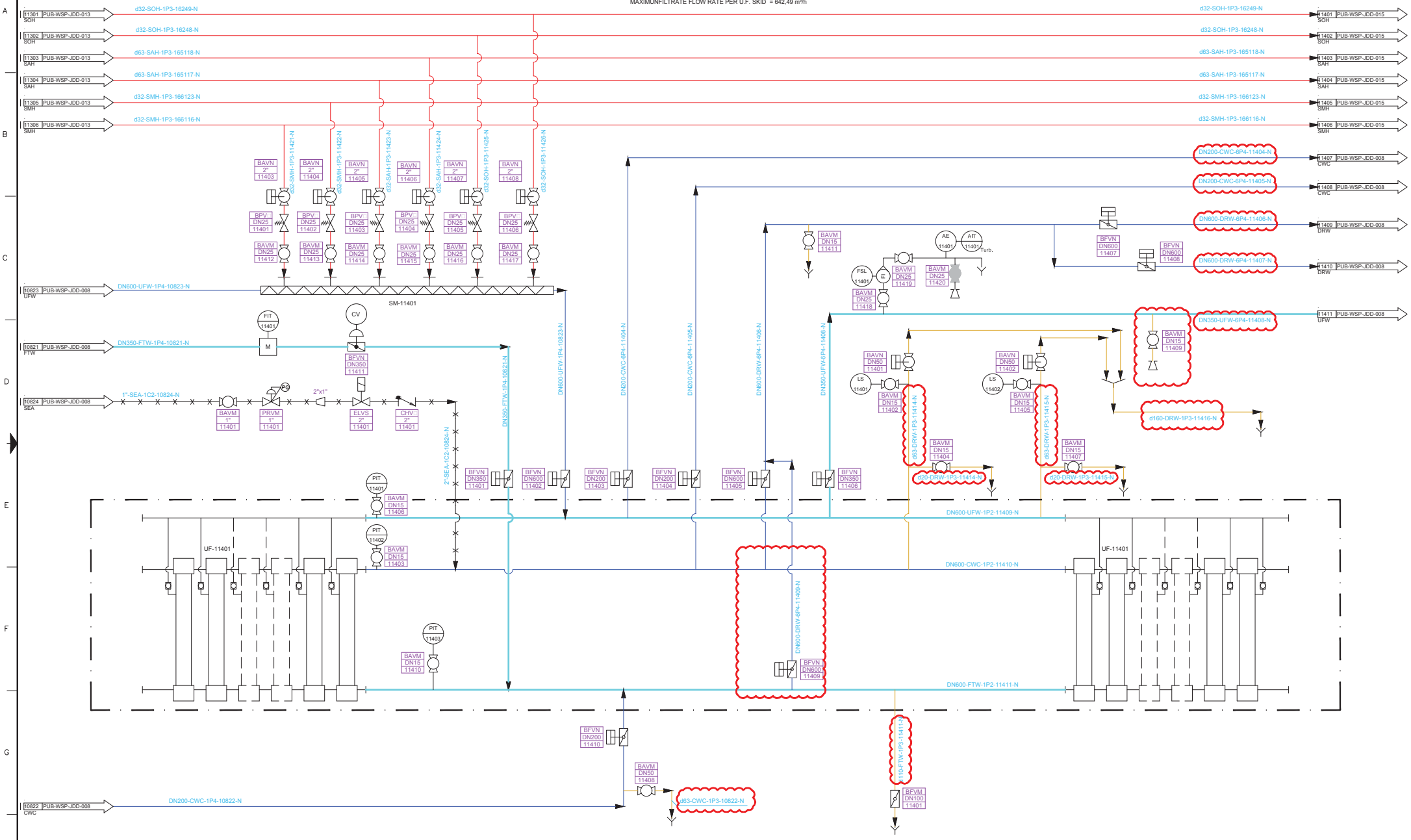
DRAWING Nº : PUB-WSP-JDD-013

FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)

ULTRAFILTRATION UF-RACK 6

NUMBER OF HOUSING PER GROUP = 56 UNITS
NUMBER OF POSSIBLE HOUSING PER GROPU = 68 UNITS
NORMAL FILTRATE FLOW RATE PER U.F: SKID AT DESIGN FLOW RATE = 584,08 m³/h
MAXIMUNFILTRATE FLOW RATE PER U.F. SKID = 642,49 m³/h



NOTES :

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	FOR APPROVAL	16/03/18	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
U.F. SYSTEM. DETAIL. RACK 6

REFERENCE :
TDI-P-15-60

DRAWING Nº :
PUB-WSP-JDD-014

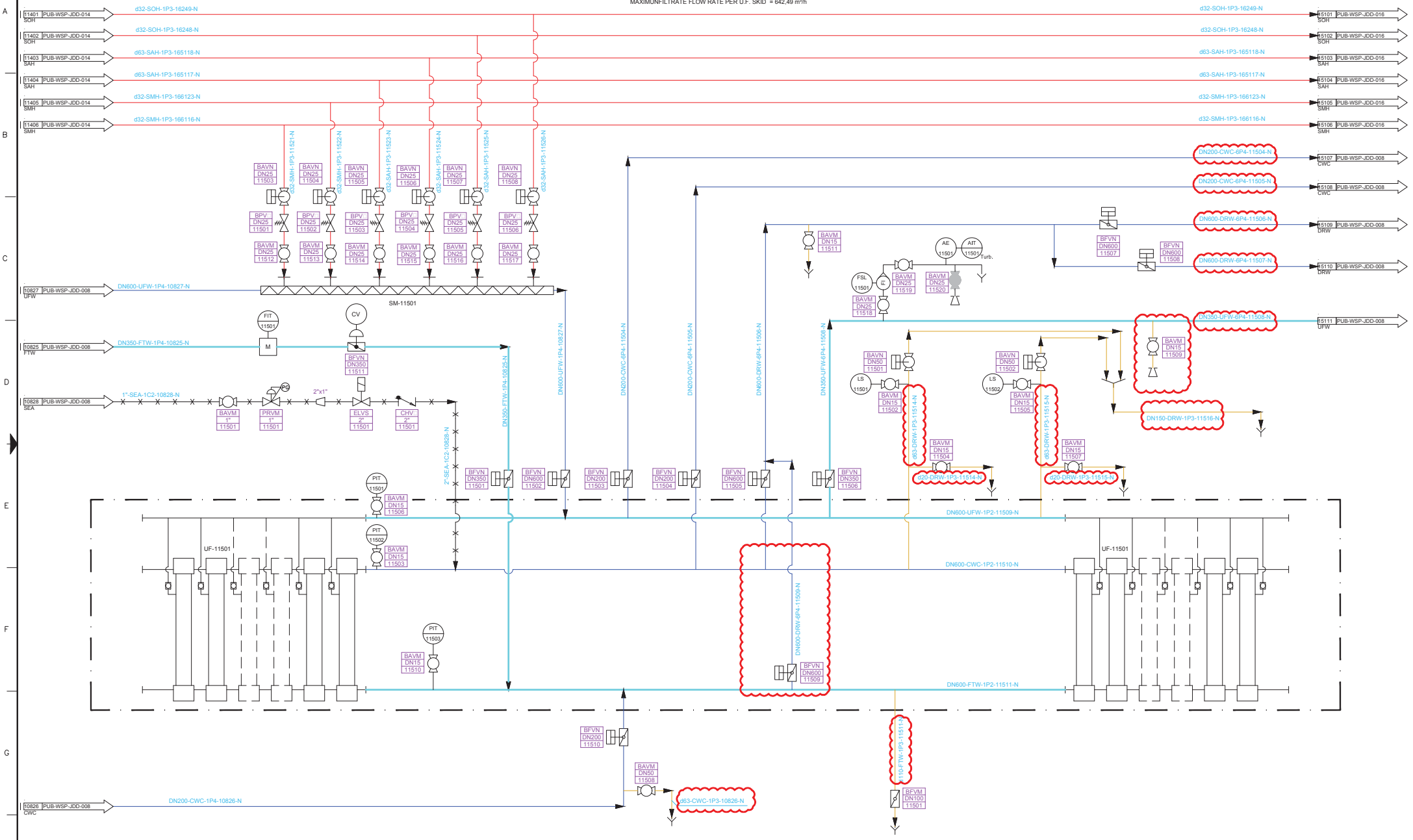
FORMAT
A1

SHEET 1
OF 1

DIN A1 (841 x 594)

ULTRAFILTRATION UF-RACK 7

NUMBER OF HOUSING PER GROUP = 56 UNITS
NUMBER OF POSSIBLE HOUSING PER GROPU = 68 UNITS
NORMAL FILTRATE FLOW RATE PER U.F: SKID AT DESIGN FLOW RATE = 584,08 m³/h
MAXIMUNFILTRATE FLOW RATE PER U.F. SKID = 642,49 m³/h



NOTES :
- THIS SHEET CORREPONSE TO AREA: 25

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
U.F. SYSTEM. DETAIL. RACK 7

REFERENCE : TDI-P-15-60

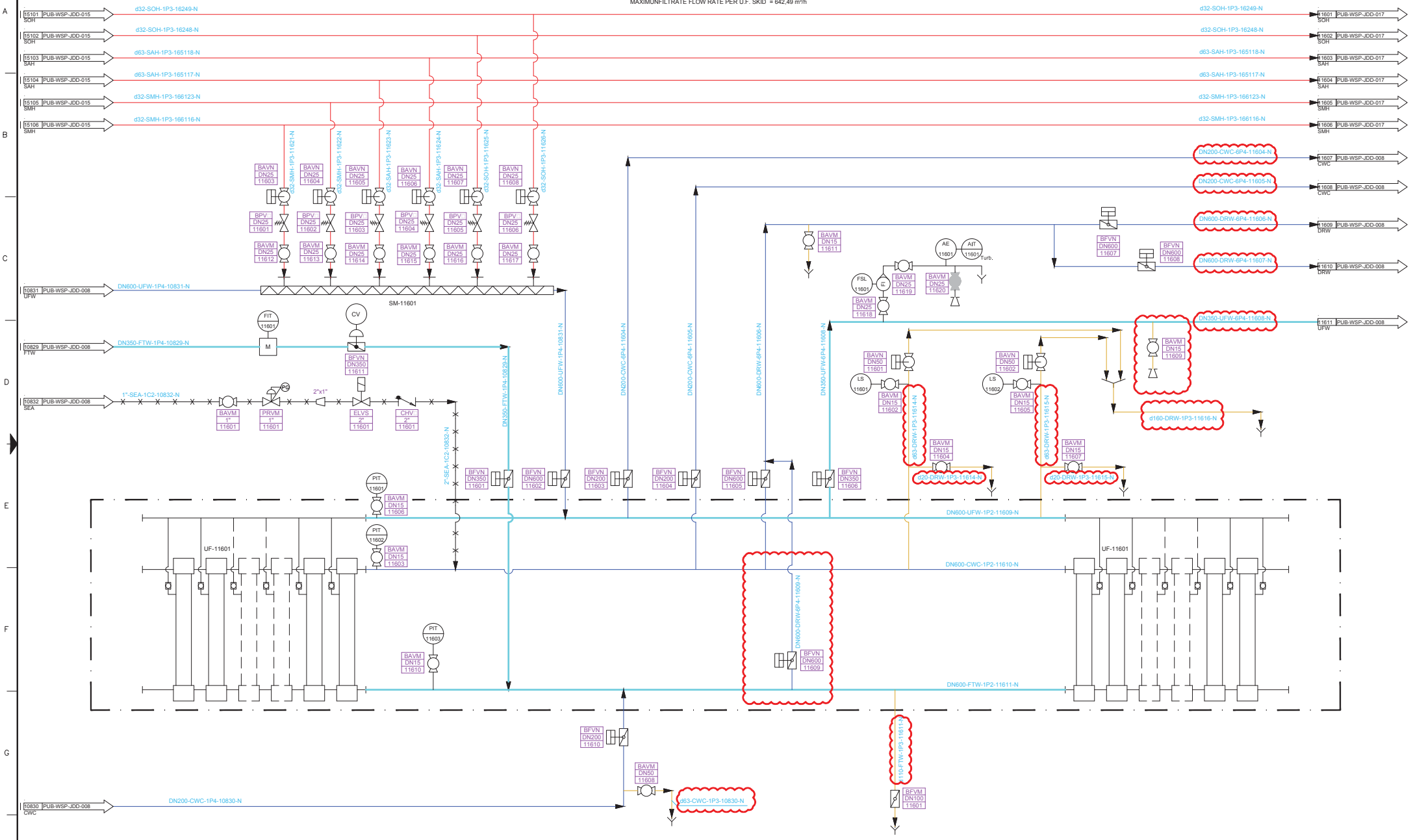
DRAWING Nº : PUB-WSP-JDD-015

FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)

ULTRAFILTRATION UF-RACK 8

NUMBER OF HOUSING PER GROUP = 56 UNITS
NUMBER OF POSSIBLE HOUSING PER GROPU = 68 UNITS
NORMAL FILTRATE FLOW RATE PER U.F: SKID AT DESIGN FLOW RATE = 584,08 m³/h
MAXIMUNFILTRATE FLOW RATE PER U.F. SKID = 642,49 m³/h



NOTES :
- THIS SHEET CORREPONSE TO AREA: 25

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
U.F. SYSTEM. DETAIL. RACK 8

REFERENCE : TDI-P-15-60

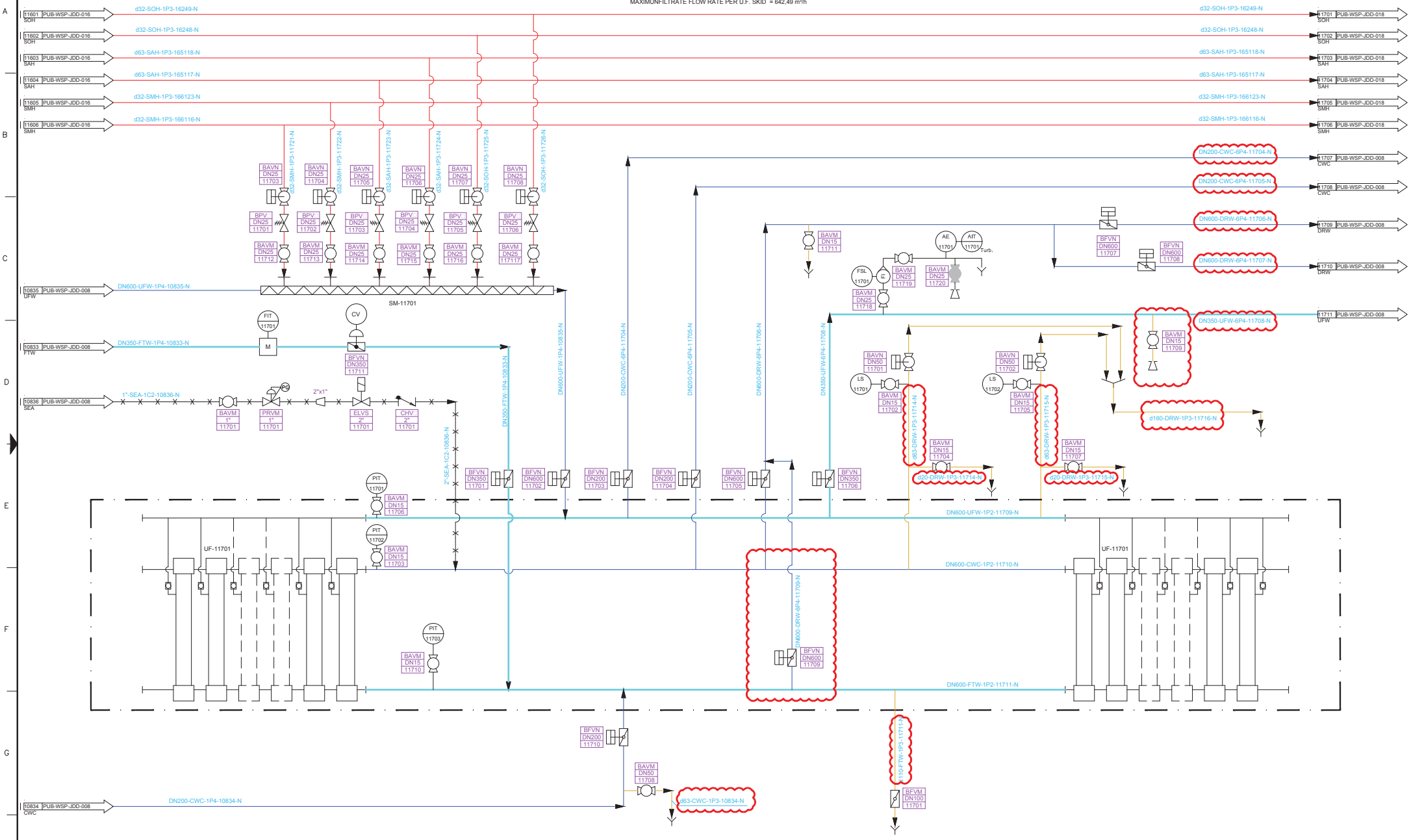
DRAWING Nº : PUB-WSP-JDD-016

FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)

ULTRAFILTRATION UF-RACK 9

NUMBER OF HOUSING PER GROUP = 56 UNITS
NUMBER OF POSSIBLE HOUSING PER GROPU = 68 UNITS
NORMAL FILTRATE FLOW RATE PER U.F: SKID AT DESIGN FLOW RATE = 584,08 m³/h
MAXIMUNFILTRATE FLOW RATE PER U.F. SKID = 642,49 m³/h



NOTES :
- THIS SHEET CORREPONSE TO AREA: 25

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
U.F. SYSTEM. DETAIL. RACK 9

REFERENCE : TDI-P-15-60

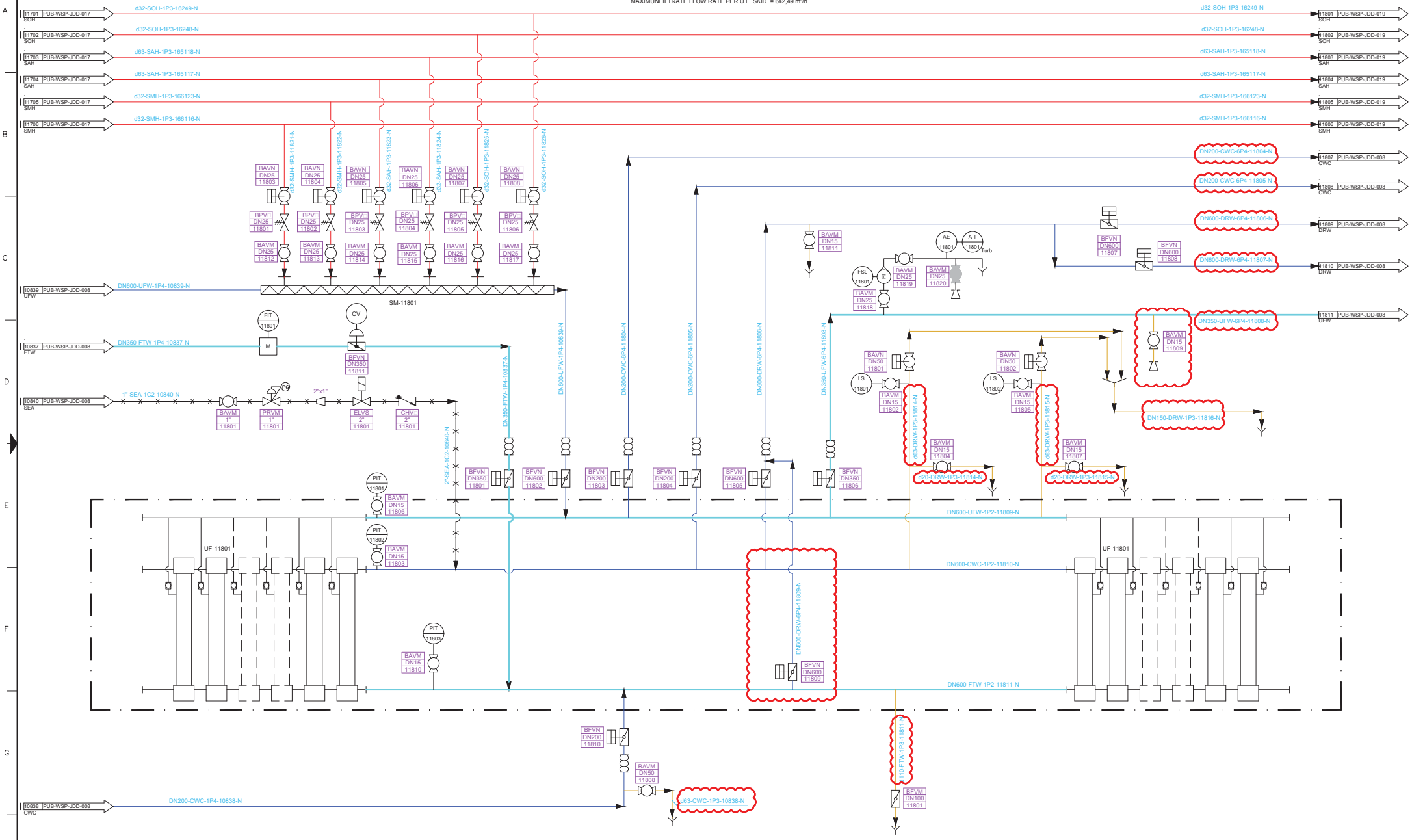
DRAWING Nº : PUB-WSP-JDD-017

FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)

ULTRAFILTRATION UF-RACK 10

NUMBER OF HOUSING PER GROUP = 56 UNITS
NUMBER OF POSSIBLE HOUSING PER GROPU = 68 UNITS
NORMAL FILTRATE FLOW RATE PER U.F: SKID AT DESIGN FLOW RATE = 584,08 m³/h
MAXIMUNFILTRATE FLOW RATE PER U.F. SKID = 642,49 m³/h



NOTES :
- THIS SHEET CORREPONSE TO AREA: 25

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
U.F. SYSTEM. DETAIL. RACK 10

REFERENCE : TDI-P-15-60

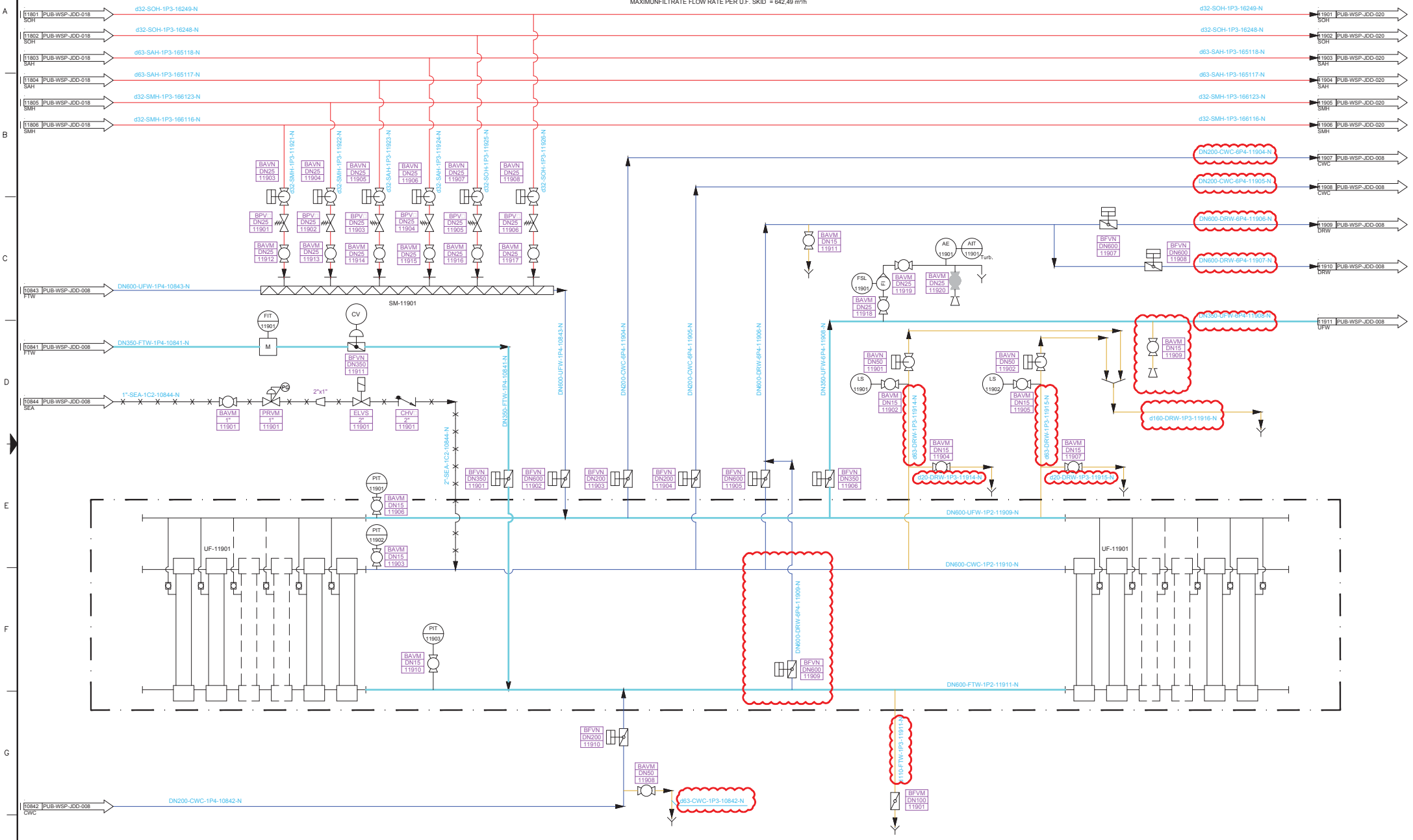
DRAWING Nº : PUB-WSP-JDD-018

FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)

ULTRAFILTRATION UF-RACK 11

NUMBER OF HOUSING PER GROUP = 56 UNITS
NUMBER OF POSSIBLE HOUSING PER GROPU = 68 UNITS
NORMAL FILTRATE FLOW RATE PER U.F: SKID AT DESIGN FLOW RATE = 584,08 m³/h
MAXIMUNFILTRATE FLOW RATE PER U.F. SKID = 642,49 m³/h



NOTES :

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	FOR APPROVAL	16/03/18	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
U.F. SYSTEM. DETAIL. RACK 11

REFERENCE :
TDI-P-15-60

DRAWING Nº :
PUB-WSP-JDD-019

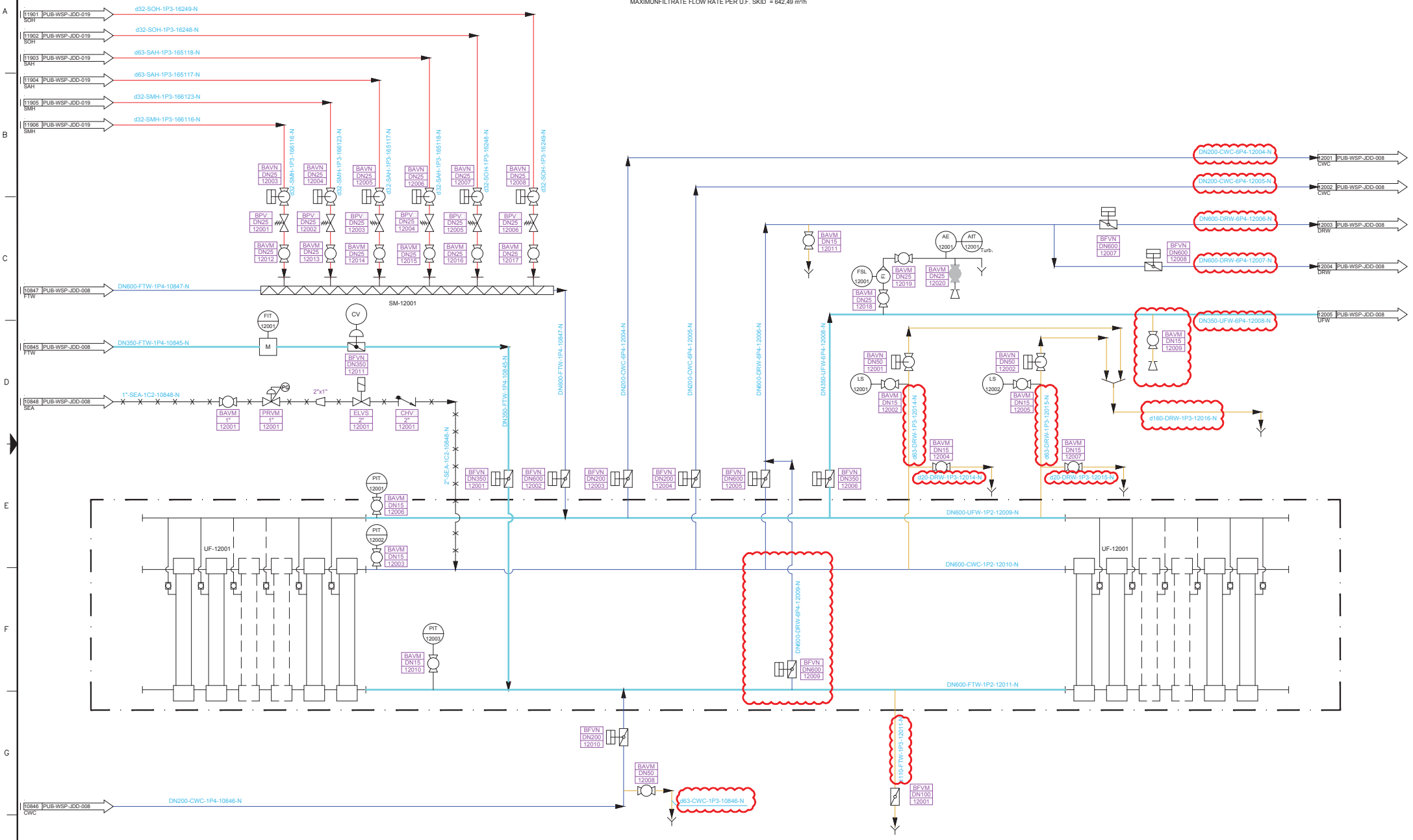
FORMAT
A1

SHEET 1
OF 1

DIN A1 (841 x 594)

ULTRAFILTRATION UF-RACK 12

NUMBER OF HOUSING PER GROUP = 56 UNITS
NUMBER OF POSSIBLE HOUSING PER GROPU = 68 UNITS
NORMAL FILTRATE FLOW RATE PER U.F: SKID AT DESIGN FLOW RATE = 584,08 m³/h
MAXIMUNFILTRATE FLOW RATE PER U.F. SKID = 642,49 m³/h



NOTES :
- THIS SHEET CORREPONSE TO AREA: 25

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
U.F. SYSTEM. DETAIL. RACK 12

REFERENCE : TDI-P-15-60

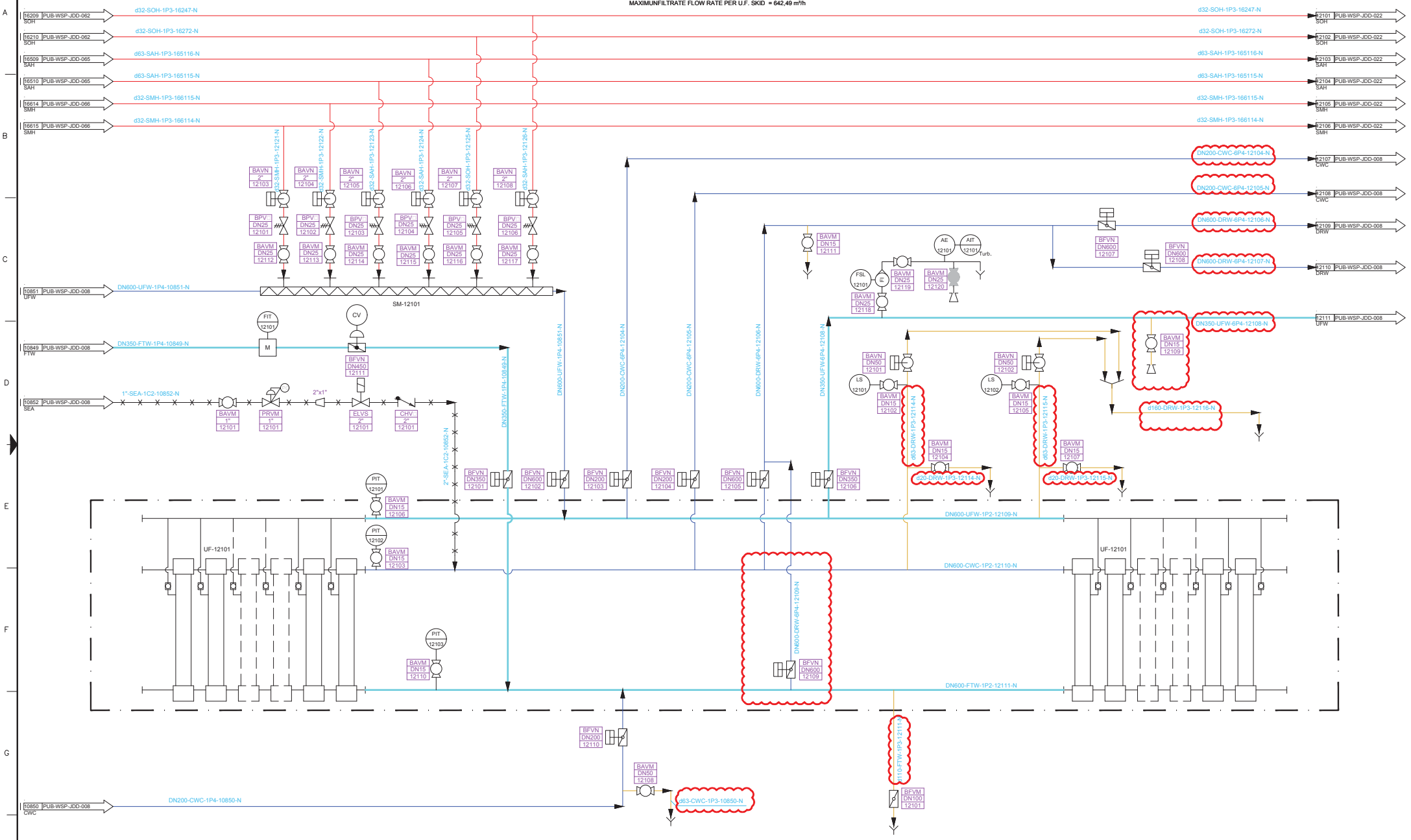
DRAWING Nº : PUB-WSP-JDD-020

FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)

ULTRAFILTRATION UF-RACK 13

NUMBER OF HOUSING PER GROUP = 56 UNITS
NUMBER OF POSSIBLE HOUSING PER GROPU = 68 UNITS
NORMAL FILTRATE FLOW RATE PER U.F: SKID AT DESIGN FLOW RATE = 584,08 m³/h
MAXIMUNFILTRATE FLOW RATE PER U.F. SKID = 642,49 m³/h



NOTES :
- THIS SHEET CORREPONSE TO AREA: 25

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
U.F. SYSTEM. DETAIL. RACK 13

REFERENCE :
TDI-P-15-60

DRAWING Nº :
PUB-WSP-JDD-021

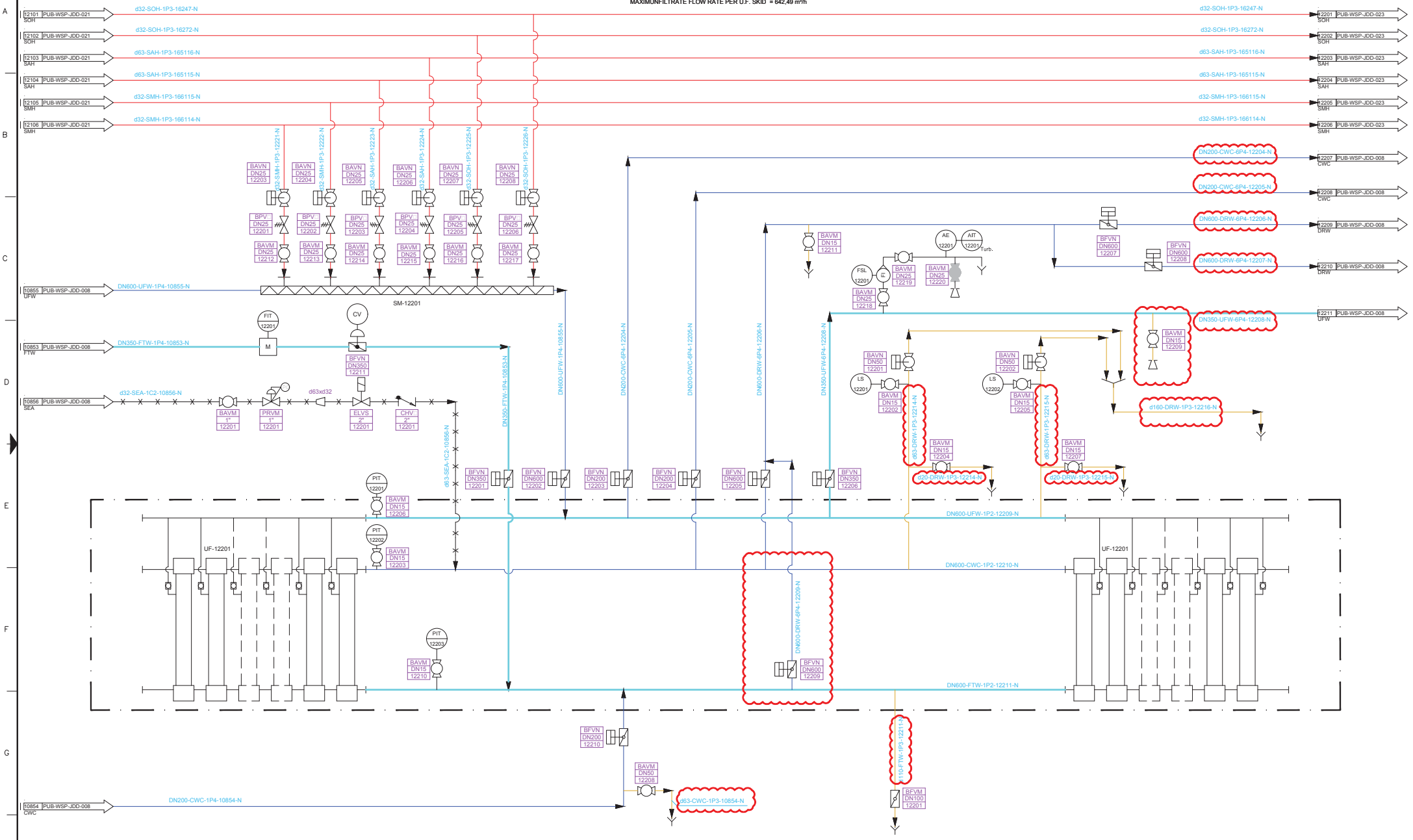
FORMAT
A1

SHEET 1 OF 1

DIN A1 (841 x 594)

ULTRAFILTRATION UF-RACK 14

NUMBER OF HOUSING PER GROUP = 56 UNITS
NUMBER OF POSSIBLE HOUSING PER GROPU = 68 UNITS
NORMAL FILTRATE FLOW RATE PER U:F: SKID AT DESIGN FLOW RATE = 584,08 m³/h
MAXIMUNFILTRATE FLOW RATE PER U.F. SKID = 642,49 m³/h



NOTES :
- THIS SHEET CORREPONSE TO AREA: 25

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
U.F. SYSTEM. DETAIL. RACK 14

REFERENCE : TDI-P-15-60

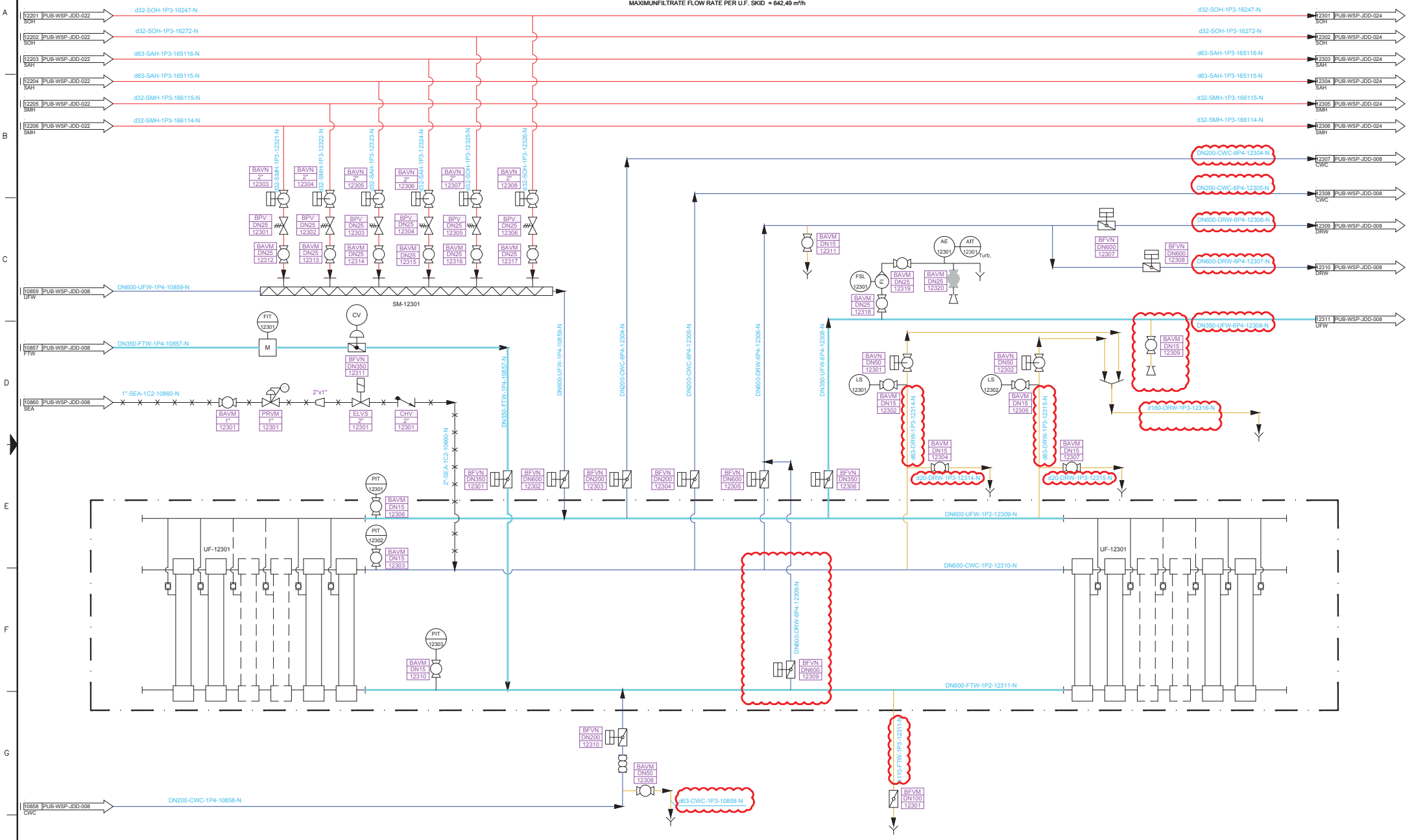
DRAWING Nº : PUB-WSP-JDD-022

FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)

ULTRAFILTRATION UF-RACK 15

NUMBER OF HOUSING PER GROUP = 56 UNITS
NUMBER OF POSSIBLE HOUSING PER GROPU = 68 UNITS
NORMAL FILTRATE FLOW RATE PER U:F: SKID AT DESIGN FLOW RATE = 584,08 m³/h
MAXIMUNFILTRATE FLOW RATE PER U.F. SKID = 642,49 m³/h



NOTES :
- THIS SHEET CORREPONSE TO AREA: 25

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
U.F. SYSTEM. DETAIL. RACK 15

REFERENCE : TDI-P-15-60

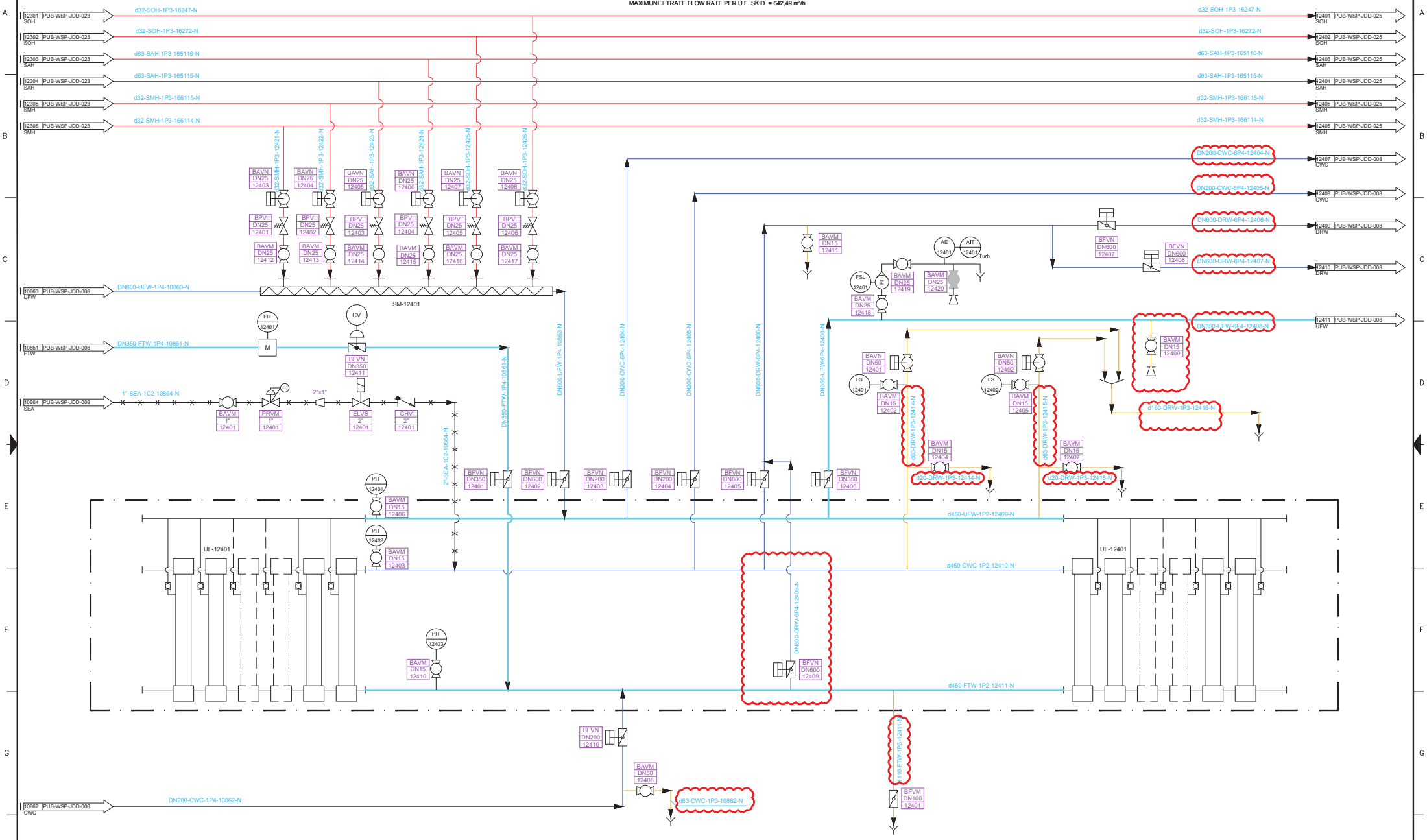
DRAWING Nº : PUB-WSP-JDD-023

FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)

ULTRAFILTRATION UF-RACK 16

NUMBER OF HOUSING PER GROUP = 56 UNITS
NUMBER OF POSSIBLE HOUSING PER GROPU = 68 UNITS
NORMAL FILTRATE FLOW RATE PER U.F: SKID AT DESIGN FLOW RATE = 584,08 m³/h
MAXIMUNFILTRATE FLOW RATE PER U.F. SKID = 642,49 m³/h



NOTES :
- THIS SHEET CORREPONSE TO AREA: 25

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
U.F. SYSTEM. DETAIL. RACK 16

REFERENCE :
TDI-P-15-60

DRAWING Nº :
PUB-WSP-JDD-024

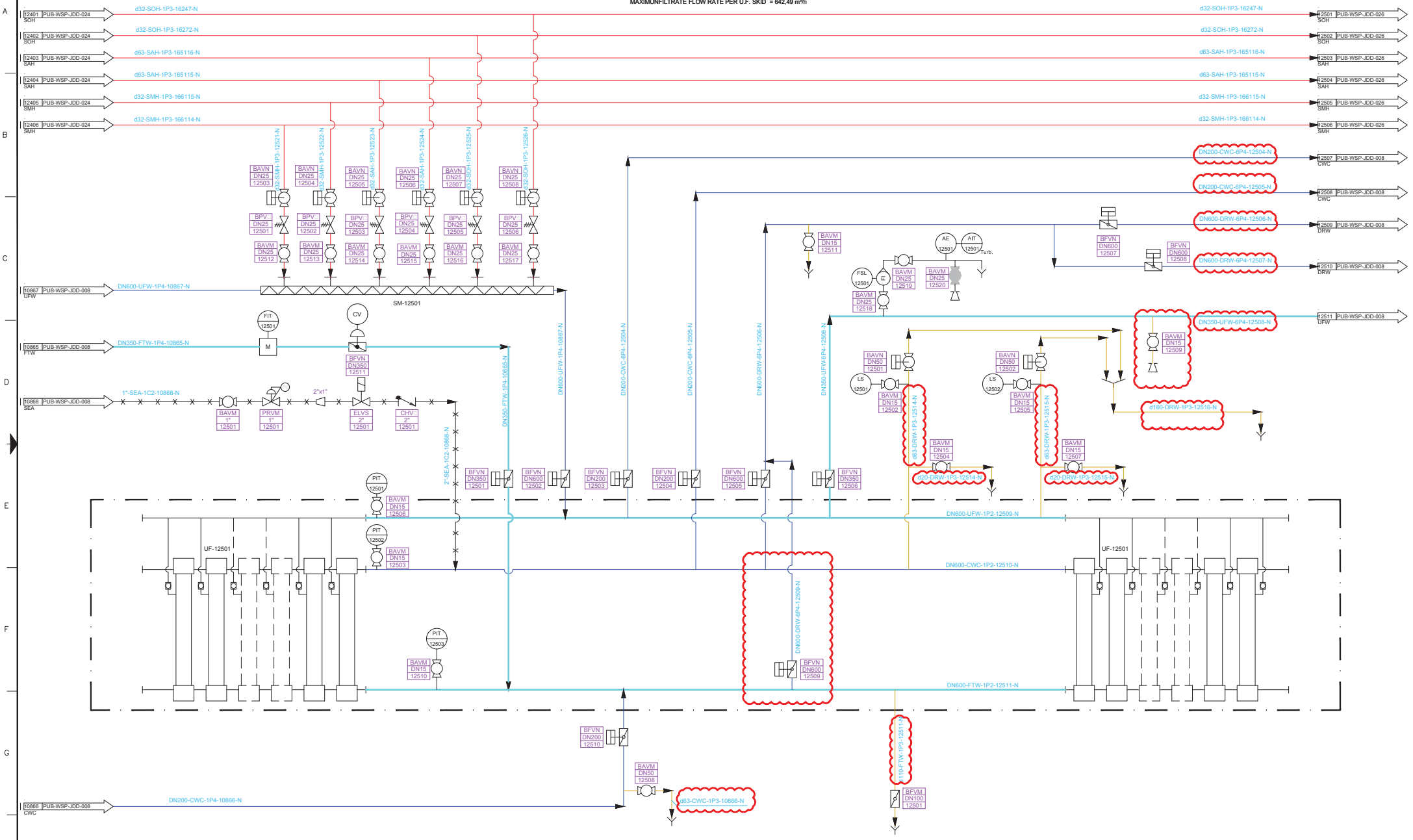
FORMAT
A1

SHEET 1 OF 1

DIN A1 (841 x 594)

ULTRAFILTRATION UF-RACK 17

NUMBER OF HOUSING PER GROUP = 56 UNITS
NUMBER OF POSSIBLE HOUSING PER GROPU = 68 UNITS
NORMAL FILTRATE FLOW RATE PER U.F: SKID AT DESIGN FLOW RATE = 584,08 m³/h
MAXIMUNFILTRATE FLOW RATE PER U.F. SKID = 642,49 m³/h



NOTES :
- THIS SHEET CORREPONSE TO AREA: 25

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
U.F. SYSTEM. DETAIL. RACK 17

REFERENCE : TDI-P-15-60

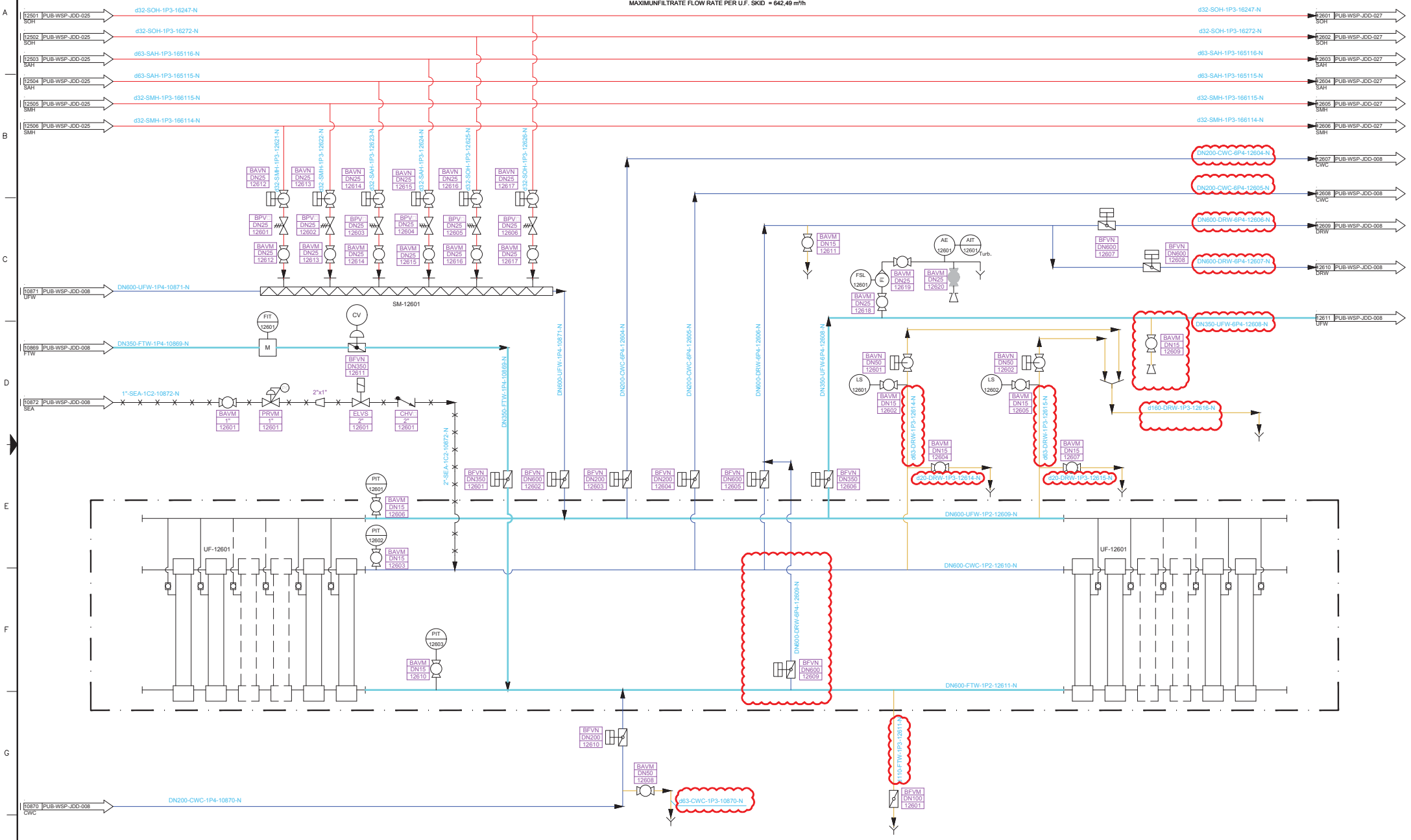
DRAWING Nº : PUB-WSP-JDD-025

FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)

ULTRAFILTRATION UF-RACK 18

NUMBER OF HOUSING PER GROUP = 56 UNITS
NUMBER OF POSSIBLE HOUSING PER GROPU = 68 UNITS
NORMAL FILTRATE FLOW RATE PER U.F: SKID AT DESIGN FLOW RATE = 584,08 m³/h
MAXIMUNFILTRATE FLOW RATE PER U.F. SKID = 642,49 m³/h



NOTES :
- THIS SHEET CORREPONSE TO AREA: 25

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
U.F. SYSTEM. DETAIL. RACK 18

REFERENCE : TDI-P-15-60

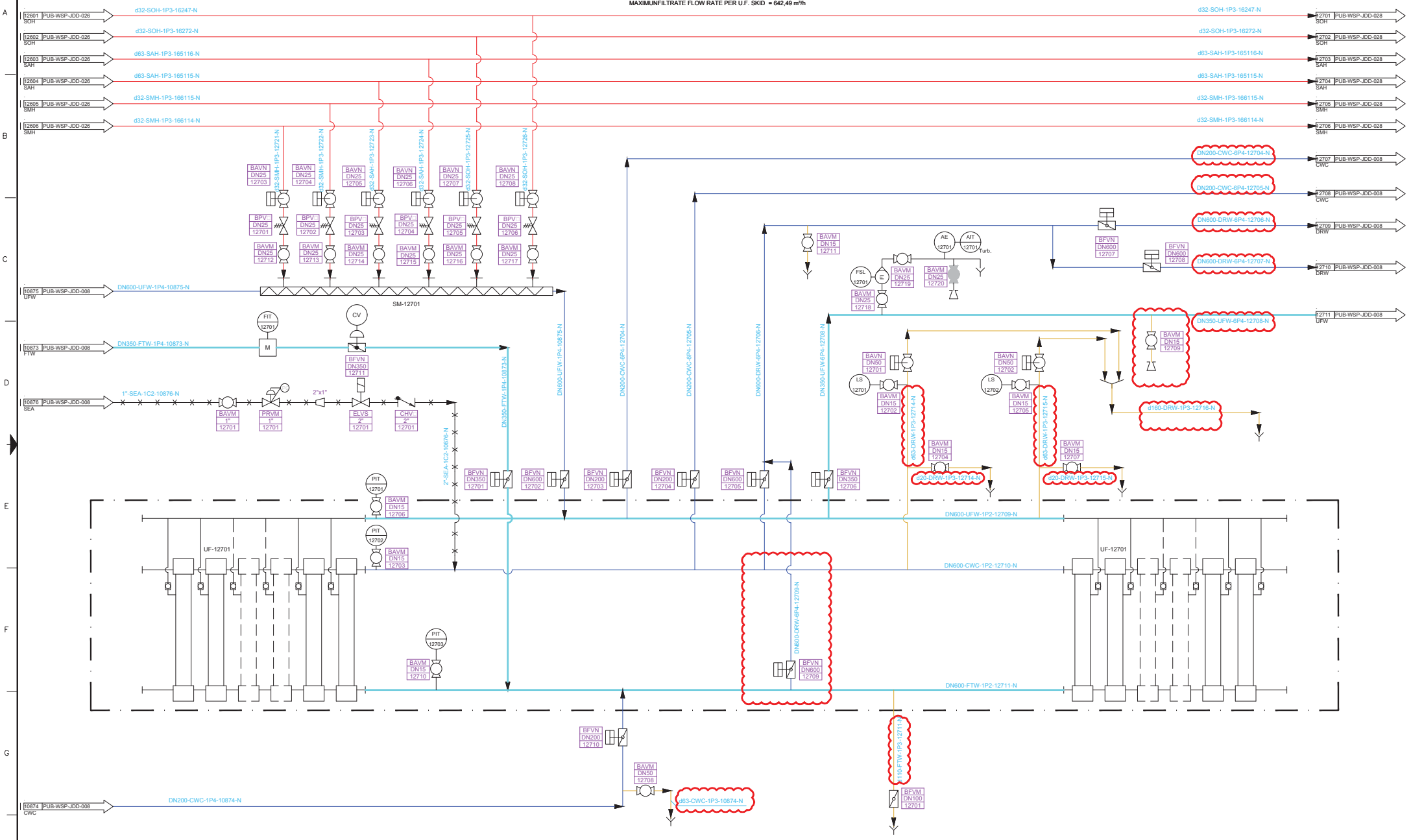
DRAWING Nº : PUB-WSP-JDD-026

FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)

ULTRAFILTRATION UF-RACK 19

NUMBER OF HOUSING PER GROUP = 56 UNITS
NUMBER OF POSSIBLE HOUSING PER GROPU = 68 UNITS
NORMAL FILTRATE FLOW RATE PER U.F: SKID AT DESIGN FLOW RATE = 584,08 m³/h
MAXIMUNFILTRATE FLOW RATE PER U.F. SKID = 642,49 m³/h



NOTES :
- THIS SHEET CORREPONSE TO AREA: 25

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
U.F. SYSTEM. DETAIL. RACK 19

REFERENCE : TDI-P-15-60

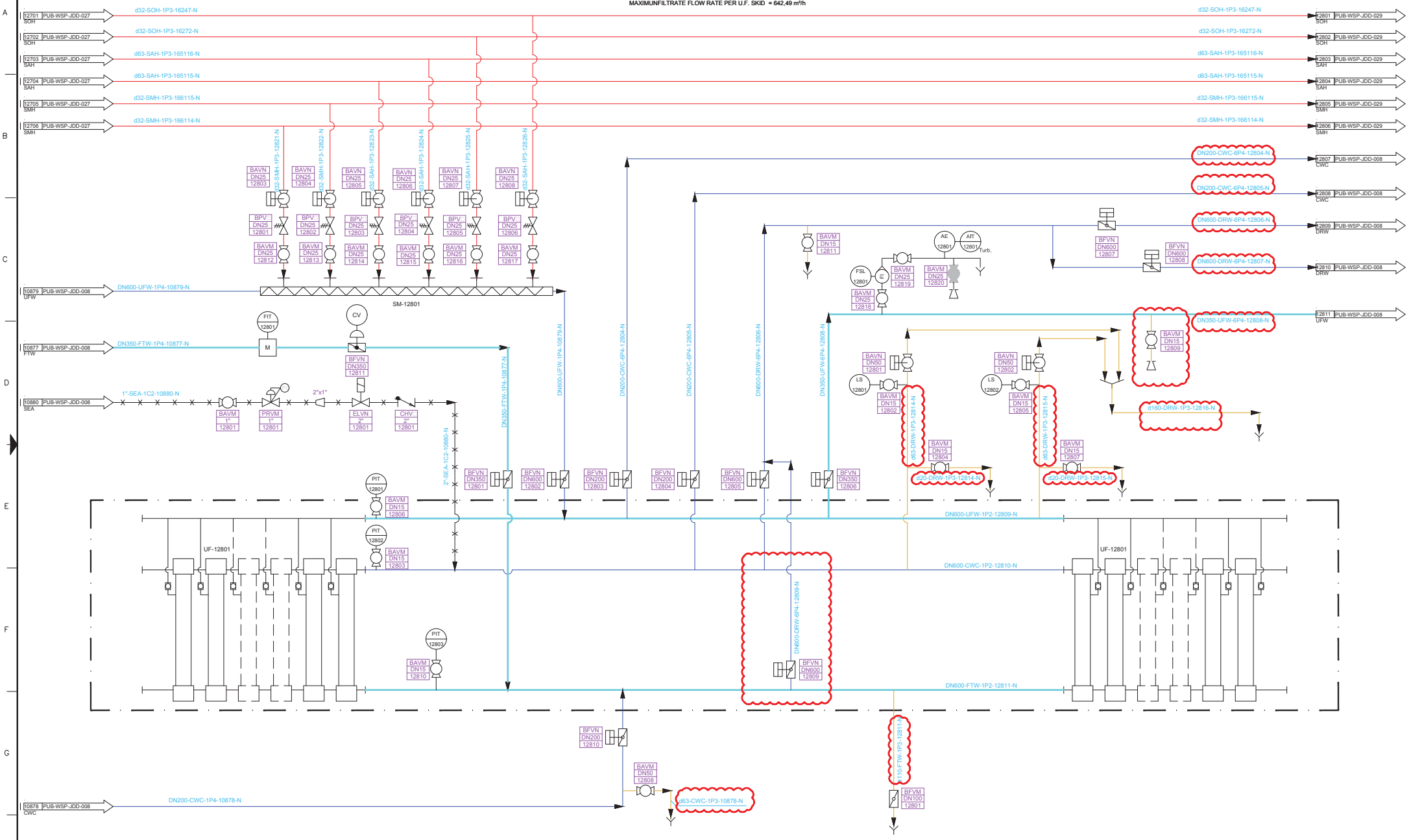
DRAWING Nº : PUB-WSP-JDD-027

FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)

ULTRAFILTRATION UF-RACK 20

NUMBER OF HOUSING PER GROUP = 56 UNITS
NUMBER OF POSSIBLE HOUSING PER GROPU = 68 UNITS
NORMAL FILTRATE FLOW RATE PER U:F: SKID AT DESIGN FLOW RATE = 584,08 m³/h
MAXIMUNFILTRATE FLOW RATE PER U.F. SKID = 642,49 m³/h



NOTES :
- THIS SHEET CORREPONSE TO AREA: 25

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
U.F. SYSTEM. DETAIL. RACK 20

REFERENCE :
TDI-P-15-60

DRAWING Nº :
PUB-WSP-JDD-028

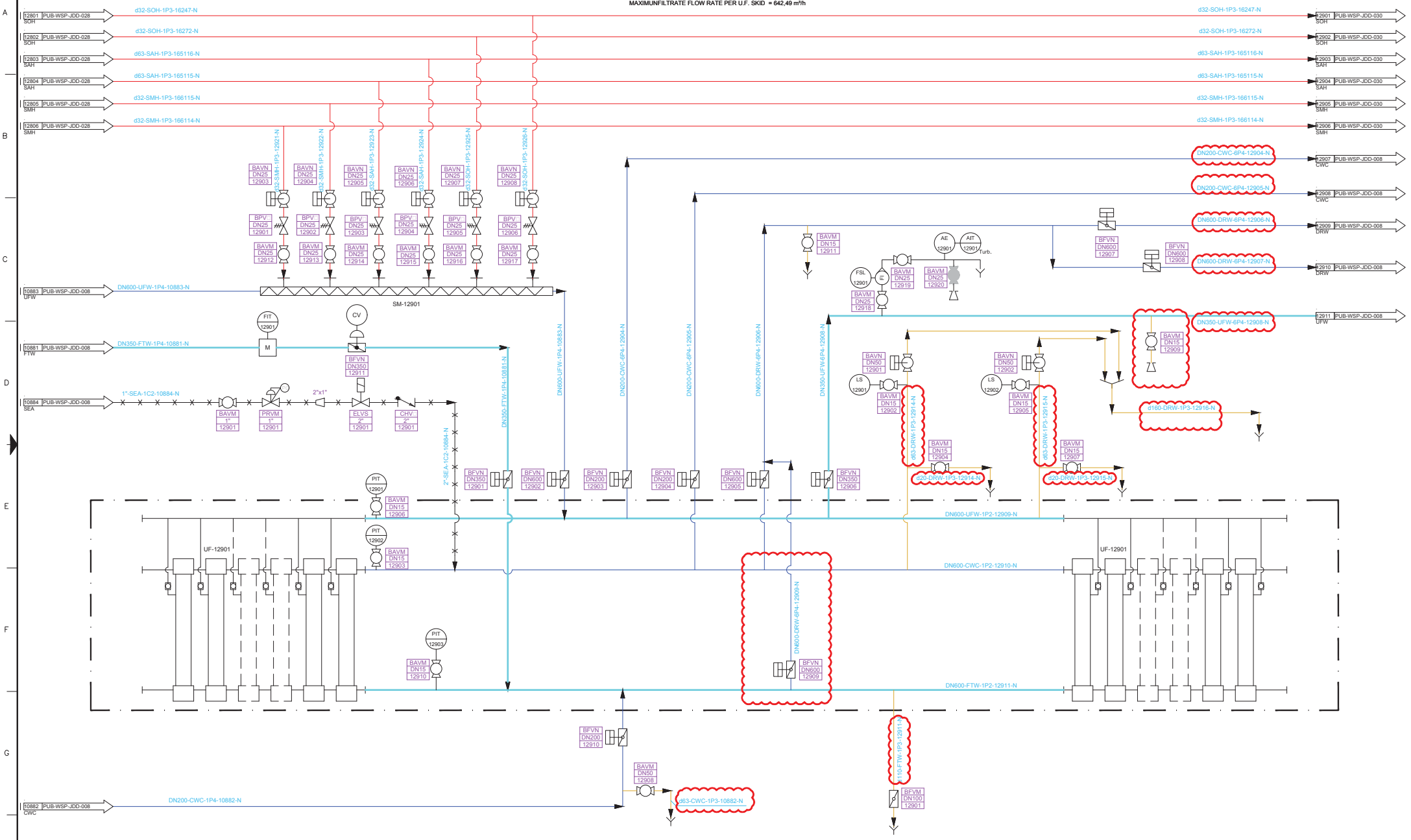
FORMAT
A1

SHEET 1 OF 1

DIN A1 (841 x 594)

ULTRAFILTRATION UF-RACK 21

NUMBER OF HOUSING PER GROUP = 56 UNITS
NUMBER OF POSSIBLE HOUSING PER GROPU = 68 UNITS
NORMAL FILTRATE FLOW RATE PER U.F: SKID AT DESIGN FLOW RATE = 584,08 m³/h
MAXIMUNFILTRATE FLOW RATE PER U.F. SKID = 642,49 m³/h



NOTES :
- THIS SHEET CORREPONSE TO AREA: 25

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
U.F. SYSTEM. DETAIL. RACK 21

REFERENCE :
TDI-P-15-60

DRAWING Nº :
PUB-WSP-JDD-029

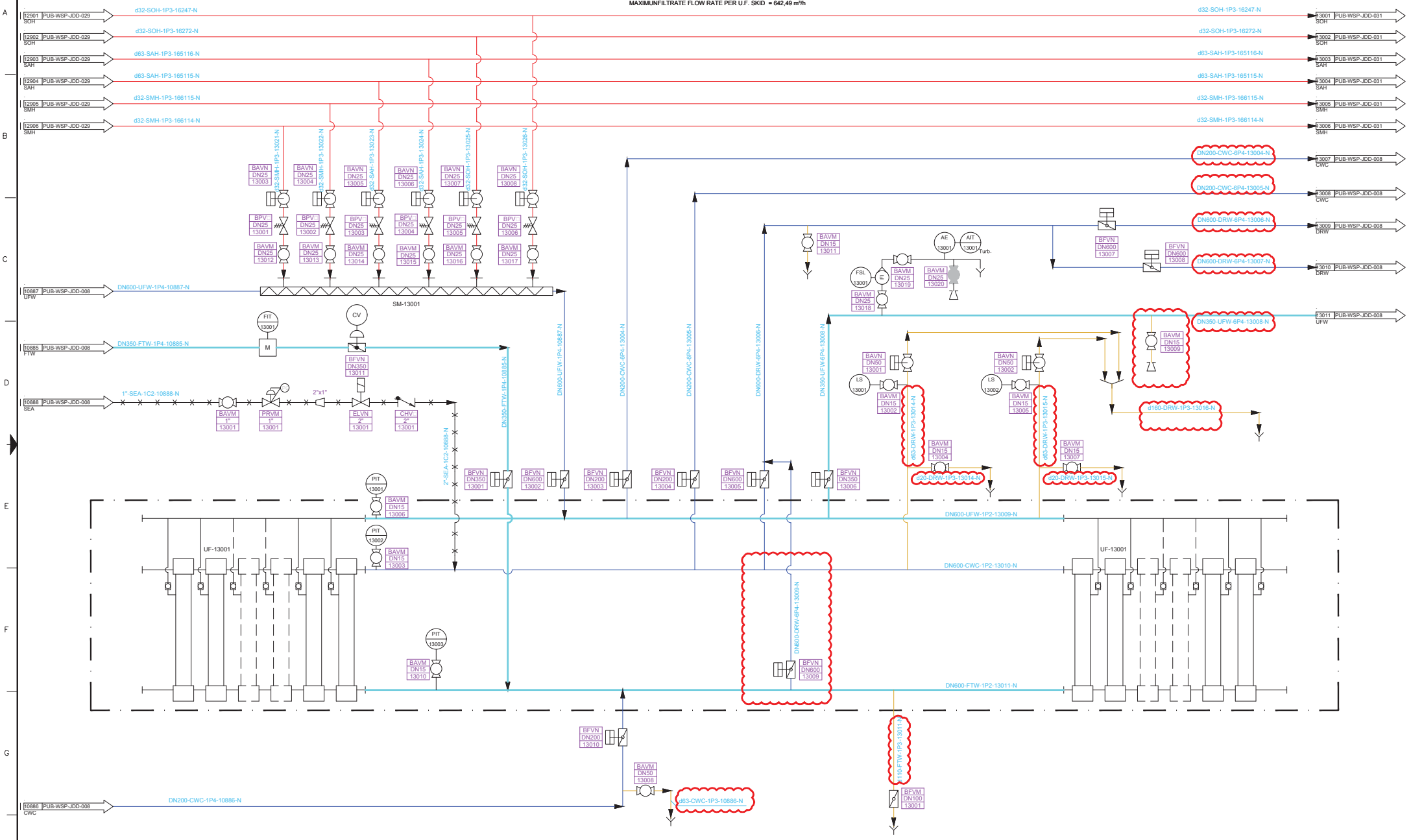
FORMAT
A1

SHEET 1
OF 1

DIN A1 (841 x 594)

ULTRAFILTRATION UF-RACK 22

NUMBER OF HOUSING PER GROUP = 56 UNITS
NUMBER OF POSSIBLE HOUSING PER GROPU = 68 UNITS
NORMAL FILTRATE FLOW RATE PER U.F: SKID AT DESIGN FLOW RATE = 584,08 m³/h
MAXIMUNFILTRATE FLOW RATE PER U.F. SKID = 642,49 m³/h



NOTES :
- THIS SHEET CORREPONSE TO AREA: 25

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

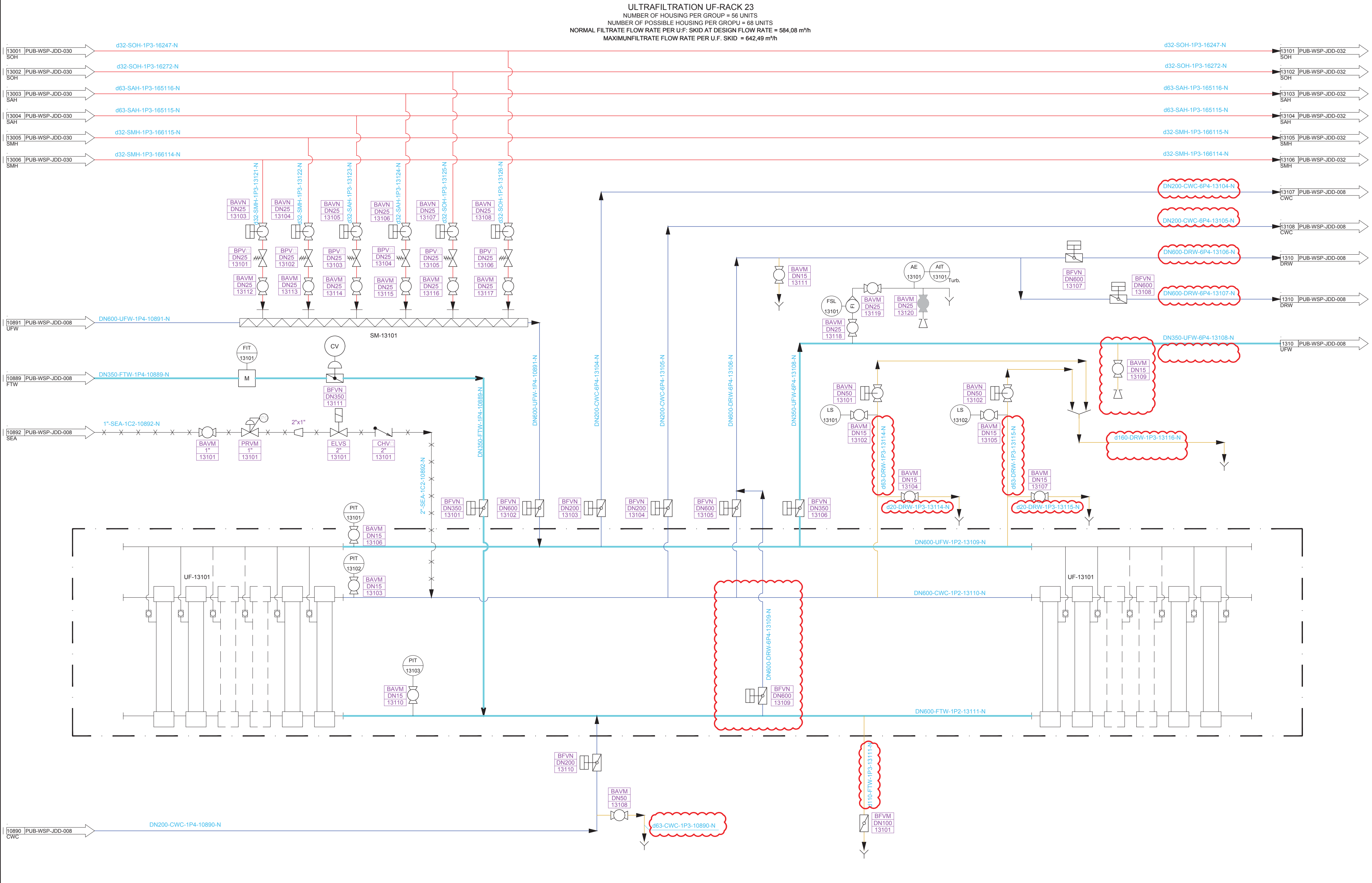
PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
U.F. SYSTEM. DETAIL. RACK 22

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-030

FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)



NOTES :

- THIS SHEET CORREPONSE TO AREA: 25

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:

CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :

SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
U.F. SYSTEM. DETAIL. RACK 23

REFERENCE : TDI-P-15-60

DRAWING N° : PUB-WSP-JDD-031

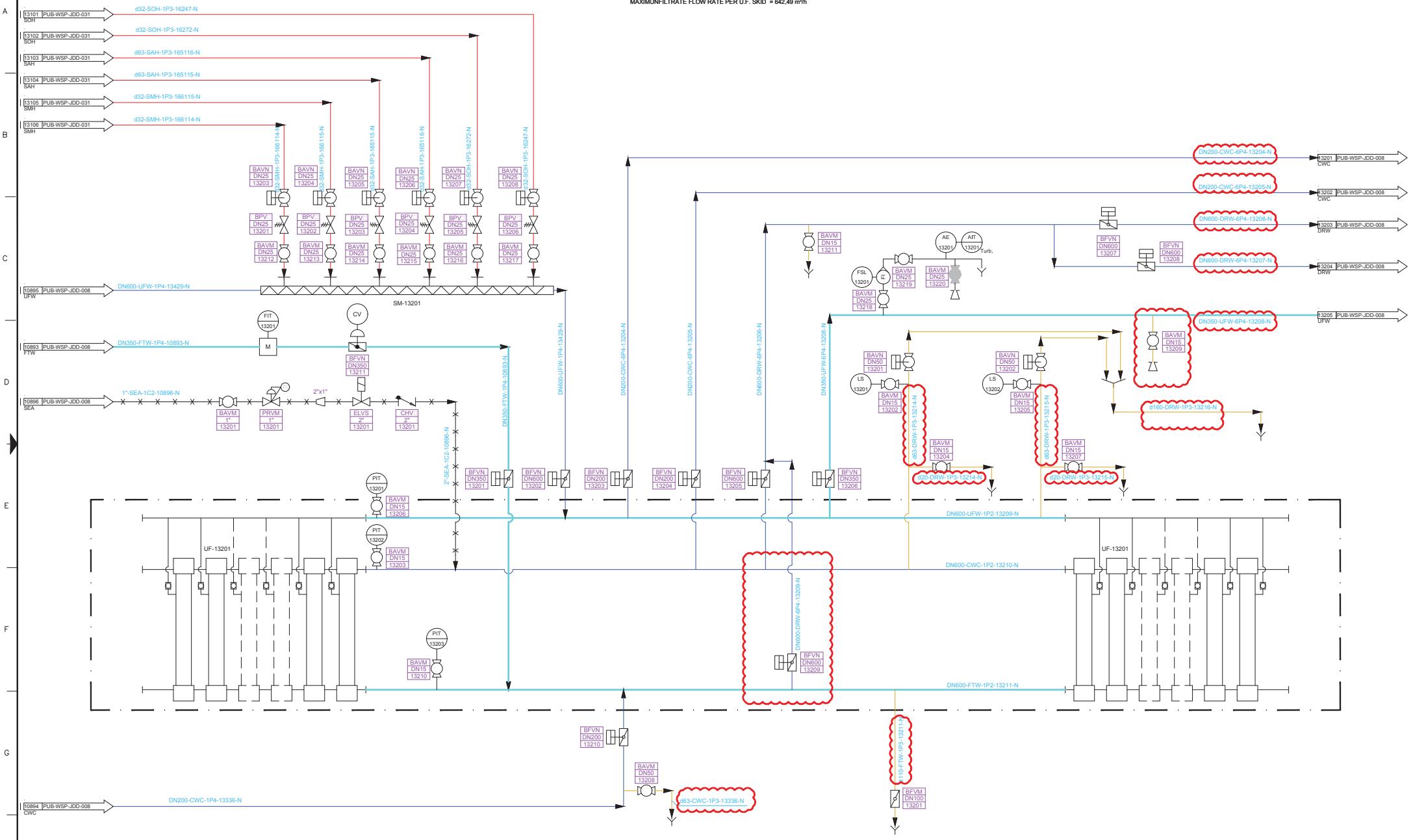
FORMAT A1

SHEET 1 OF 1

DIN A1 (841 x 594)

ULTRAFILTRATION UF-RACK 24

NUMBER OF HOUSING PER GROUP = 56 UNITS
NUMBER OF POSSIBLE HOUSING PER GROPU = 68 UNITS
NORMAL FILTRATE FLOW RATE PER U.F: SKID AT DESIGN FLOW RATE = 584,08 m³/h
MAXIMUNFILTRATE FLOW RATE PER U.F. SKID = 642,49 m³/h



NOTES :
- THIS SHEET CORREPONSE TO AREA: 25

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

CI:

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
U.F. SYSTEM. DETAIL. RACK 24

REFERENCE :
TDI-P-15-60

DRAWING Nº :
PUB-WSP-JDD-032

FORMAT
A1

SHEET 1
OF 1

DIN A1 (841 x 594)

ACID CIP HEATING SYSTEM
FITTED UNITS PER TANK = 1
VOLUME UNITS PER TANK = 1
UNIT RESISTANCE POWER = 200 kW

BASIC CIP HEATING SYSTEM
FITTED UNITS PER TANK = 1
VOLUME UNITS PER TANK = 1
UNIT RESISTANCE POWER = 200 kW

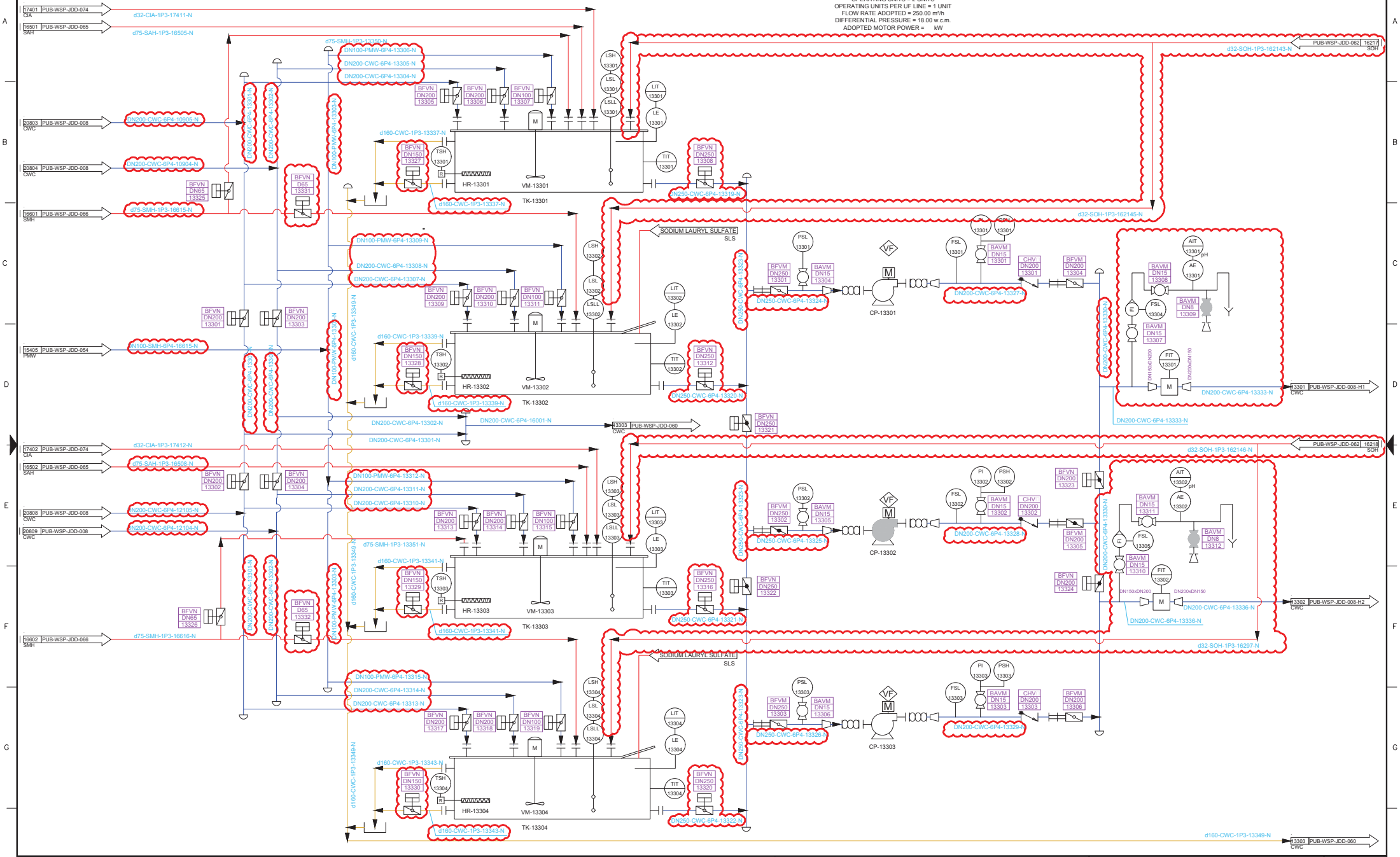
ACID CIP TANK
FITTED UNITS = 2 UNITS
VOLUME UNIT = 20 m³
OPERATING UNIT = 2

ACID CIP MIXER
FITTED UNIT PER TANK = 1
OPERATING UNITS PER TANK = 1
MOTOR ADOPTED POWER = 1,5 kW

BASIC CIP TANK
FITTED UNITS = 2 UNITS
VOLUME UNIT = 20 m³
OPERATING UNIT = 2

BASIC CIP MIXER
FITTED UNIT PER TANK = 1
OPERATING UNITS PER TANK = 1
MOTOR ADOPTED POWER = 1,5 kW

CIP PUMPS
HORIZONTAL CENTRIFUGAL
FITTED UNITS = 3 UNITS
OPERATING UNITS = 2 UNITS
OPERATING UNITS PER UF LINE = 1 UNIT
FLOW RATE ADOPTED = 250.00 m³/h
DIFFERENTIAL PRESSURE = 18.00 w.c.m.
ADOPTED MOTOR POWER = kW



NOTES :
- THIS SHEET CORREPONSE TO AREA: 25

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
U.F. SYSTEM CIP

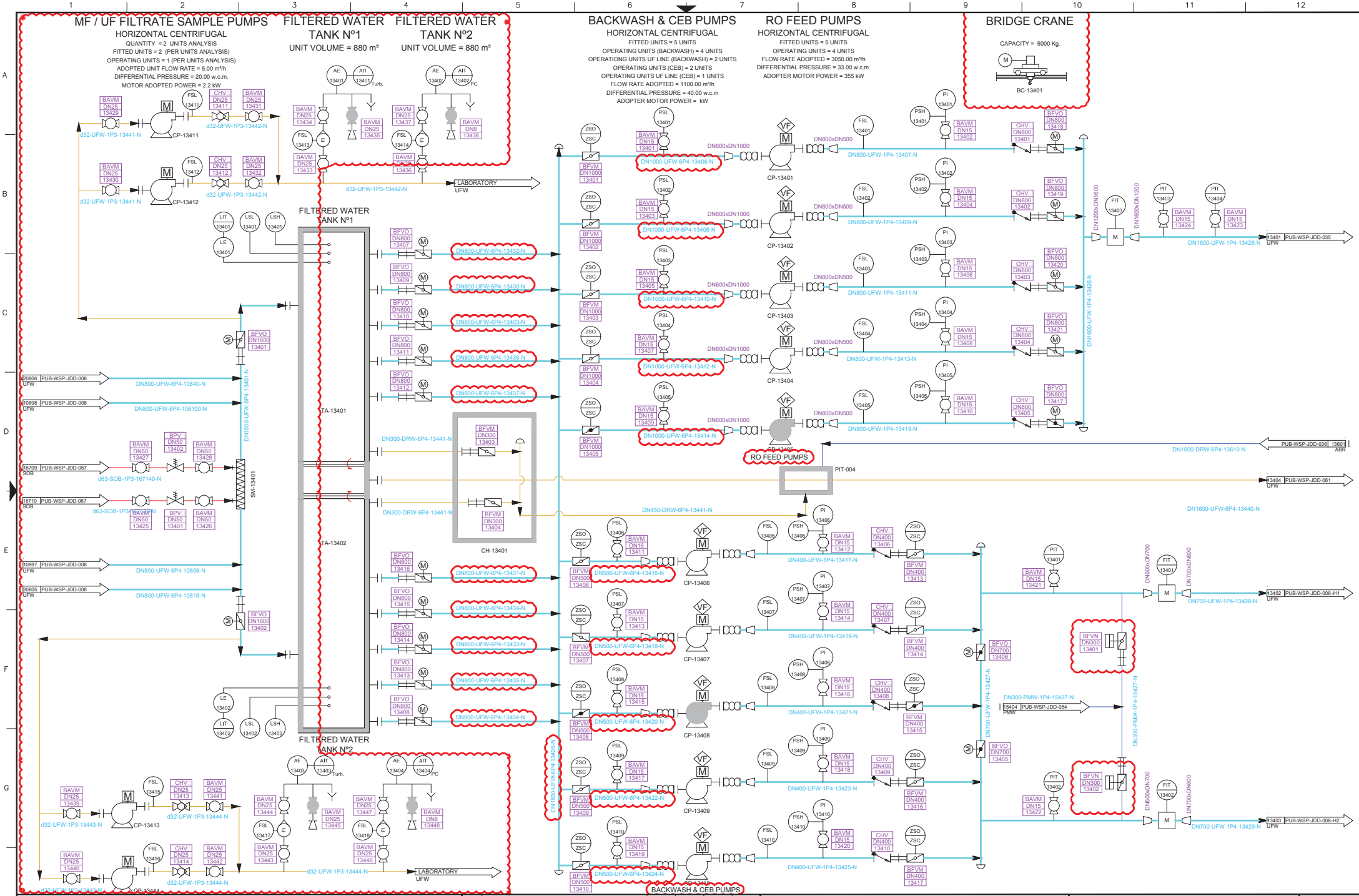
REFERENCE :
TDI-P-15-60

DRAWING Nº :
PUB-WSP-JDD-033

FORMAT A1

SHEET 1 OF 1

DIN A1 (841 x 594)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 46

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

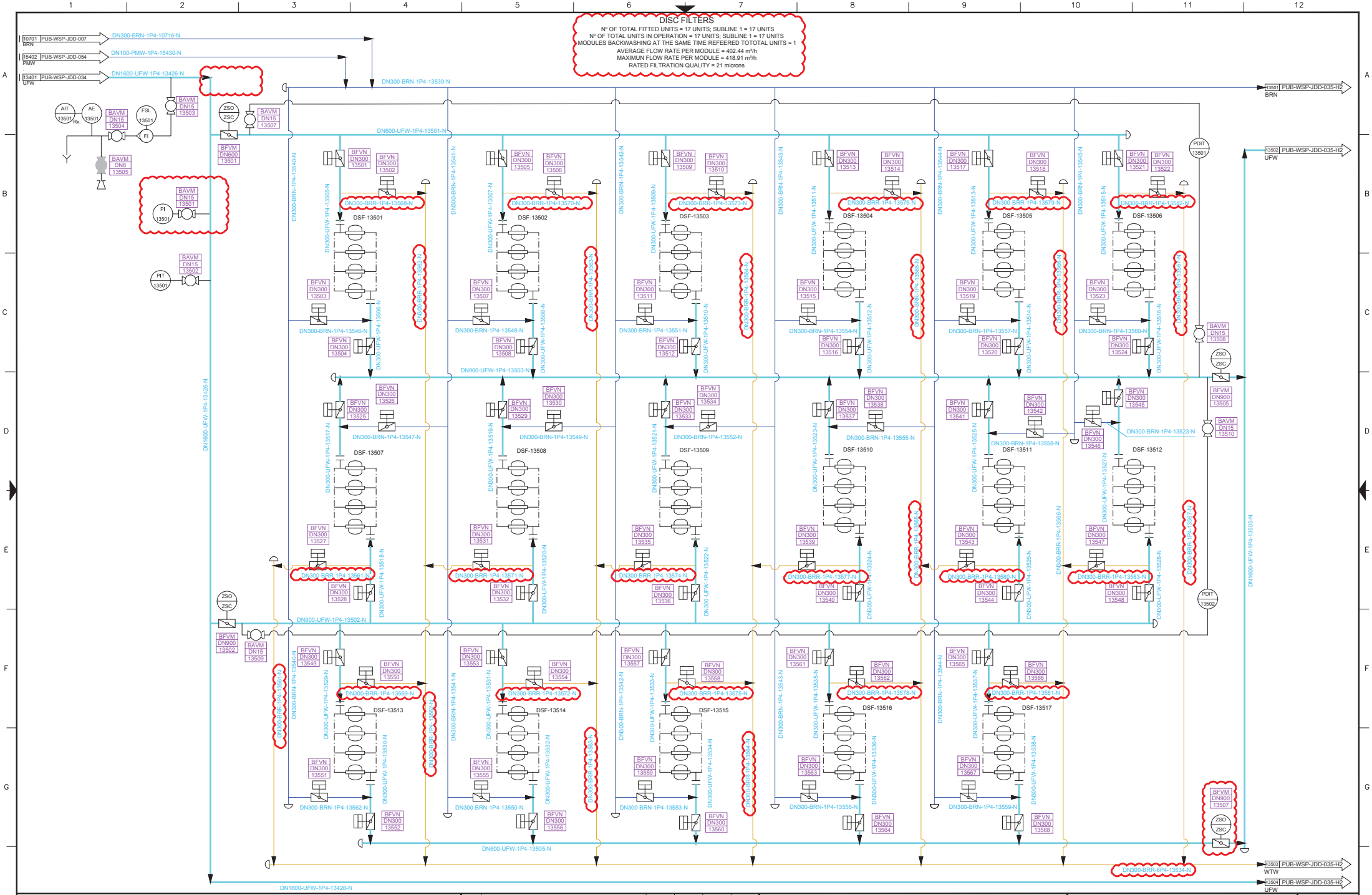
PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
FILTERED WATER TANKS

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-034

FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 46

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

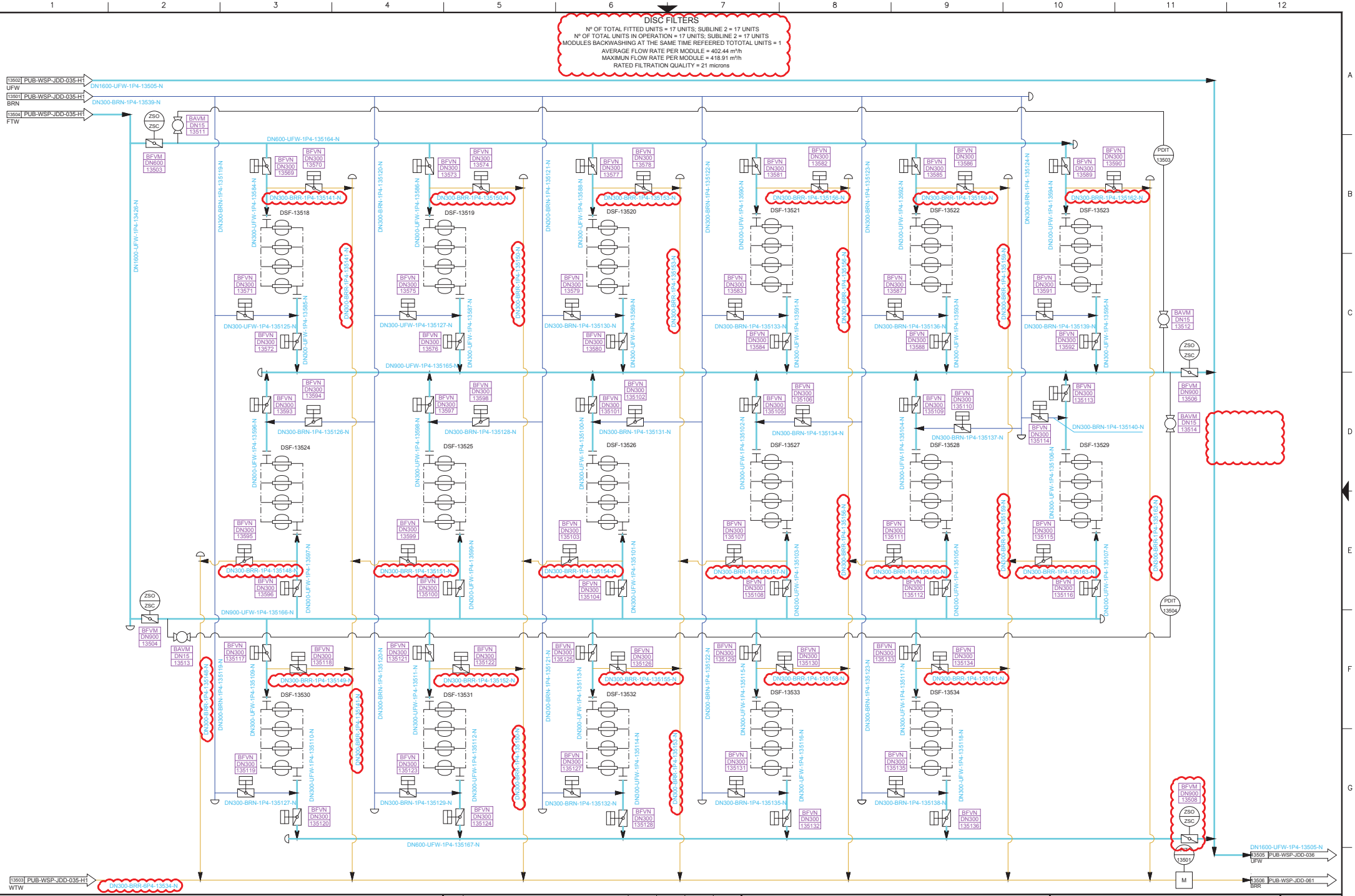
PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
RO PROTECTION FILTERS I

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-035

FORMAT A1 | SHEET 1 OF 2

DIN A1 (841 x 594)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 46

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
RO PROTECTION FILTERS II

REFERENCE : TDI-P-15-60

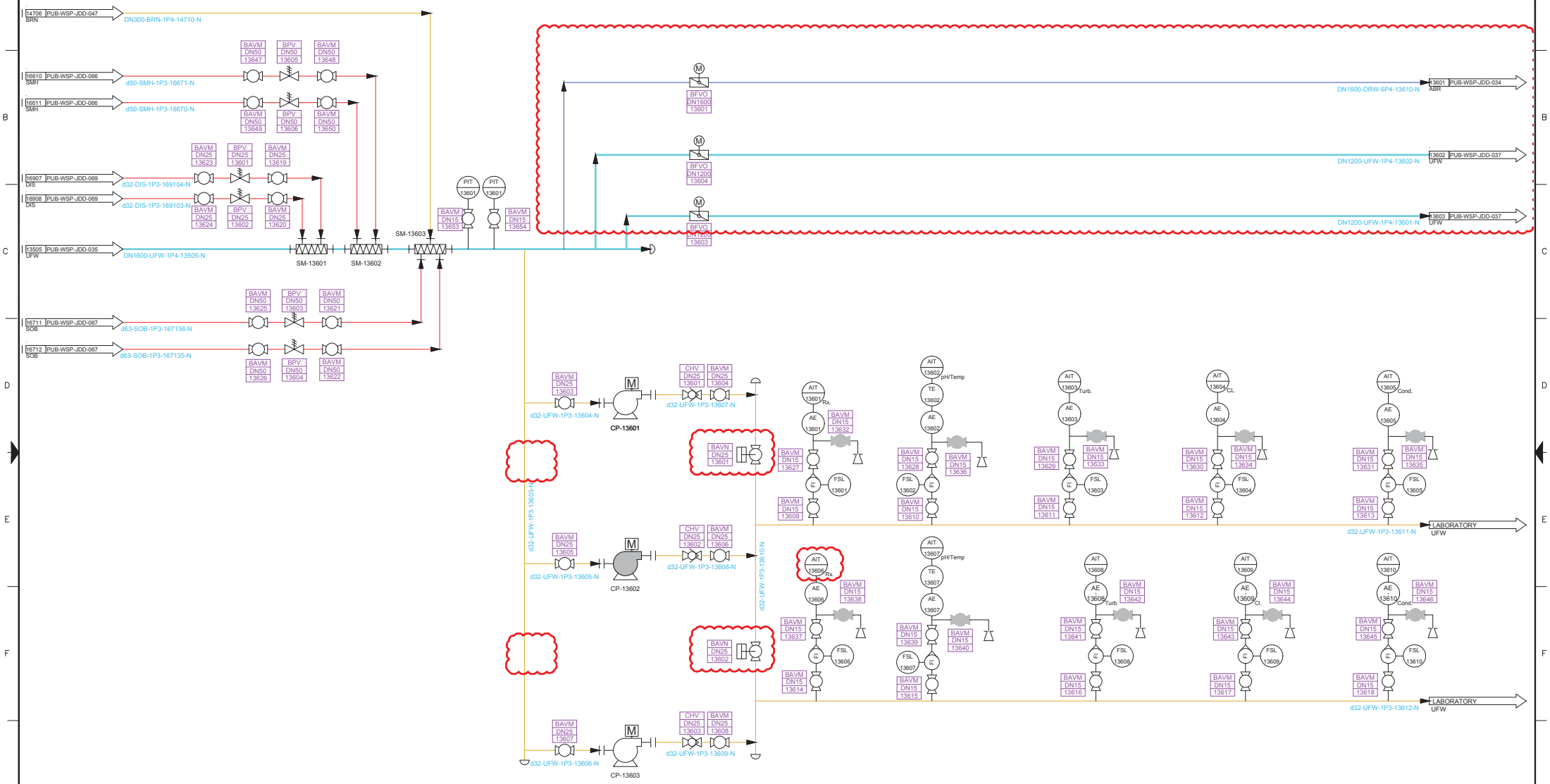
DRAWING Nº : PUB-WSP-JDD-035

FORMAT A1 | SHEET 2 OF 2

DIN A1 (841 x 594)

RO DISC FILTER SAMPLE PUMPS

FITTED UNITS = 3 UNITS
OPERATING UNITS = 2 UNITS
FLOW RATE ADOPTED = 5.00 m³/h
DIFFERENTIAL PRESSURE = 20.00 w.c.m.
ADOPTED MOTOR POWER = 2.2 kW



NOTES :
- THIS SHEET CORREPONSE TO AREA: 46

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
RO PROTECTION FILTERS - SAMPLE PUMPS

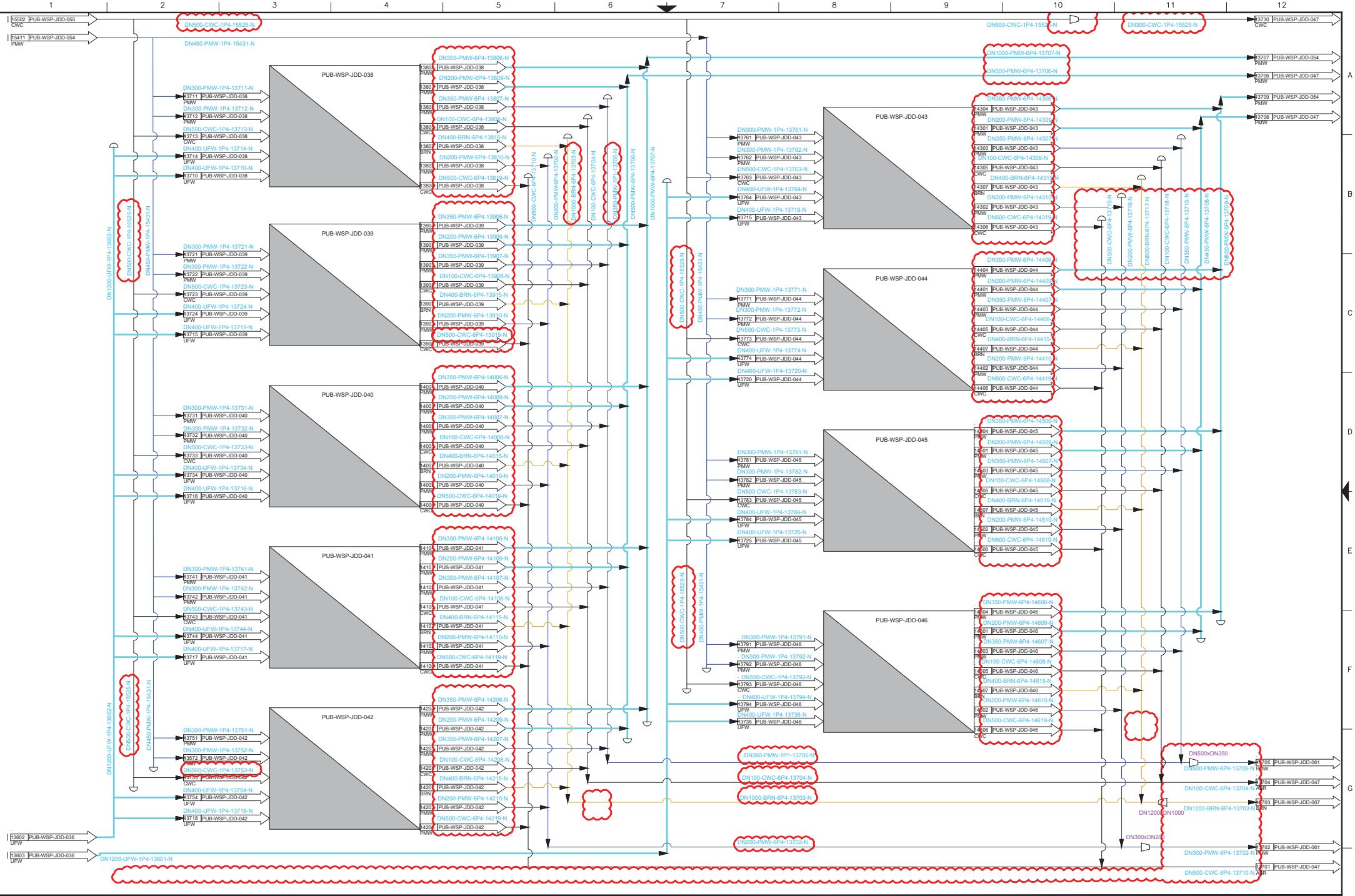
REFERENCE :
TDI-P-15-60

DRAWING Nº :
PUB-WSP-JDD-036

FORMAT
A1

SHEET 1
OF 1

DIN A1 (841 x 594)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 46

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
1st PASS RO. GENERAL DIAGRAM

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-037

FORMAT A1 | SHEET 1 OF 1

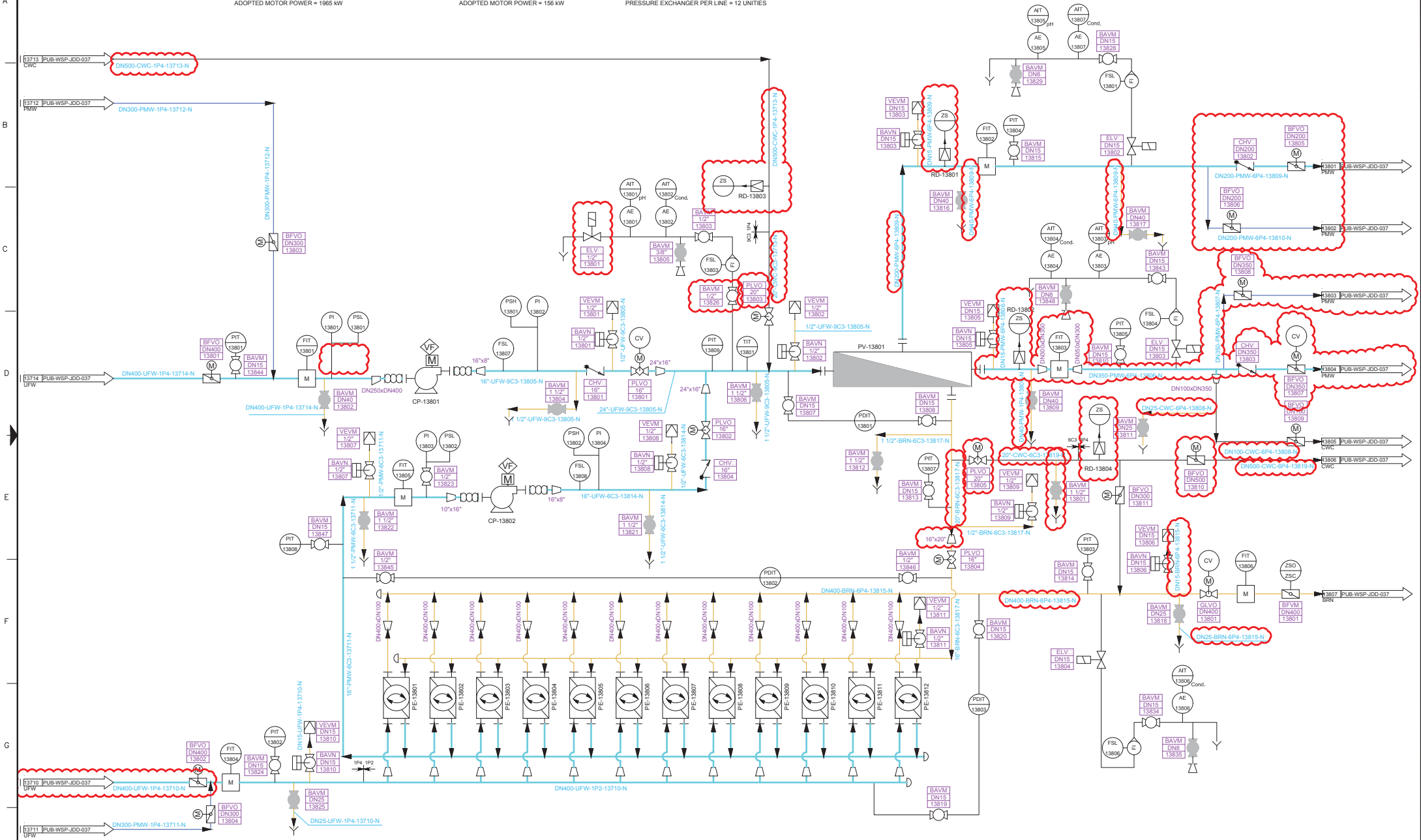
DIN A1 (841 x 594)

HIGH PRESSURE PUMP 1st PASS
HORIZONTAL CENTRIFUGAL
FLOW RATE = 805.00 m³/h
DIFERENTIAL PRESSURE ADOPTED = 65.00 bar
FITTED UNITS = 9 UNITS
OPERATING UNITS = 8 UNITS
ADOPTED MOTOR POWER = 1965 kW

BOOSTER PUMP
HORIZONTAL CENTRIFUGAL
FLOW RATE = 790.00 m³/h
DIFERENTIAL PRESSURE ADOPTED = 4.4 bar
FITTED UNITS = 9 UNITS
OPERATING UNITS = 8 UNITS
ADOPTED MOTOR POWER = 156 kW

ENERGY RECOVERY SYSTEM
ERI PX-Q300
FITTED TRAINS = 9 UNITS
OPERATING UNITS = 8 UNITS
CONCENTRATE FLOW RATE PER LINE = 765.96 m³/h
CONCENTRATE FLOW RATE PER PRESSURE EXCHANGER = 63.69 m³/h
PRESSURE EXCHANGER PER LINE = 12 UNITIES

1st PASS RO SKIDS
FITTED LINES = 9 UNITS
OPERATING LINES = 8 UNITS
164 PRESSURE VESSELS OF 7 ELEMENTS PER RACK (1148 ELEMENTS PER LINE)
MAXIMUM MEMBRANE DESIGN PRESSURE = 68.95 bar (1200 psi)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 46

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
1st PASS RO. RACK 1

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-038

FORMAT A1 | SHEET 1 OF 1

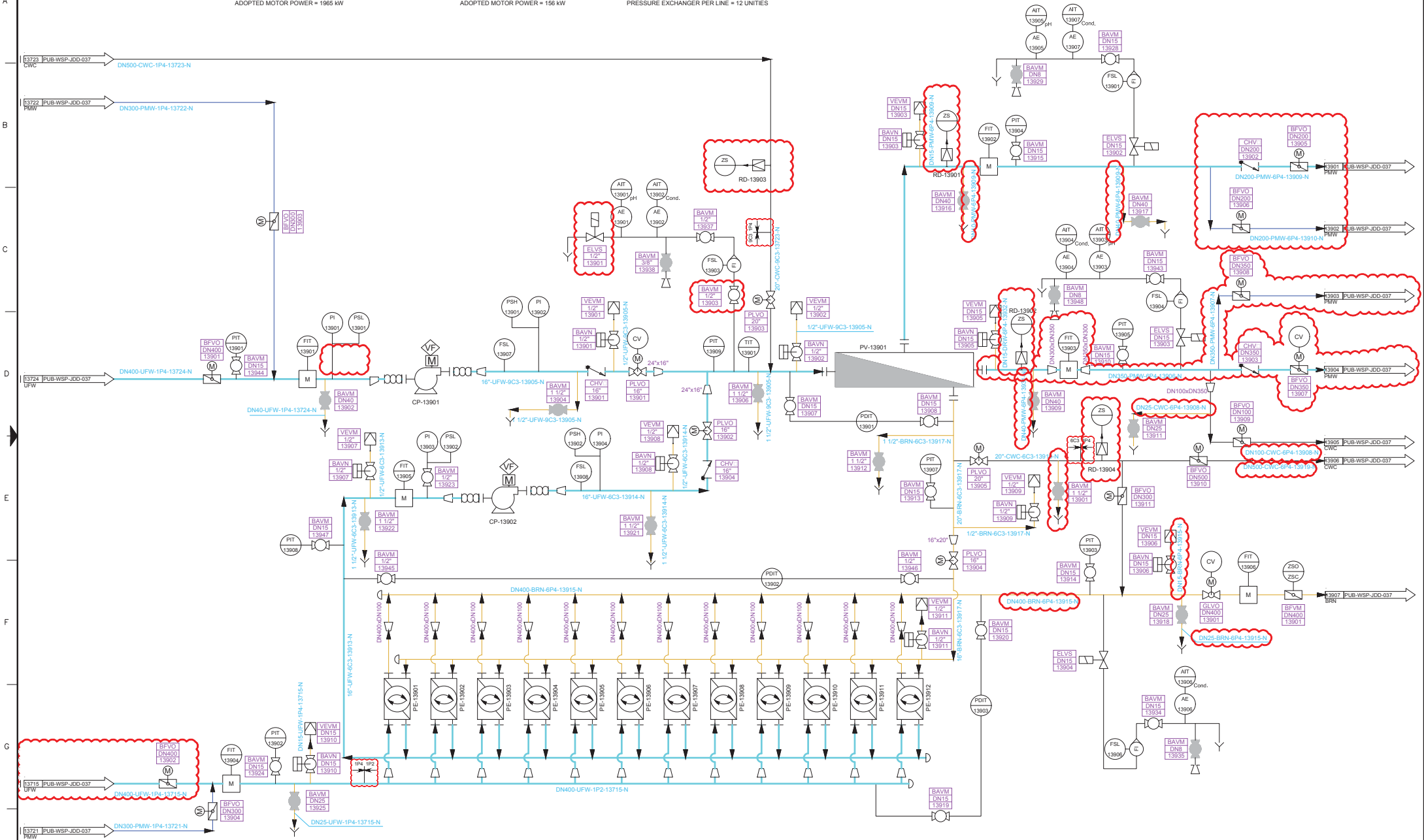
DIN A1 (841 x 594)

HIGH PRESSURE PUMP 1st PASS
HORIZONTAL CENTRIFUGAL
FLOW RATE = 805.00 m³/h
DIFERENTIAL PRESSURE ADOPTED = 65.00 bar
FITTED UNITS = 9 UNITS
OPERATING UNITS = 8 UNITS
ADOPTED MOTOR POWER = 1965 kW

BOOSTER PUMP
HORIZONTAL CENTRIFUGAL
FLOW RATE = 790.00 m³/h
DIFERENTIAL PRESSURE ADOPTED = 4.4 bar
FITTED UNITS = 9 UNITS
OPERATING UNITS = 8 UNITS
ADOPTED MOTOR POWER = 156 kW

ENERGY RECOVERY SYSTEM
ERI PX-Q300
FITTED TRAINS = 9 UNITS
OPERATING UNITS = 8 UNITS
CONCENTRATE FLOW RATE PER LINE = 765.96 m³/h
CONCENTRATE FLOW RATE PER PRESSURE EXCHANGER = 63.69 m³/h
PRESSURE EXCHANGER PER LINE = 12 UNITIES

1st PASS RO SKIDS
FITTED LINES = 9 UNITS
OPERATING LINES = 8 UNITS
164 PRESSURE VESSELS OF 7 ELEMENTS PER RACK (1148 ELEMENTS PER LINE)
MAXIMUM MEMBRANE DESIGN PRESSURE = 68.95 bar (1200 psi)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 46

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
1st PASS RO. RACK 2

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-039

FORMAT A1 | SHEET 1 OF 1

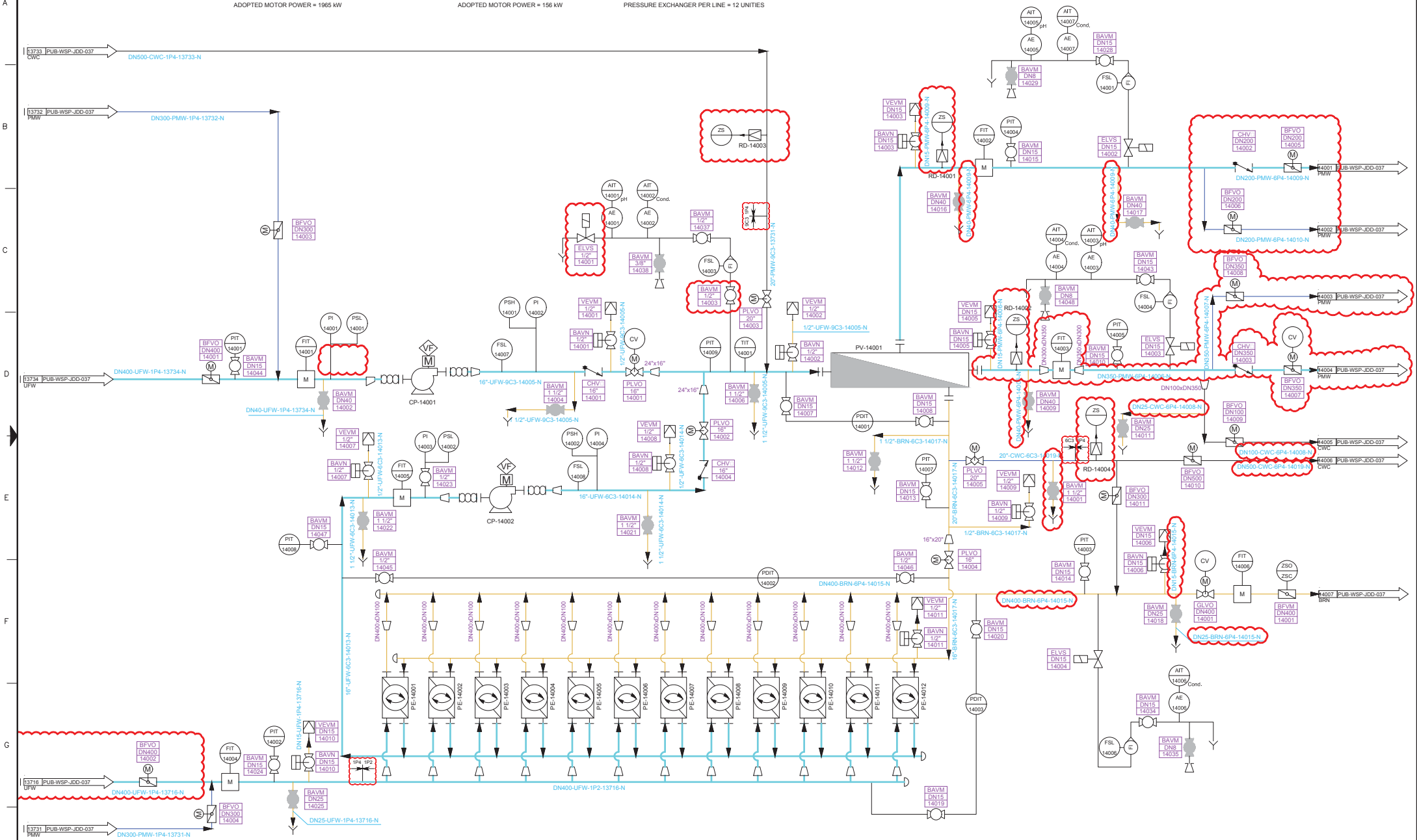
DIN A1 (841 x 594)

HIGH PRESSURE PUMP 1st PASS
HORIZONTAL CENTRIFUGAL
FLOW RATE = 805.00 m³/h
DIFERENTIAL PRESSURE ADOPTED = 65.00 bar
FITTED UNITS = 9 UNITS
OPERATING UNITS = 8 UNITS
ADOPTED MOTOR POWER = 1965 kW

BOOSTER PUMP
HORIZONTAL CENTRIFUGAL
FLOW RATE = 790.00 m³/h
DIFERENTIAL PRESSURE ADOPTED = 4.4 bar
FITTED UNITS = 9 UNITS
OPERATING UNITS = 8 UNITS
ADOPTED MOTOR POWER = 156 kW

ENERGY RECOVERY SYSTEM
ERI PX-Q300
FITTED TRAINS = 9 UNITS
OPERATING UNITS = 8 UNITS
CONCENTRATE FLOW RATE PER LINE = 765.96 m³/h
CONCENTRATE FLOW RATE PER PRESSURE EXCHANGER = 63.69 m³/h
PRESSURE EXCHANGER PER LINE = 12 UNITIES

1st PASS RO SKIDS
FITTED LINES = 9 UNITS
OPERATING LINES = 8 UNITS
164 PRESSURE VESSELS OF 7 ELEMENTS PER RACK (1148 ELEMENTS PER LINE)
MAXIMUM MEMBRANE DESIGN PRESSURE = 68.95 bar (1200 psi)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 46

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
1st PASS RO. RACK 3

REFERENCE :
TDI-P-15-60

DRAWING Nº :
PUB-WSP-JDD-040

FORMAT
A1

SHEET 1 OF 1

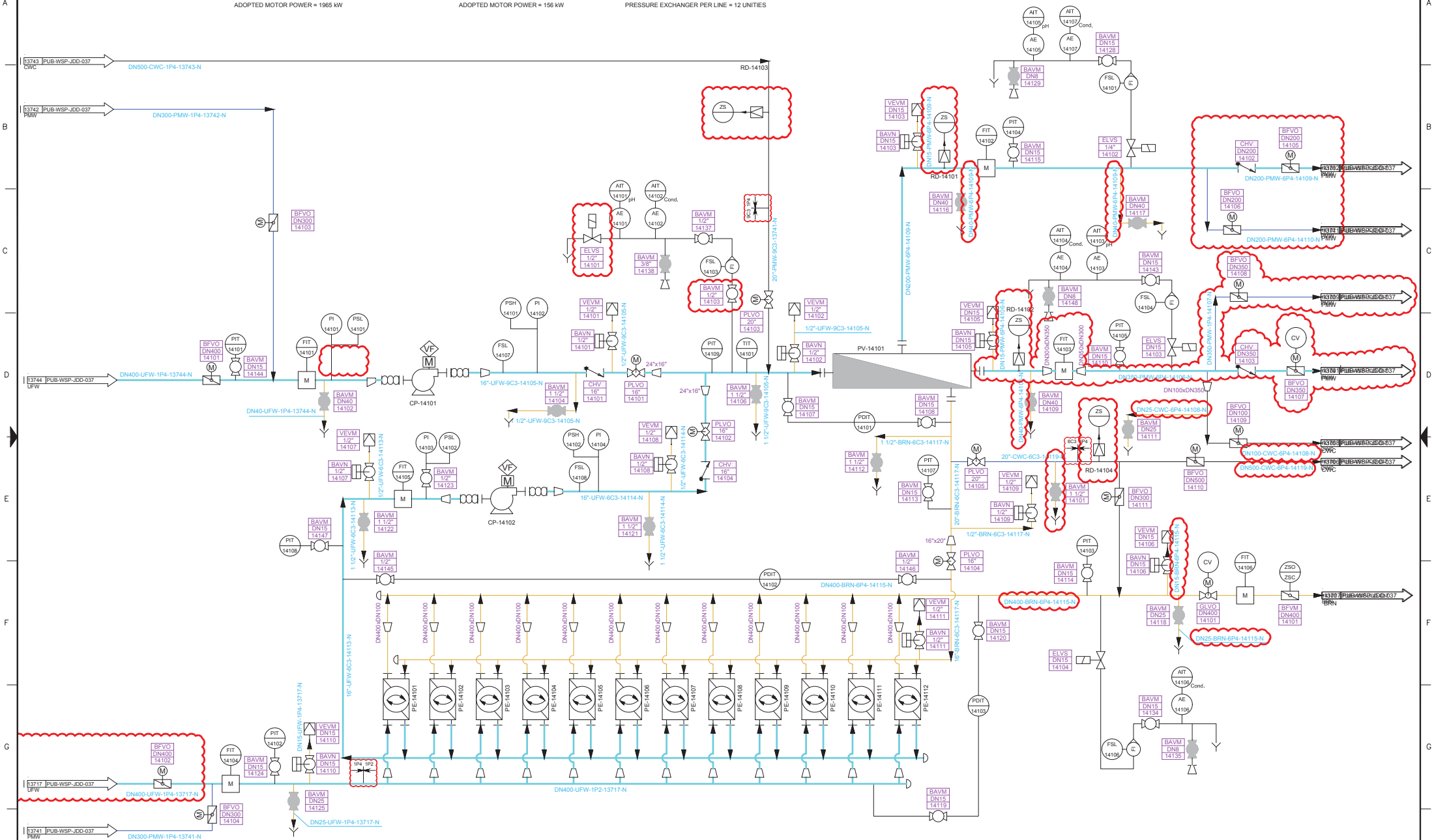
DIN A1 (841 x 594)

HIGH PRESSURE PUMP 1st PASS
HORIZONTAL CENTRIFUGAL
FLOW RATE = 805.00 m³/h
DIFERENTIAL PRESSURE ADOPTED = 65.00 bar
FITTED UNITS = 9 UNITS
OPERATING UNITS = 8 UNITS
ADOPTED MOTOR POWER = 1965 kW

BOOSTER PUMP
HORIZONTAL CENTRIFUGAL
FLOW RATE = 790.00 m³/h
DIFERENTIAL PRESSURE ADOPTED = 4.4 bar
FITTED UNITS = 9 UNITS
OPERATING UNITS = 8 UNITS
ADOPTED MOTOR POWER = 156 kW

ENERGY RECOVERY SYSTEM
ERI PX-Q300
FITTED TRAINS = 9 UNITS
OPERATING UNITS = 8 UNITS
CONCENTRATE FLOW RATE PER LINE = 765.96 m³/h
CONCENTRATE FLOW RATE PER PRESSURE EXCHANGER = 63.69 m³/h
PRESSURE EXCHANGER PER LINE = 12 UNITIES

1st PASS RO SKIDS
FITTED LINES = 9 UNITS
OPERATING LINES = 8 UNITS
164 PRESSURE VESSELS OF 7 ELEMENTS PER RACK (1148 ELEMENTS PER LINE)
MAXIMUM MEMBRANE DESIGN PRESSURE = 68.95 bar (1200 psi)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 46

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
1st PASS RO. RACK 4

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-041

FORMAT A1 | SHEET 1 OF 1

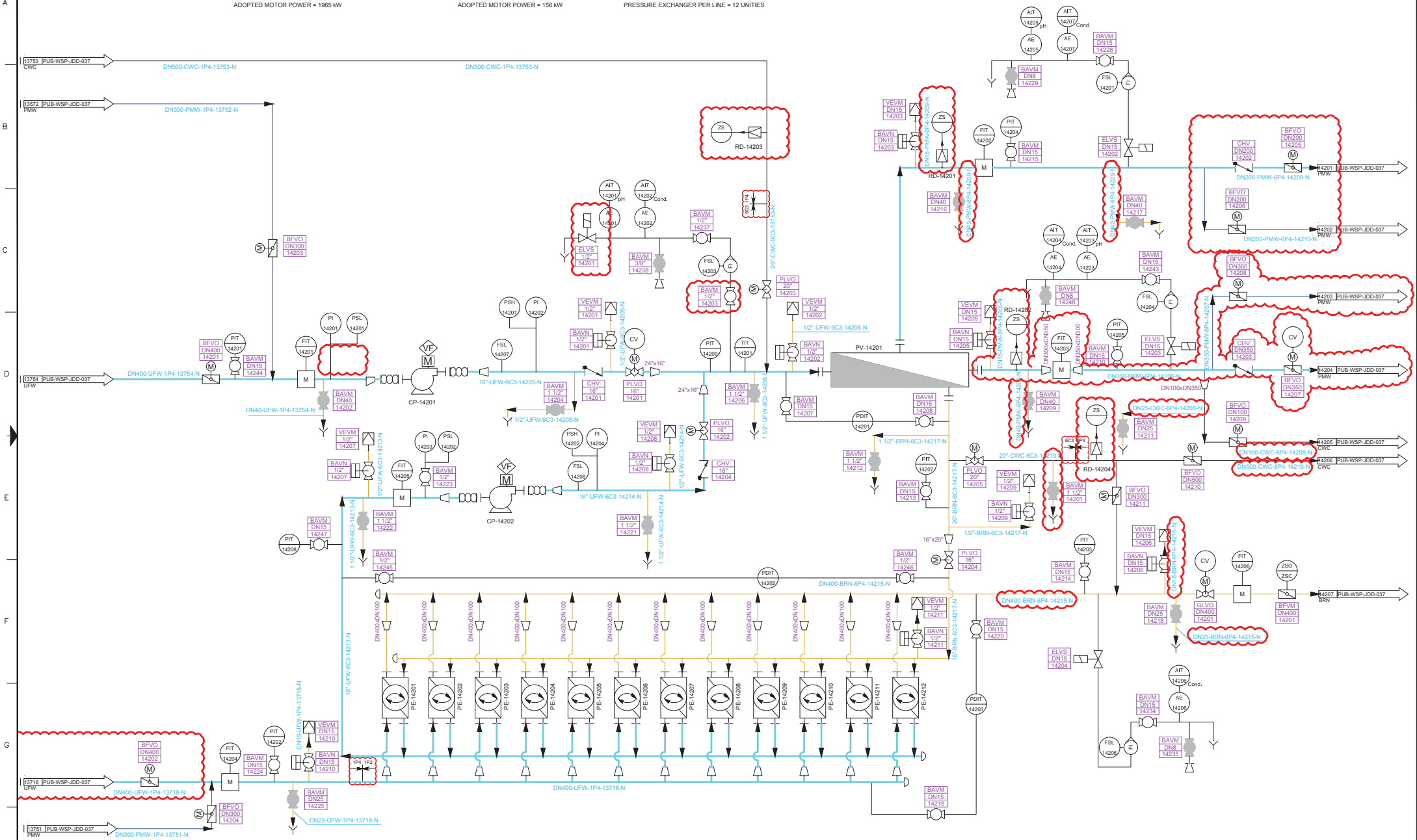
DIN A1 (841 x 594)

HIGH PRESSURE PUMP 1st PASS
HORIZONTAL CENTRIFUGAL
FLOW RATE = 805.00 m³/h
DIFERENTIAL PRESSURE ADOPTED = 65.00 bar
FITTED UNITS = 9 UNITS
OPERATING UNITS = 8 UNITS
ADOPTED MOTOR POWER = 1965 kW

BOOSTER PUMP
HORIZONTAL CENTRIFUGAL
FLOW RATE = 790.00 m³/h
DIFERENTIAL PRESSURE ADOPTED = 4.4 bar
FITTED UNITS = 9 UNITS
OPERATING UNITS = 8 UNITS
ADOPTED MOTOR POWER = 156 kW

ENERGY RECOVERY SYSTEM
ERI PX-Q300
FITTED TRAINS = 9 UNITS
OPERATING UNITS = 8 UNITS
CONCENTRATE FLOW RATE PER LINE = 765.96 m³/h
CONCENTRATE FLOW RATE PER PRESSURE EXCHANGER = 63.69 m³/h
PRESSURE EXCHANGER PER LINE = 12 UNITIES

1st PASS RO SKIDS
FITTED LINES = 9 UNITS
OPERATING LINES = 8 UNITS
164 PRESSURE VESSELS OF 7 ELEMENTS PER RACK (1148 ELEMENTS PER LINE)
MAXIMUM MEMBRANE DESIGN PRESSURE = 68.95 bar (1200 psi)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 46

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
1st PASS RO. RACK 5

REFERENCE :
TDI-P-15-60

DRAWING Nº :
PUB-WSP-JDD-042

FORMAT
A1

SHEET 1
OF 1

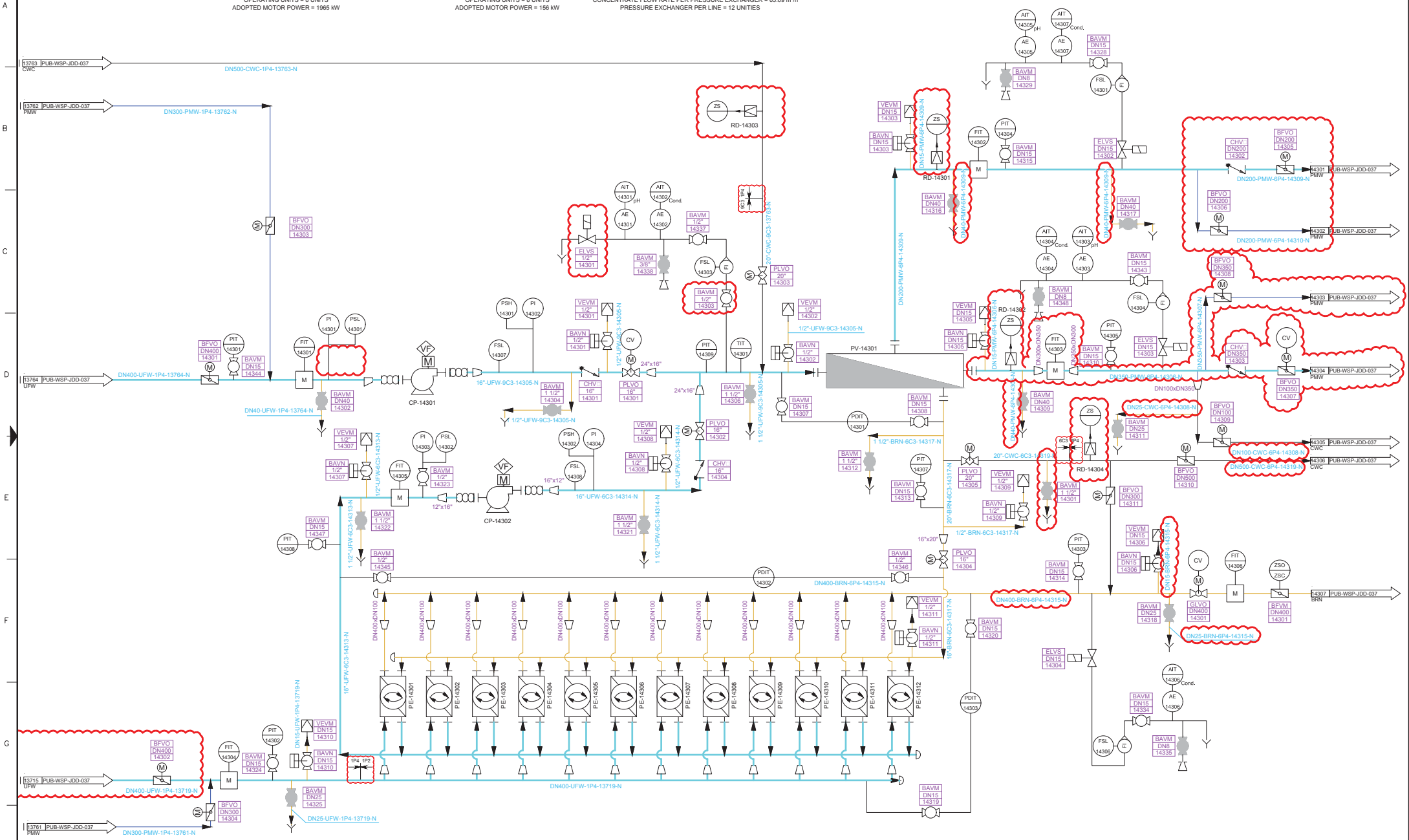
DIN A1 (841 x 594)

HIGH PRESSURE PUMP 1st PASS
HORIZONTAL CENTRIFUGAL
FLOW RATE = 805.00 m³/h
DIFERENTIAL PRESSURE ADOPTED = 65.00 bar
FITTED UNITS = 9 UNITS
OPERATING UNITS = 8 UNITS
ADOPTED MOTOR POWER = 1965 kW

BOOSTER PUMP
HORIZONTAL CENTRIFUGAL
FLOW RATE = 790.00 m³/h
DIFERENTIAL PRESSURE ADOPTED = 4.4 bar
FITTED UNITS = 9 UNITS
OPERATING UNITS = 8 UNITS
ADOPTED MOTOR POWER = 156 kW

ENERGY RECOVERY SYSTEM
ERI PX-Q300
FITTED TRAINS = 9 UNITS
OPERATING UNITS = 8 UNITS
CONCENTRATE FLOW RATE PER LINE = 765.96 m³/h
CONCENTRATE FLOW RATE PER PRESSURE EXCHANGER = 63.69 m³/h
PRESSURE EXCHANGER PER LINE = 12 UNITIES

1st PASS RO SKIDS
FITTED LINES = 9 UNITS
OPERATING LINES = 8 UNITS
164 PRESSURE VESSELS OF 7 ELEMENTS PER RACK (1148 ELEMENTS PER LINE)
MAXIMUM MEMBRANE DESIGN PRESSURE = 68.95 bar (1200 psi)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 46

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
1st PASS RO. RACK 6

REFERENCE :
TDI-P-15-60

DRAWING N° :
PUB-WSP-JDD-043

FORMAT
A1

SHEET 1 OF 1

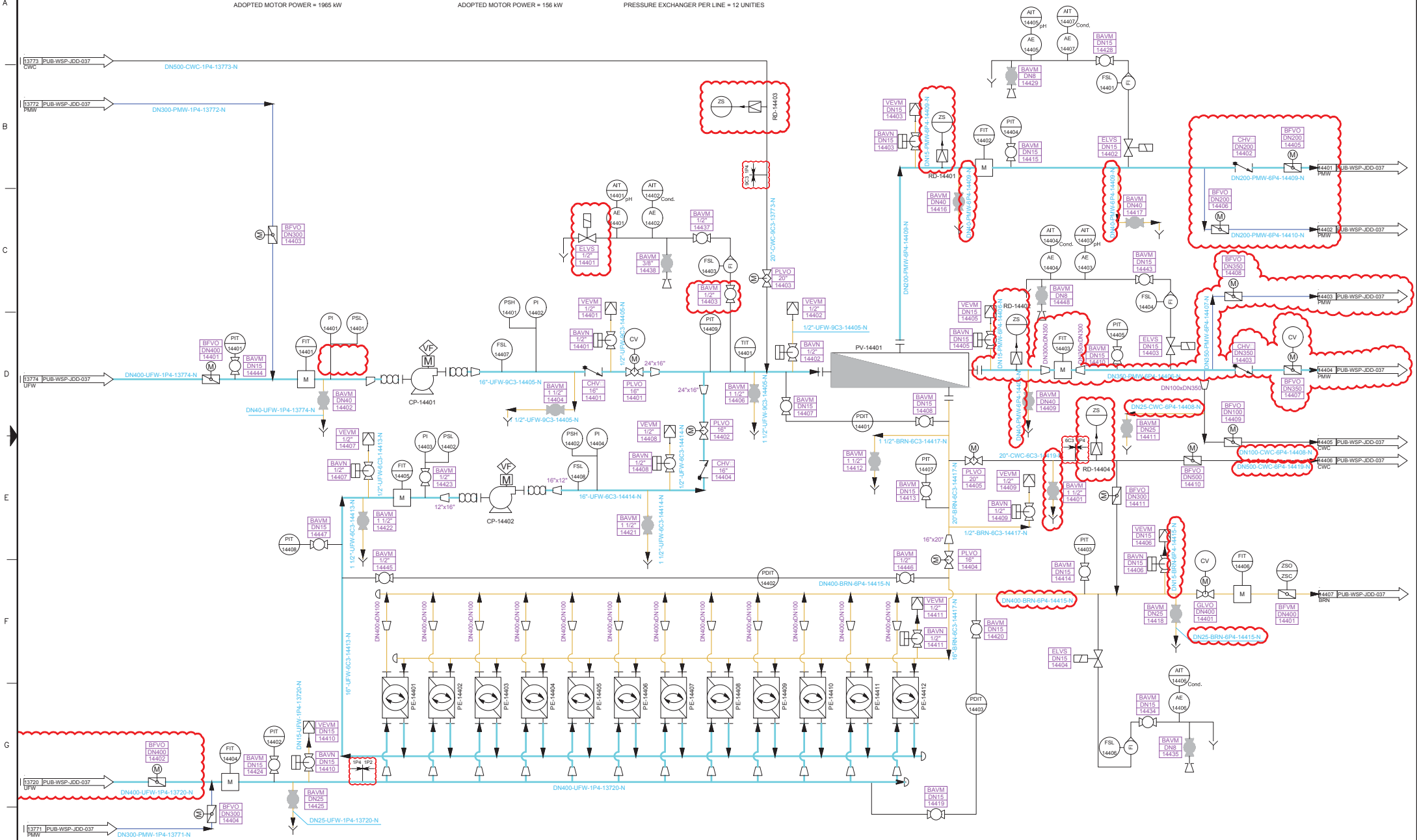
DIN A1 (841 x 594)

HIGH PRESSURE PUMP 1st PASS
HORIZONTAL CENTRIFUGAL
FLOW RATE = 805.00 m³/h
DIFERENTIAL PRESSURE ADOPTED = 65.00 bar
FITTED UNITS = 9 UNITS
OPERATING UNITS = 8 UNITS
ADOPTED MOTOR POWER = 1965 kW

BOOSTER PUMP
HORIZONTAL CENTRIFUGAL
FLOW RATE = 790.00 m³/h
DIFERENTIAL PRESSURE ADOPTED = 4.4 bar
FITTED UNITS = 9 UNITS
OPERATING UNITS = 8 UNITS
ADOPTED MOTOR POWER = 156 kW

ENERGY RECOVERY SYSTEM
ERI PX-Q300
FITTED TRAINS = 9 UNITS
OPERATING UNITS = 8 UNITS
CONCENTRATE FLOW RATE PER LINE = 765.96 m³/h
CONCENTRATE FLOW RATE PER PRESSURE EXCHANGER = 63.69 m³/h
PRESSURE EXCHANGER PER LINE = 12 UNITIES

1st PASS RO SKIDS
FITTED LINES = 9 UNITS
OPERATING LINES = 8 UNITS
164 PRESSURE VESSELS OF 7 ELEMENTS PER RACK (1148 ELEMENTS PER LINE)
MAXIMUM MEMBRANE DESIGN PRESSURE = 68.95 bar (1200 psi)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 46

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
1st PASS RO. RACK 7

REFERENCE :
TDI-P-15-60

DRAWING Nº :
PUB-WSP-JDD-044

FORMAT
A1

SHEET 1 OF 1

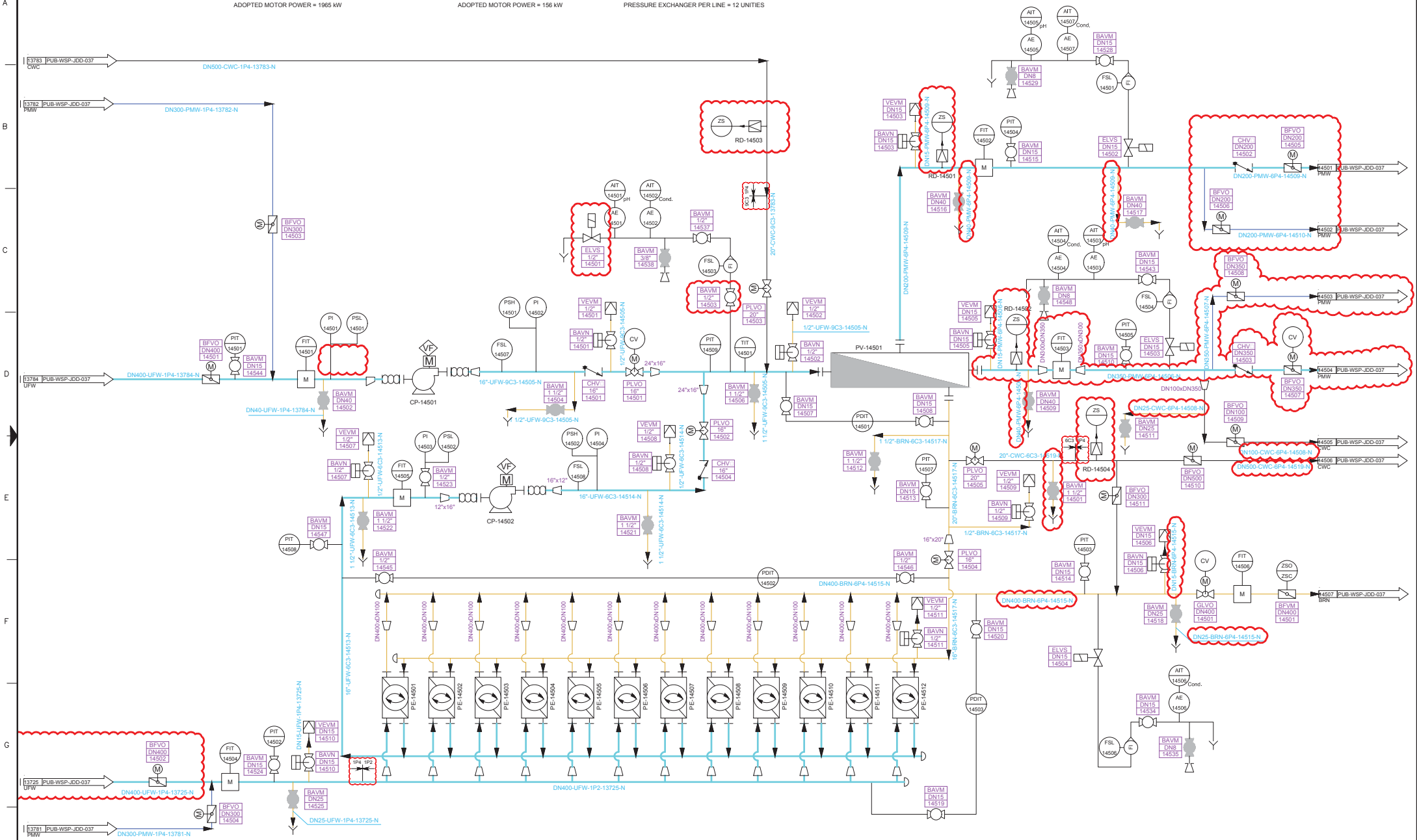
DIN A1 (841 x 594)

HIGH PRESSURE PUMP 1st PASS
HORIZONTAL CENTRIFUGAL
FLOW RATE = 805.00 m³/h
DIFERENTIAL PRESSURE ADOPTED = 65.00 bar
FITTED UNITS = 9 UNITS
OPERATING UNITS = 8 UNITS
ADOPTED MOTOR POWER = 1965 kW

BOOSTER PUMP
HORIZONTAL CENTRIFUGAL
FLOW RATE = 790.00 m³/h
DIFERENTIAL PRESSURE ADOPTED = 4.4 bar
FITTED UNITS = 9 UNITS
OPERATING UNITS = 8 UNITS
ADOPTED MOTOR POWER = 156 kW

ENERGY RECOVERY SYSTEM
ERI PX-Q300
FITTED TRAINS = 9 UNITS
OPERATING UNITS = 8 UNITS
CONCENTRATE FLOW RATE PER LINE = 765.96 m³/h
CONCENTRATE FLOW RATE PER PRESSURE EXCHANGER = 63.69 m³/h
PRESSURE EXCHANGER PER LINE = 12 UNITIES

1st PASS RO SKIDS
FITTED LINES = 9 UNITS
OPERATING LINES = 8 UNITS
164 PRESSURE VESSELS OF 7 ELEMENTS PER RACK (1148 ELEMENTS PER LINE)
MAXIMUM MEMBRANE DESIGN PRESSURE = 68.95 bar (1200 psi)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 46

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
1st PASS RO. RACK 8

REFERENCE :
TDI-P-15-60

DRAWING Nº :
PUB-WSP-JDD-045

FORMAT
A1

SHEET 1 OF 1

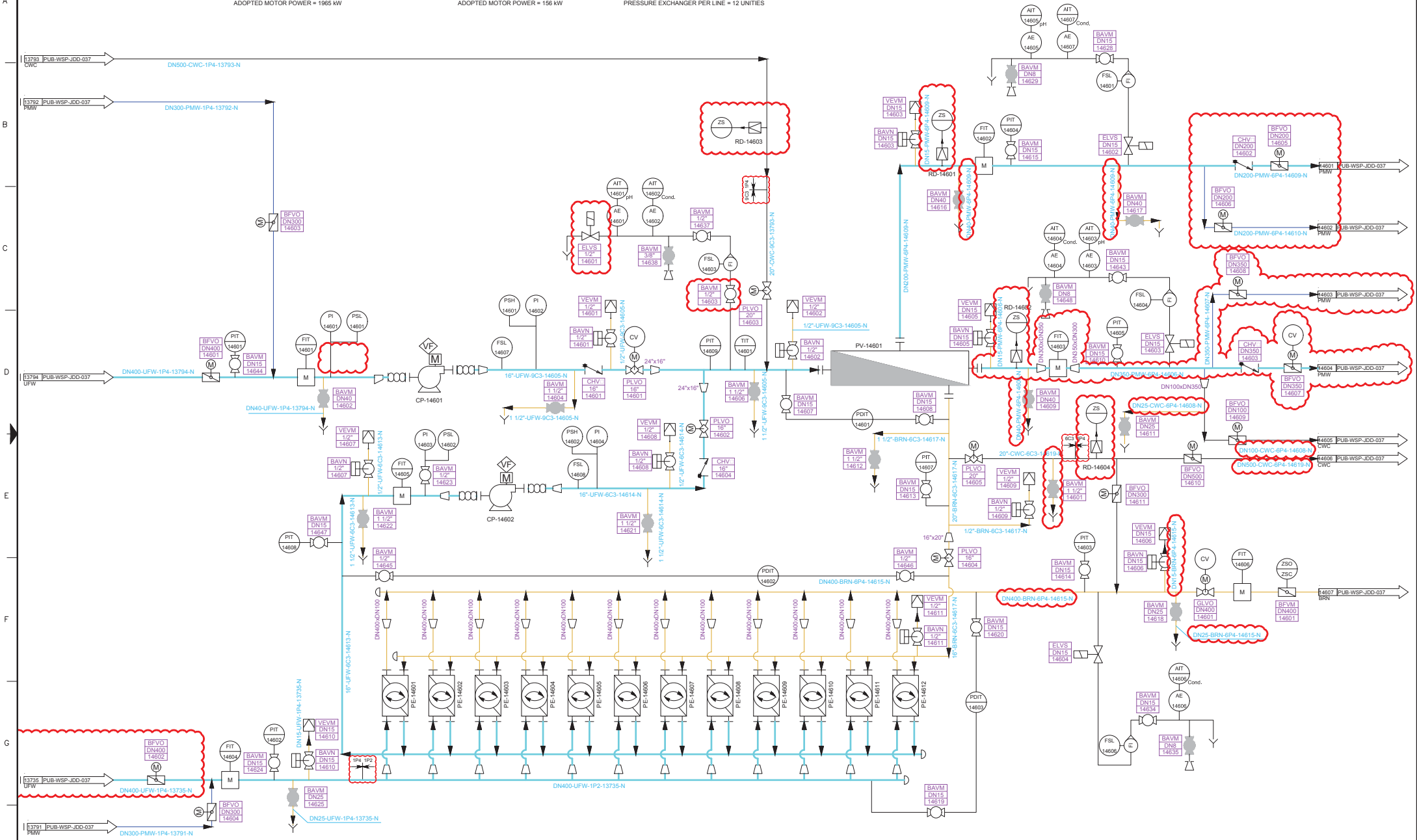
DIN A1 (841 x 594)

HIGH PRESSURE PUMP 1st PASS
HORIZONTAL CENTRIFUGAL
FLOW RATE = 805.00 m³/h
DIFERENTIAL PRESSURE ADOPTED = 65.00 bar
FITTED UNITS = 9 UNITS
OPERATING UNITS = 8 UNITS
ADOPTED MOTOR POWER = 1965 kW

BOOSTER PUMP
HORIZONTAL CENTRIFUGAL
FLOW RATE = 790.00 m³/h
DIFERENTIAL PRESSURE ADOPTED = 4.4 bar
FITTED UNITS = 9 UNITS
OPERATING UNITS = 8 UNITS
ADOPTED MOTOR POWER = 156 kW

ENERGY RECOVERY SYSTEM
ERI PX-Q300
FITTED TRAINS = 9 UNITS
OPERATING UNITS = 8 UNITS
CONCENTRATE FLOW RATE PER LINE = 765.96 m³/h
CONCENTRATE FLOW RATE PER PRESSURE EXCHANGER = 63.69 m³/h
PRESSURE EXCHANGER PER LINE = 12 UNITIES

1st PASS RO SKIDS
FITTED LINES = 9 UNITS
OPERATING LINES = 8 UNITS
164 PRESSURE VESSELS OF 7 ELEMENTS PER RACK (1148 ELEMENTS PER LINE)
MAXIMUM MEMBRANE DESIGN PRESSURE = 68.95 bar (1200 psi)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 46

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
1st PASS RO. RACK 9

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-046

FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)

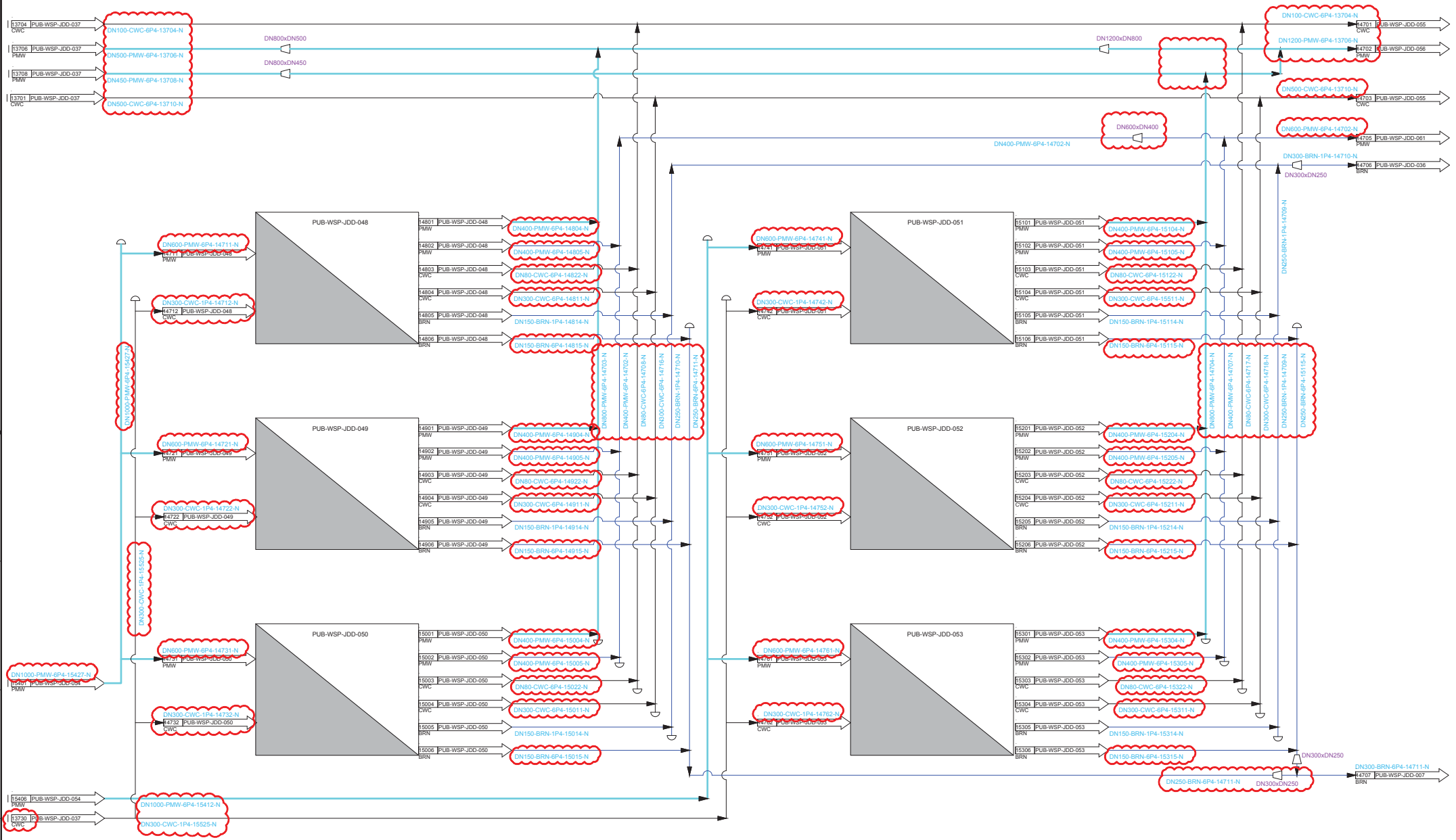
2nd PASS FEED PUMP

HORIZONTAL CENTRIFUGAL

FLOW RATE = 1060.00 m³/h
DIFFERENTIAL PRESSURE ADOPTED = 15.00 bar
FITTED UNITS = 6 UNITS
OPERATING UNITS = 4 UNITS
ADOPTED MOTOR POWER = 630 kW

2nd PASS RO TRAINS

FITTED TRAINS = 6 (4+2) UNITS
1st STAGE - 66 PRESSURE VESSELS OF 7 ELEMENTS PER RACK (462 ELEMENTS PER LINE)
2nd STAGE - 32 PRESSURE VESSELS OF 7 ELEMENTS PER RACK (224 ELEMENTS PER LINE)
PV DESIGN PRESSURE = 20.68 bar (300 psi)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 46

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
2nd PASS RO. GENERAL DIAGRAM

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-047

FORMAT A1 | SHEET 1 OF 1

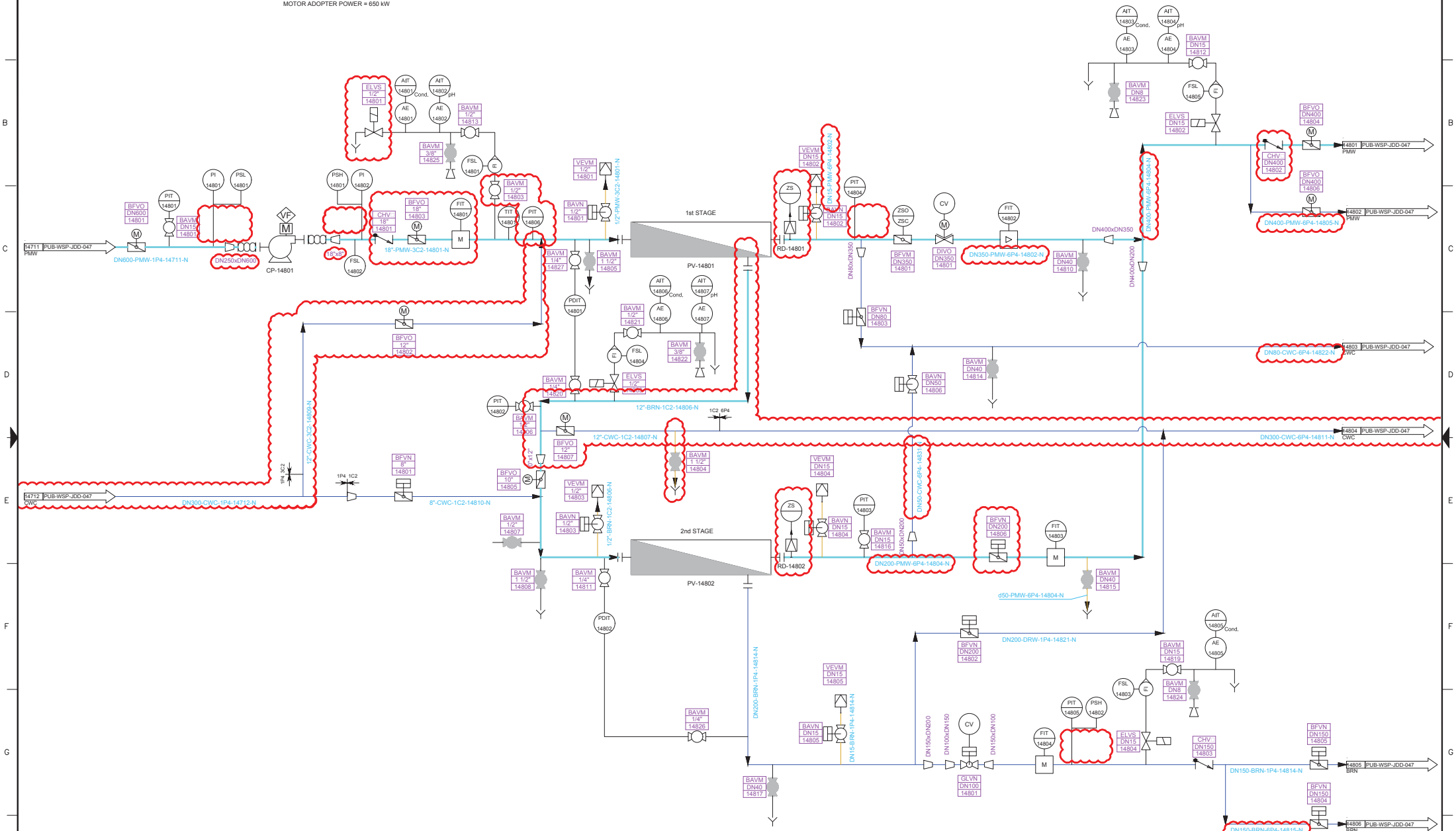
DIN A1 (841 x 594)

2nd PASS FEED PUMPS

HORIZONTAL CENTRIFUGAL
FLOW RATE = 1060.00 m³/h
DIFFERENTIAL PRESSURE ADOPTED = 15.00 bar
FITTED UNITS = 6 UNITS
OPERATING UNITS = 4 UNITS
MOTOR ADOPTER POWER = 650 kW

2nd PASS RO SKIDS

FITTED TRAINS = 6 (4+2) UNITS
1st STAGE - 66 PRESSURE VESSELS OF 7 ELEMENTS PER RACK (462 ELEMENTS PER LINE)
2nd STAGE - 32 PRESSURE VESSELS OF 7 ELEMENTS PER RACK (224 ELEMENTS PER LINE)
MAXIMUM VESSELS DESIGN PRESSURE = 20.68 bar (300 psi)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 46

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

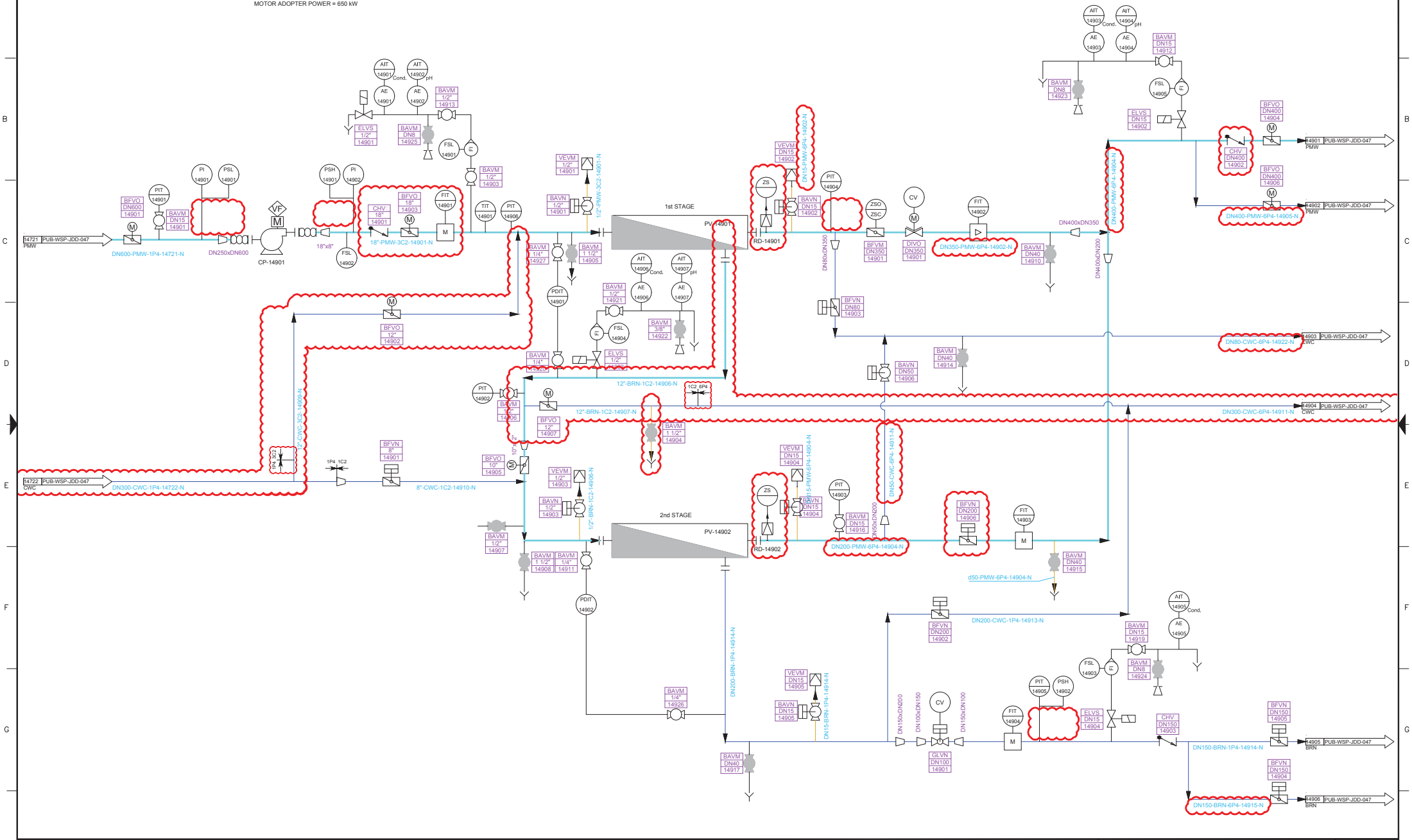
PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
2nd PASS RO. RACK 1

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-048

FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 46

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

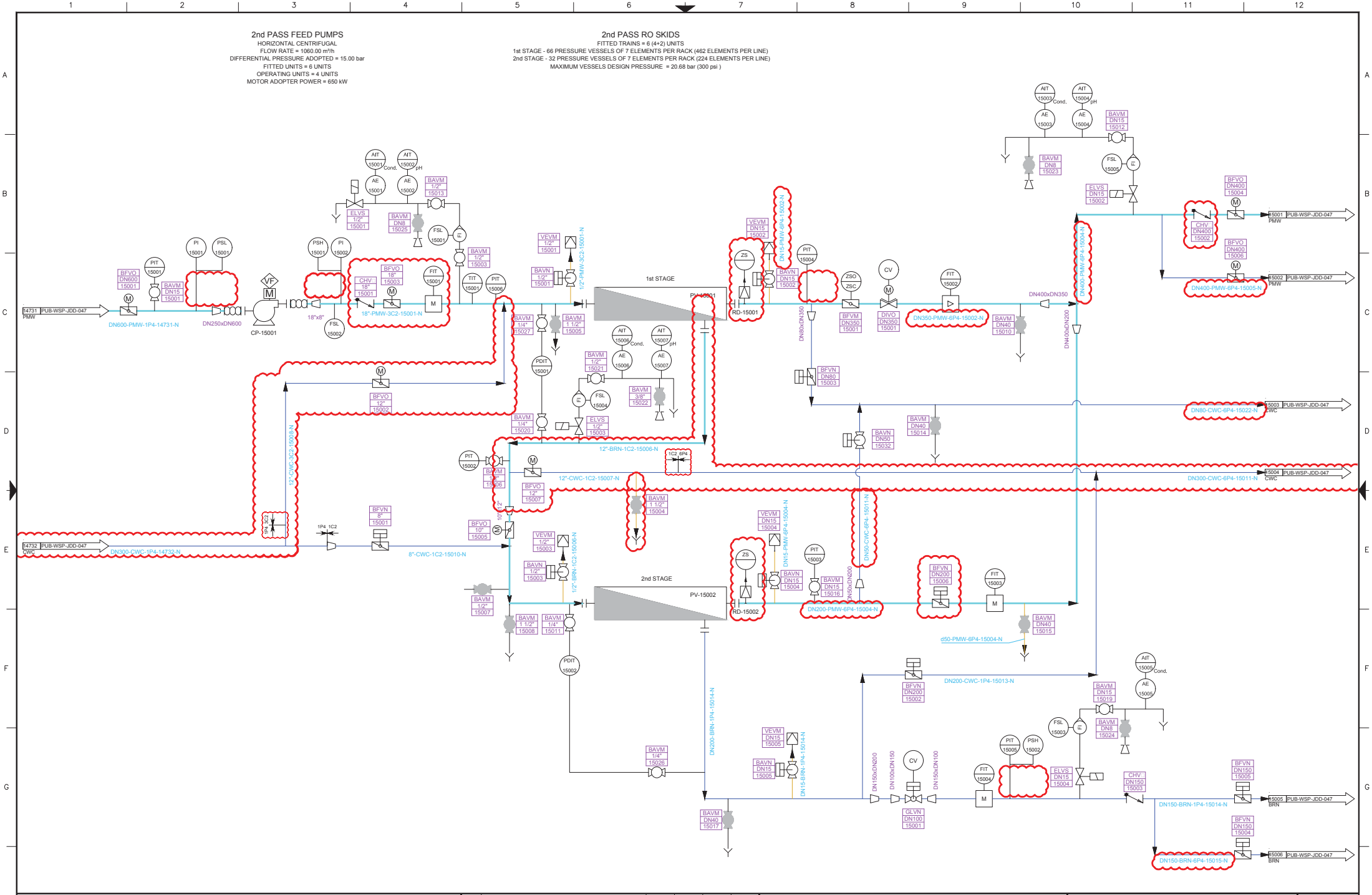
PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
2nd PASS RO. RACK 2

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-049

FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 46

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
2nd PASS RO. RACK 3

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-050

FORMAT A1 | SHEET 1 OF 1

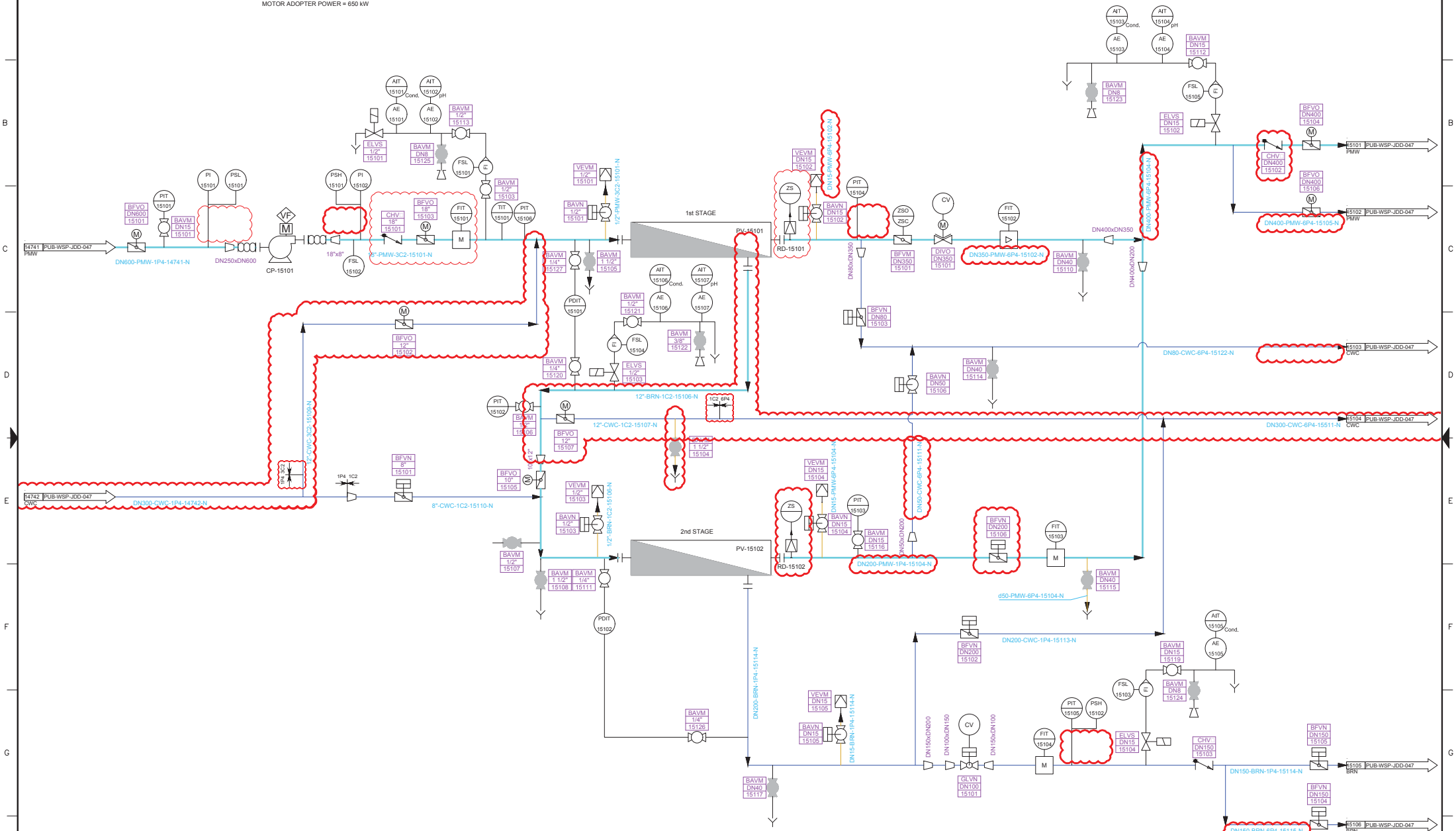
DIN A1 (841 x 594)

2nd PASS FEED PUMPS

HORIZONTAL CENTRIFUGAL
FLOW RATE = 1060.00 m³/h
DIFFERENTIAL PRESSURE ADOPTED = 15.00 bar
FITTED UNITS = 6 UNITS
OPERATING UNITS = 4 UNITS
MOTOR ADOPTER POWER = 650 kW

2nd PASS RO SKIDS

FITTED TRAINS = 6 (4+2) UNITS
1st STAGE - 66 PRESSURE VESSELS OF 7 ELEMENTS PER RACK (462 ELEMENTS PER LINE)
2nd STAGE - 32 PRESSURE VESSELS OF 7 ELEMENTS PER RACK (224 ELEMENTS PER LINE)
MAXIMUM VESSELS DESIGN PRESSURE = 20.68 bar (300 psi)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 46

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
2nd PASS RO. RACK 4

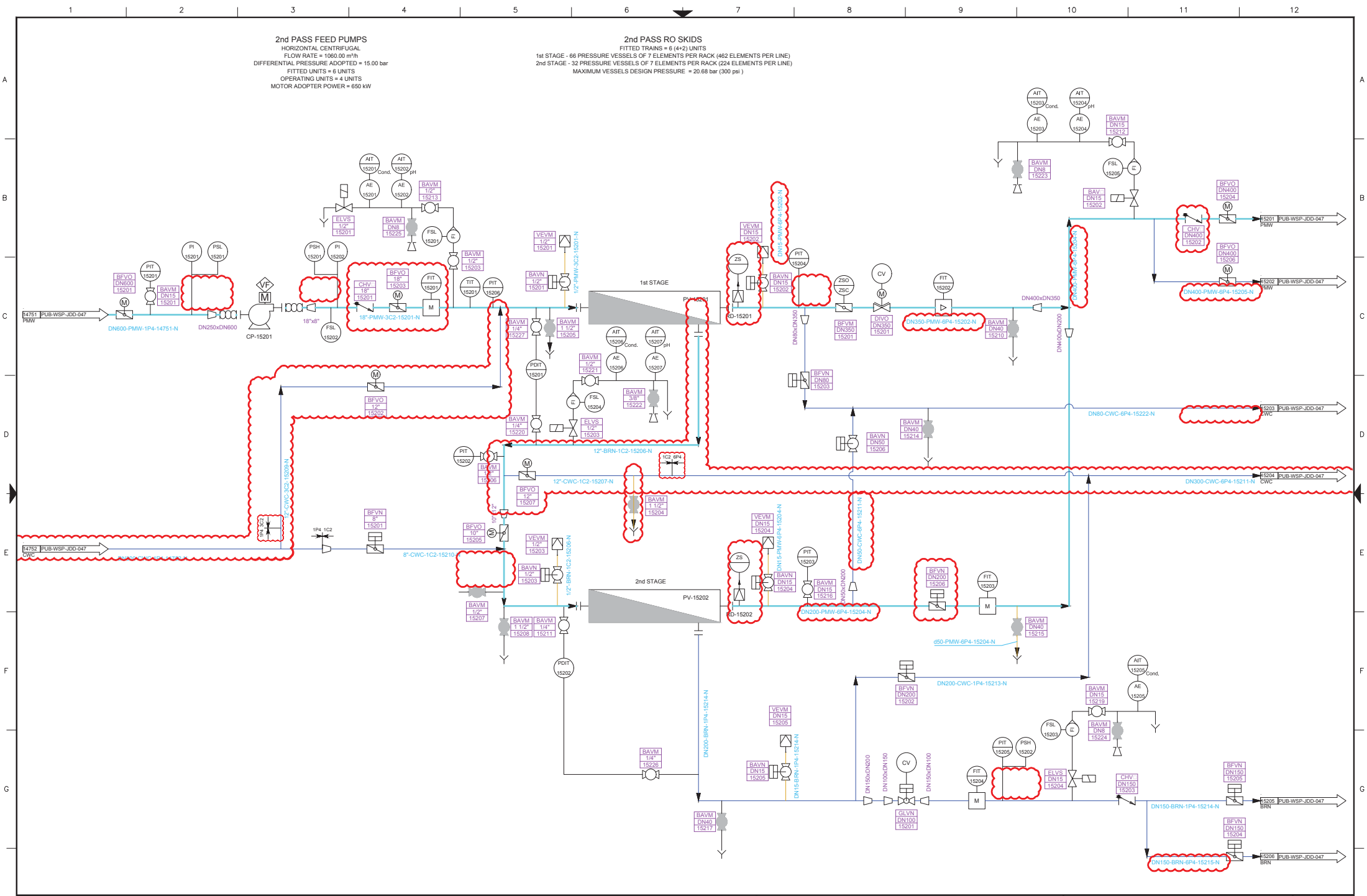
REFERENCE :
TDI-P-15-60

DRAWING Nº :
PUB-WSP-JDD-051

FORMAT
A1

SHEET 1 OF 1

DIN A1 (841 x 594)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 46

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

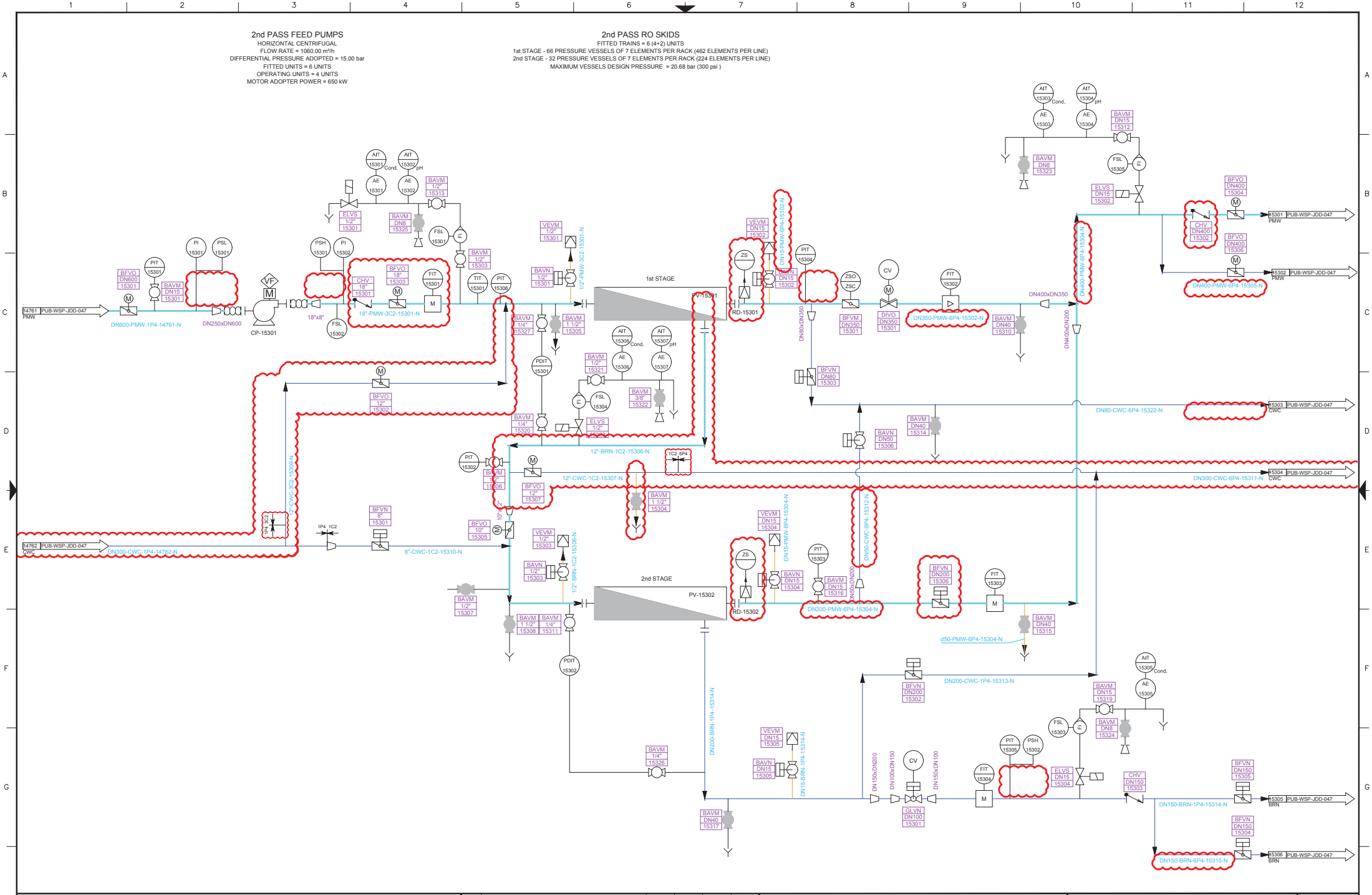
PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
2nd PASS RO. RACK 5

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-052

FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 46

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
2nd PASS RO. RACK 6

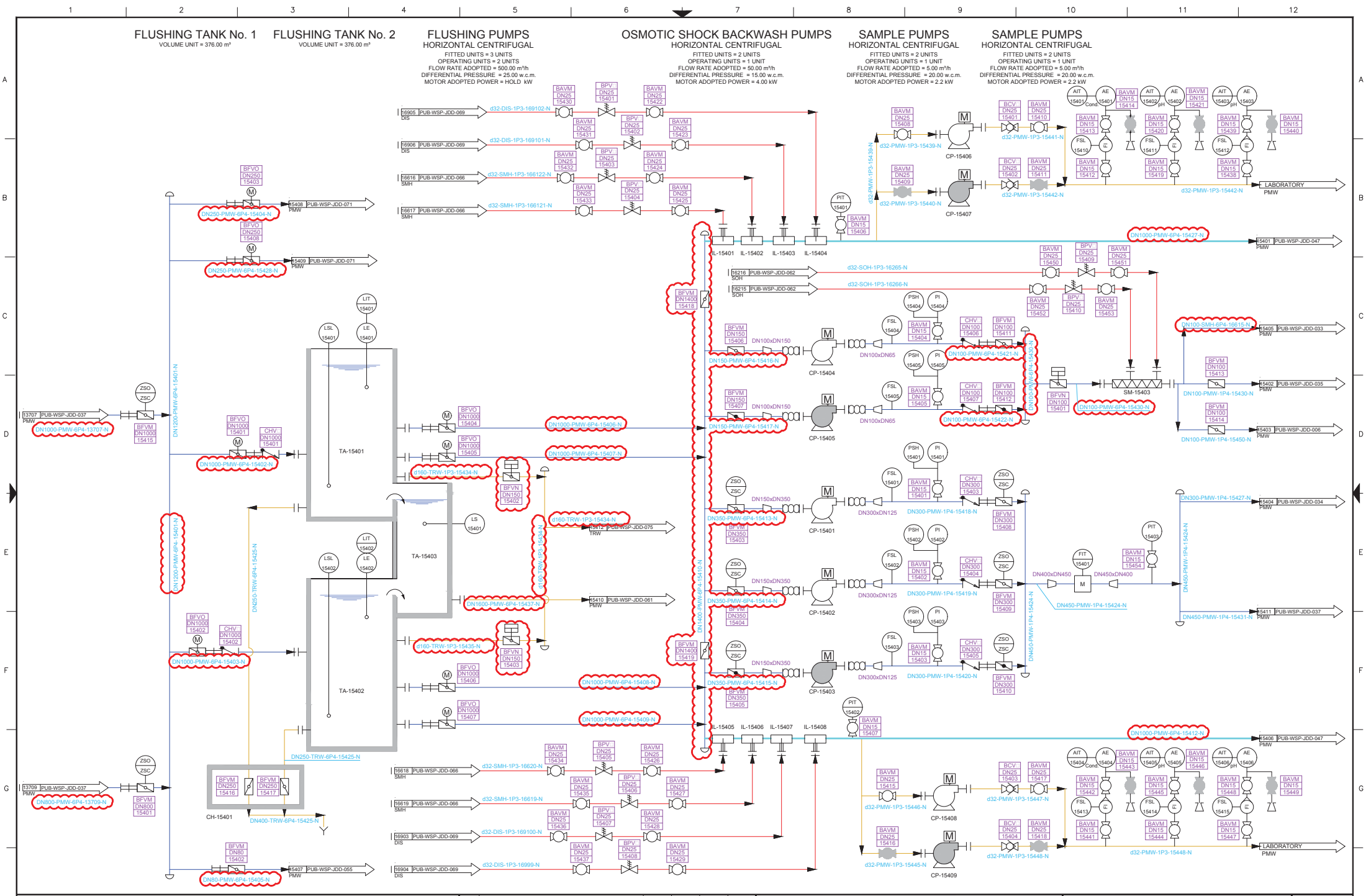
REFERENCE :
TDI-P-15-60

DRAWING Nº :
PUB-WSP-JDD-053

FORMAT
A1

SHEET 1 OF 1

DIN A1 (841 x 594)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 46

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
RO FLUSHING & OSMOTIC SHOCK

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-054

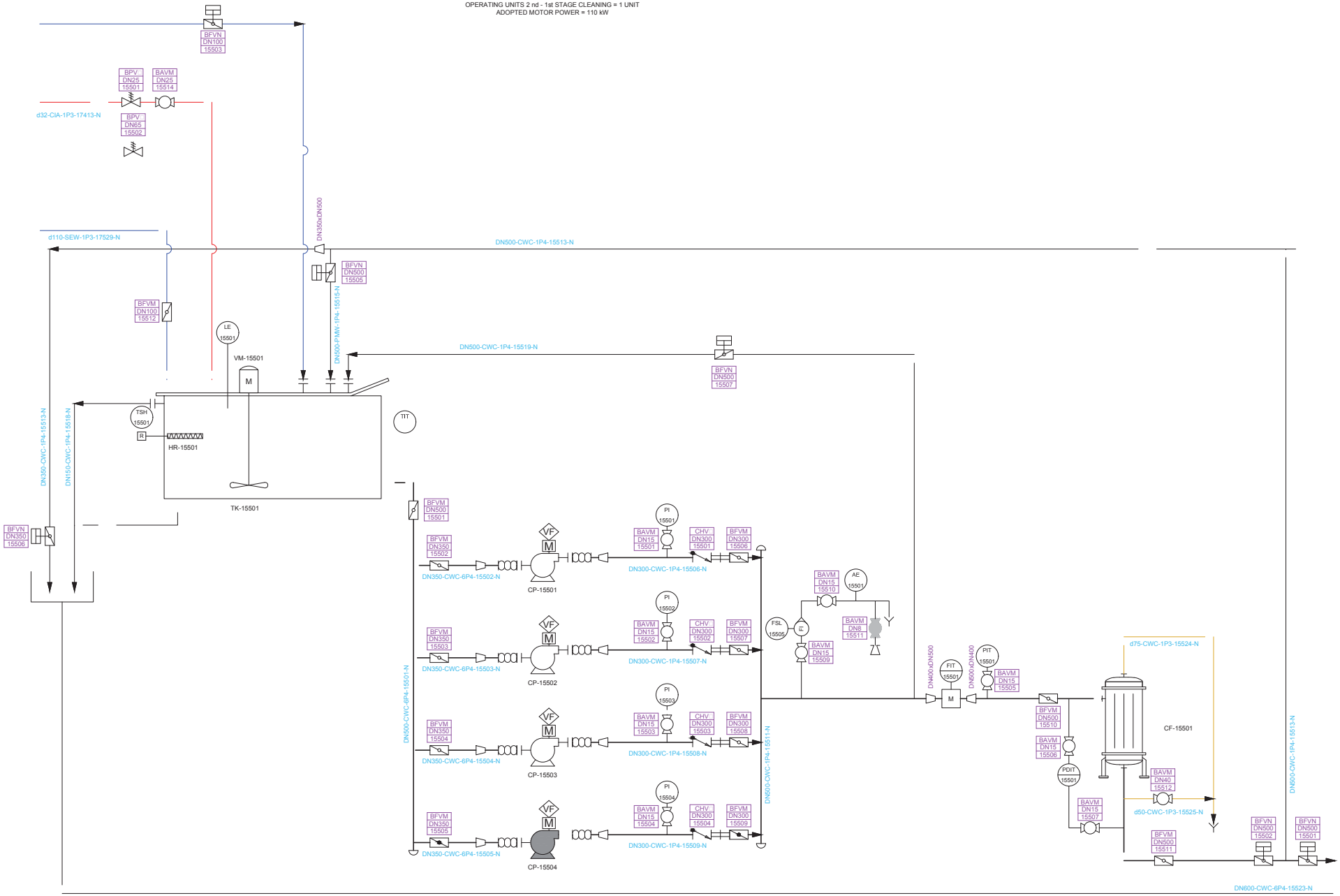
FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)

RO CIP TANK
HORIZONTAL CENTRIFUGAL
FITTED UNITS = 1 UNIT
VOLUME UNIT = 75.00 m³

RO CHEMICAL CLEANING
HORIZONTAL CENTRIFUGAL
FLOW RATE = 500.00 m³/h
DIFFERENTIAL PRESSURE = 55.00 w.c.m.
FITTED UNITS = 4 UNITS
OPERATING UNITS 1 st PASS CLEANING = 3 UNITS
OPERATING UNITS 2 nd - 1st STAGE CLEANING = 2 UNITS
OPERATING UNITS 2 nd - 1st STAGE CLEANING = 1 UNIT
ADOPTED MOTOR POWER = 110 kW

CARTRIDGE FILTER
VERTICAL
FITTED UNITS = 1 UNIT
FLOW RATE = 1500.00 m³/h

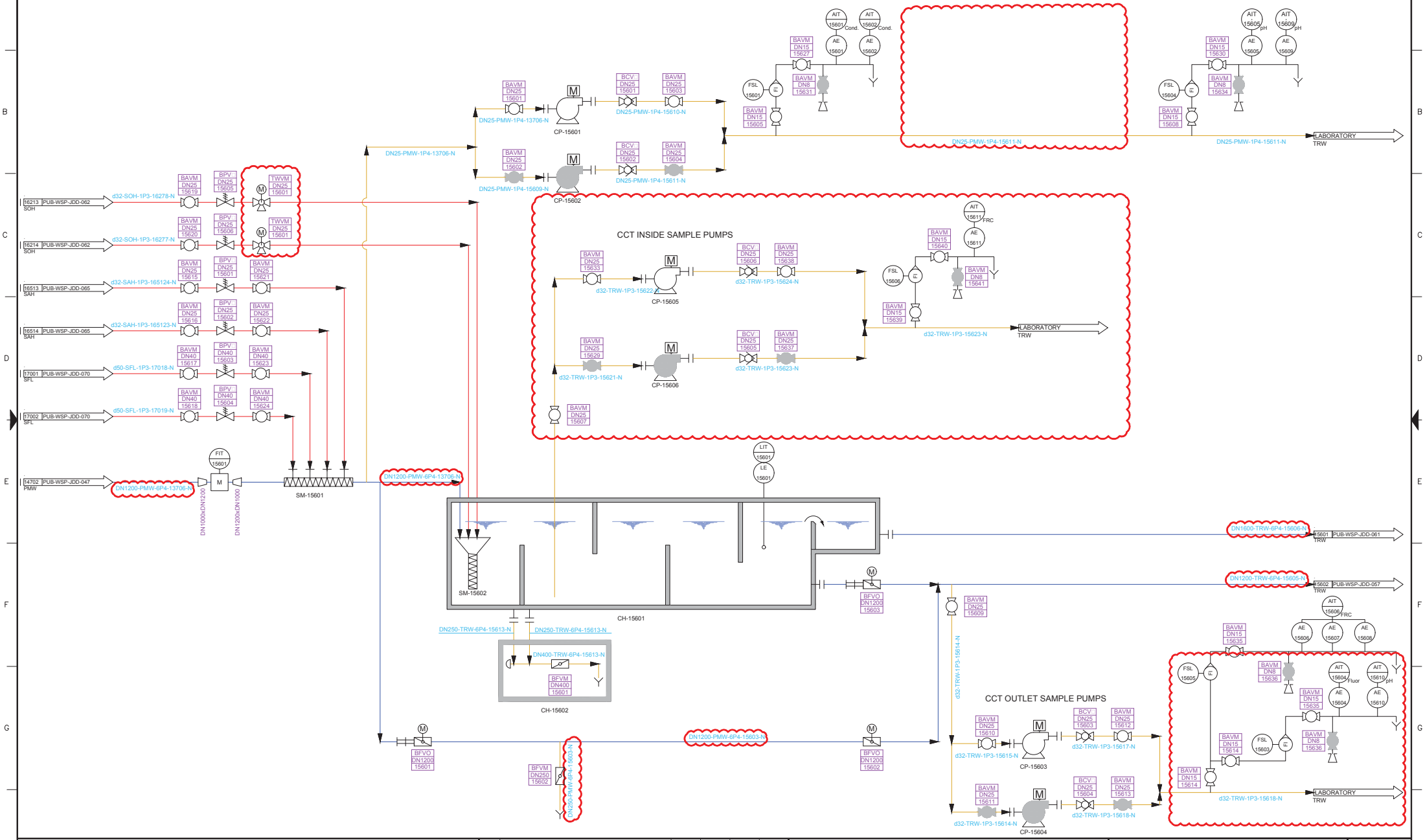


POST CHLORINATION SAMPLE PUMPS
HORIZONTAL CENTRIFUGAL
FITTED UNITS = 2 UNITS
OPERATING UNITS = 1 UNIT
ADOPTED UNIT FLOW RATE = 5.00 m³/h
DIFFERENTIAL PRESSURE = 20.00 w.c.m.
MOTOR ADOPTED POWER = 2.2 kW

CHLORINE CONTACT CHAMBER
FITTED UNITS = 1 UNIT
LENGHT = 19.70 m
WIDTH = 8.90 m
USEFUL HEIGHT = 13.00 m

CCT INSIDE SAMPLE PUMPS
HORIZONTAL CENTRIFUGAL
FITTED UNITS = 2 UNITS
OPERATING UNITS = 1 UNIT
ADOPTED UNIT FLOW RATE = 5.00 m³/h
DIFFERENTIAL PRESSURE = 20.00 w.c.m.
MOTOR ADOPTED POWER = 2.2 kW

CCT OUTLET SAMPLE PUMPS
HORIZONTAL CENTRIFUGAL
FITTED UNITS = 2 UNITS
OPERATING UNITS = 1 UNIT
ADOPTED UNIT FLOW RATE = 5.00 m³/h
DIFFERENTIAL PRESSURE = 20.00 w.c.m.
MOTOR ADOPTED POWER = 2.2 kW



NOTES :
- THIS SHEET CORREPONSE TO AREA: 60

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
CHLORINE CONTACT CHAMBER

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-056

FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)

CHLORAMINATION SAMPLE PUMPS

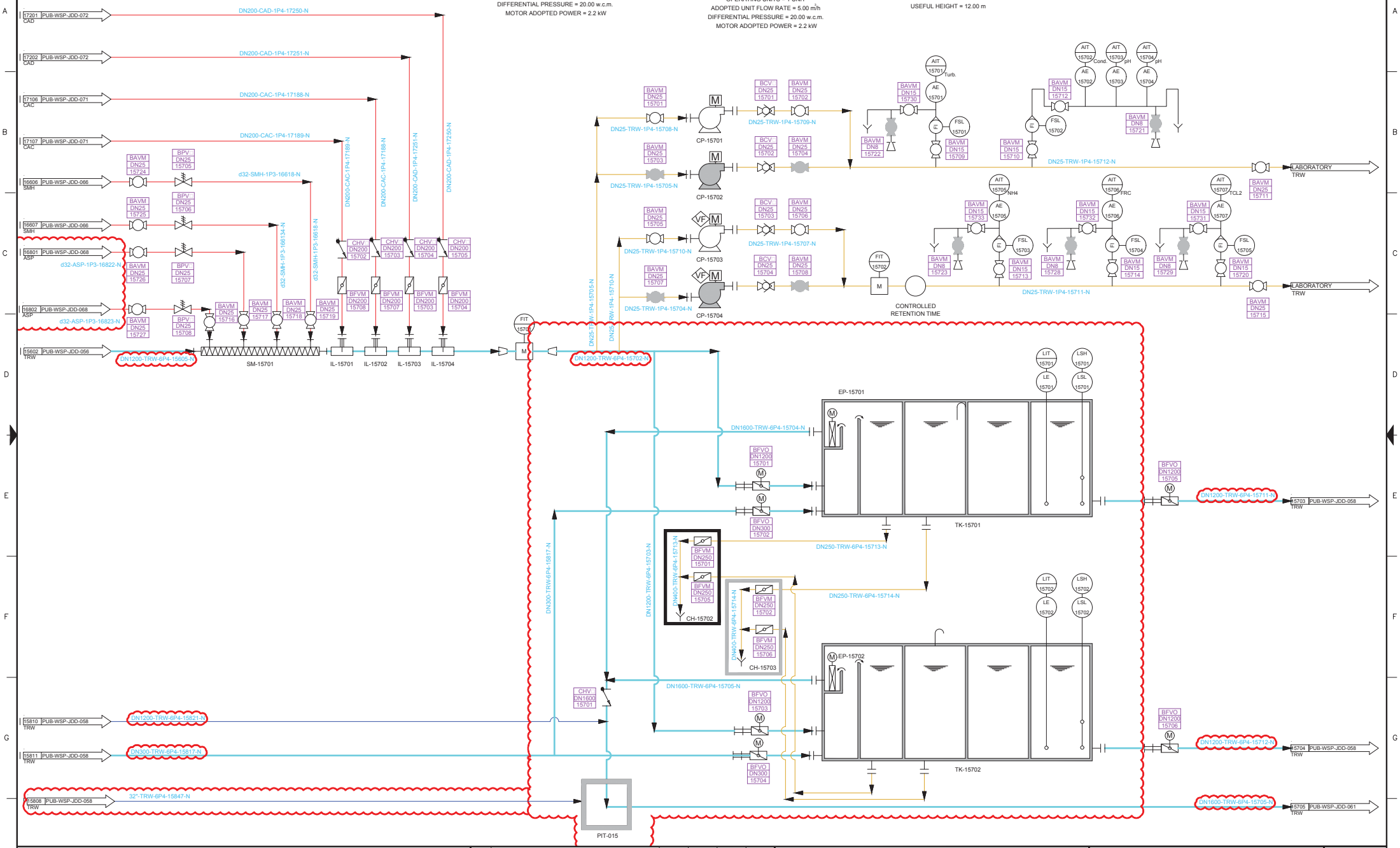
FITTED UNITS = 2 UNITS
OPERATING UNITS = 1 UNIT
ADOPTED UNIT FLOW RATE = 5.00 m³/h
DIFFERENTIAL PRESSURE = 20.00 w.c.m.
MOTOR ADOPTED POWER = 2.2 kW

TWT INLET SAMPLE PUMPS

HORIZONTAL CENTRIFUGAL
FITTED UNITS = 2 UNITS
OPERATING UNITS = 1 UNIT
ADOPTED UNIT FLOW RATE = 5.00 m³/h
DIFFERENTIAL PRESSURE = 20.00 w.c.m.
MOTOR ADOPTED POWER = 2.2 kW

TREATED WATER TANKS

FITTED UNITS = 2 UNITS
LENGHT= 33.5 m
WIDTH = 15.00 m
USEFUL HEIGHT = 12.00 m



NOTES :
- THIS SHEET CORREPONSE TO AREA: 70

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

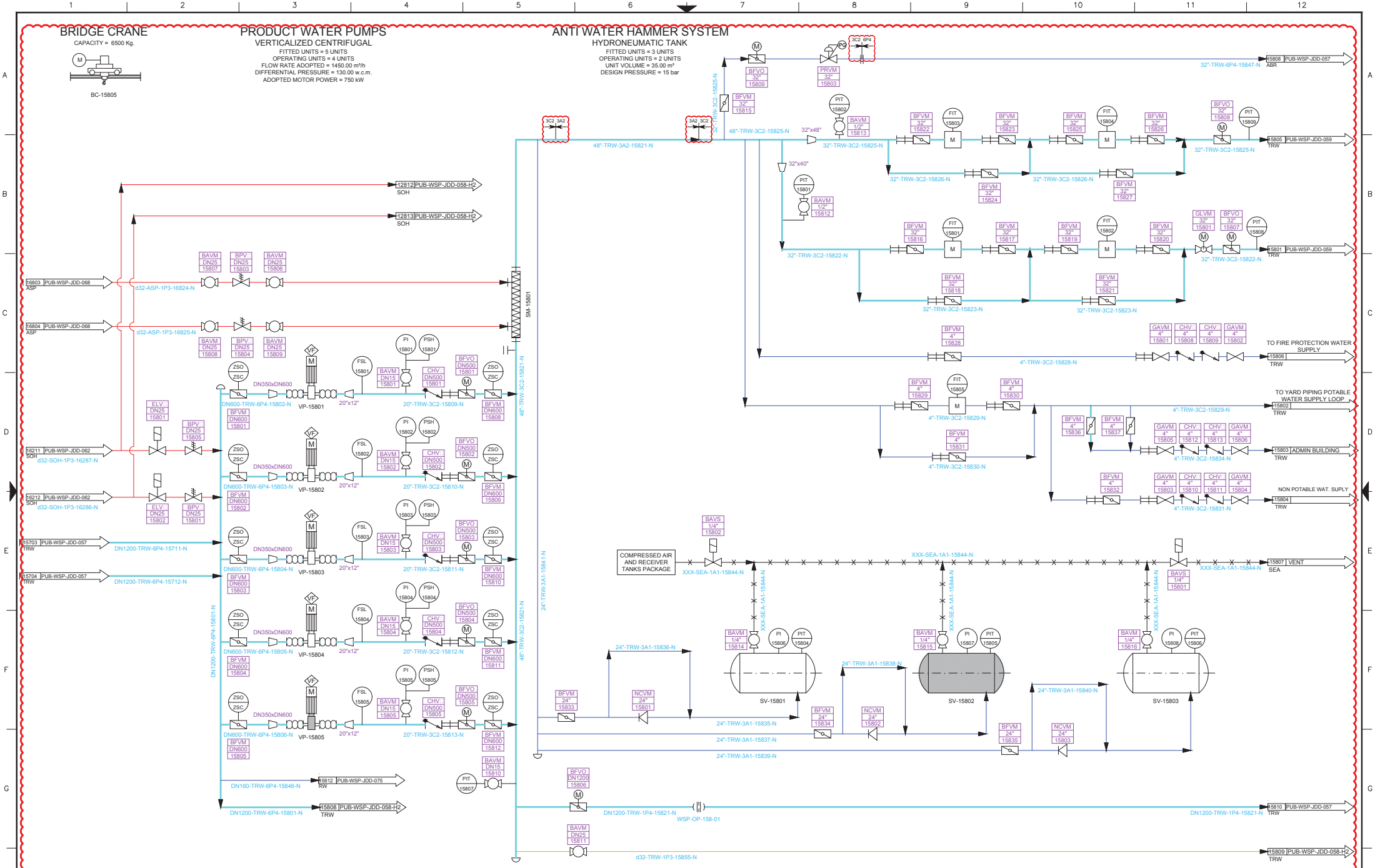
PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
PRODUCT WATER TANK

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-057

FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 71

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
PRODUCT WATER PUMPING STATION

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-058

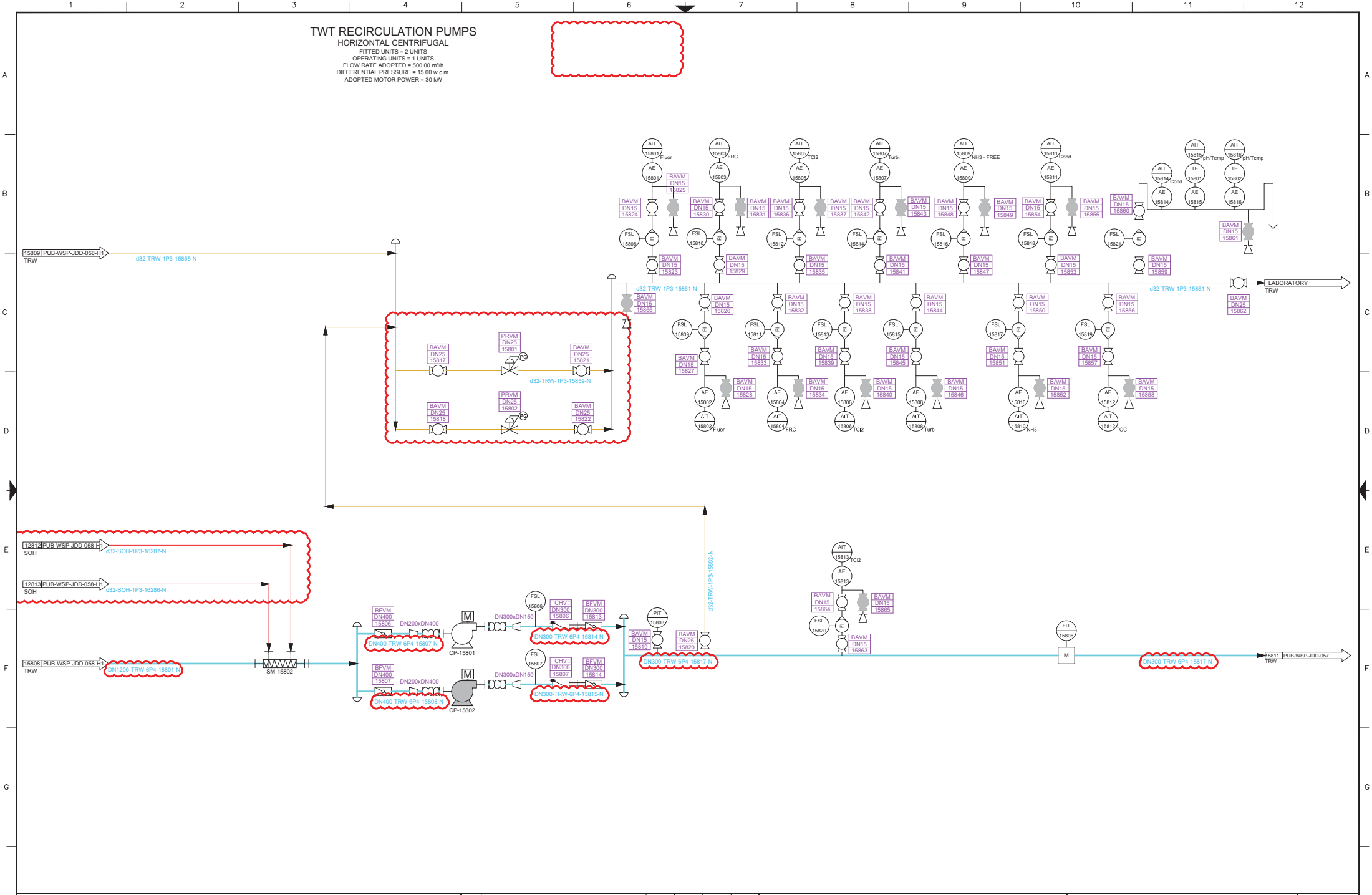
FORMAT A1 | SHEET 1 OF 2

DIN A1 (841 x 594)

TWT RECIRCULATION PUMPS

HORIZONTAL CENTRIFUGAL

FITTED UNITS = 2 UNITS
OPERATING UNITS = 1 UNITS
FLOW RATE ADOPTED = 500.00 m³/h
DIFFERENTIAL PRESSURE = 15.00 w.c.m.
ADOPTED MOTOR POWER = 30 kW



NOTES :
- THIS SHEET CORREPONSE TO AREA: 71

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
PRODUCT WATER PUMPING STATION

REFERENCE :
TDI-P-15-60

DRAWING Nº :
PUB-WSP-JDD-058

FORMAT
A1

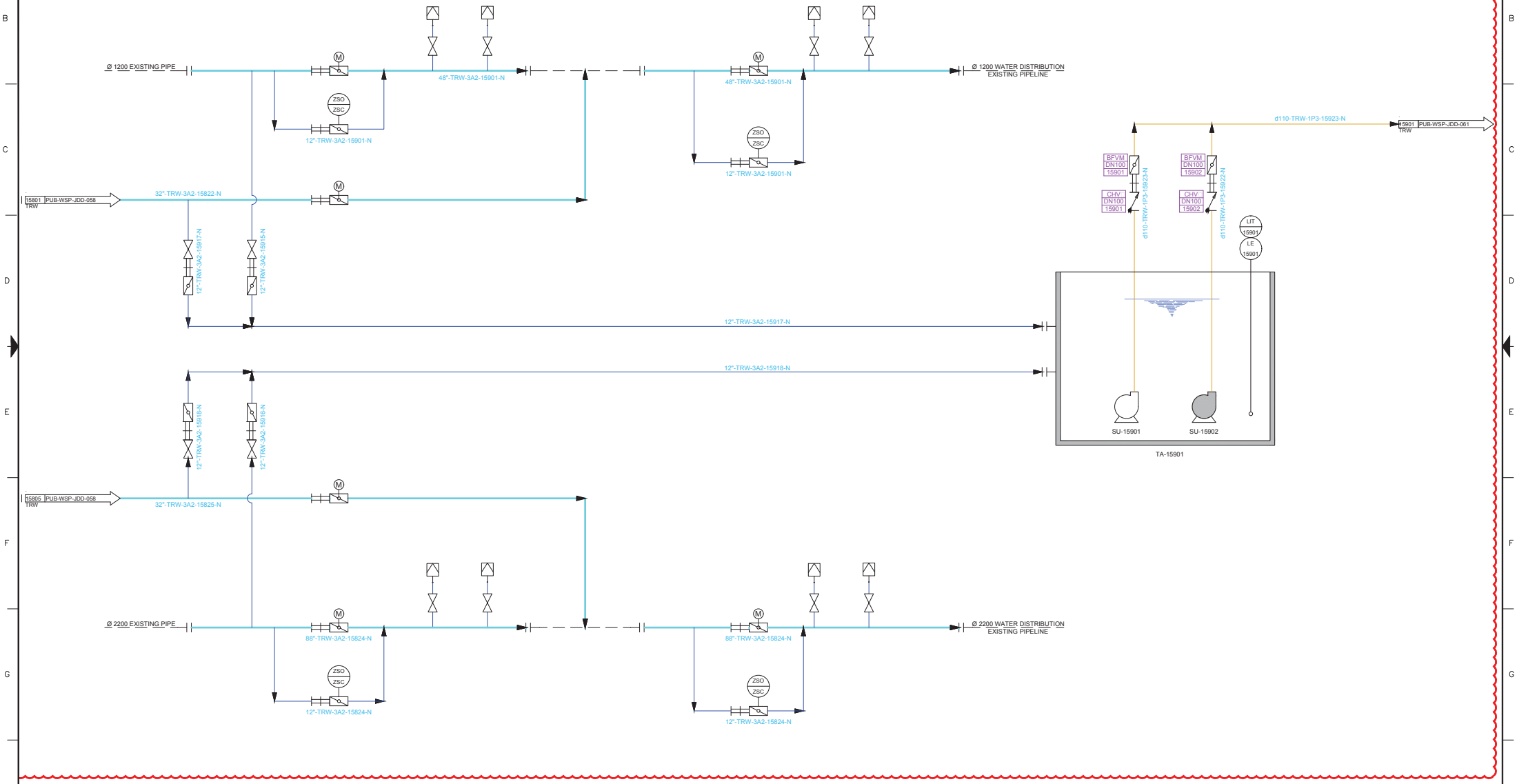
SHEET 2 OF 2

DIN A1 (841 x 594)

DRAIN PUMPS

SUBMERSIBLE CENTRIFUGAL

FITTED UNITS = 2 UNITS
OPERATING UNITS = 1 UNIT
ADOPTED UNIT FLOW RATE = 50.00 m³/h
DIFFERENTIAL PRESSURE = 15.00 w.c.m.
PUMP POWER = 3.00 kW



NOTES :
- THIS SHEET CORREPONSE TO AREA: 71

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

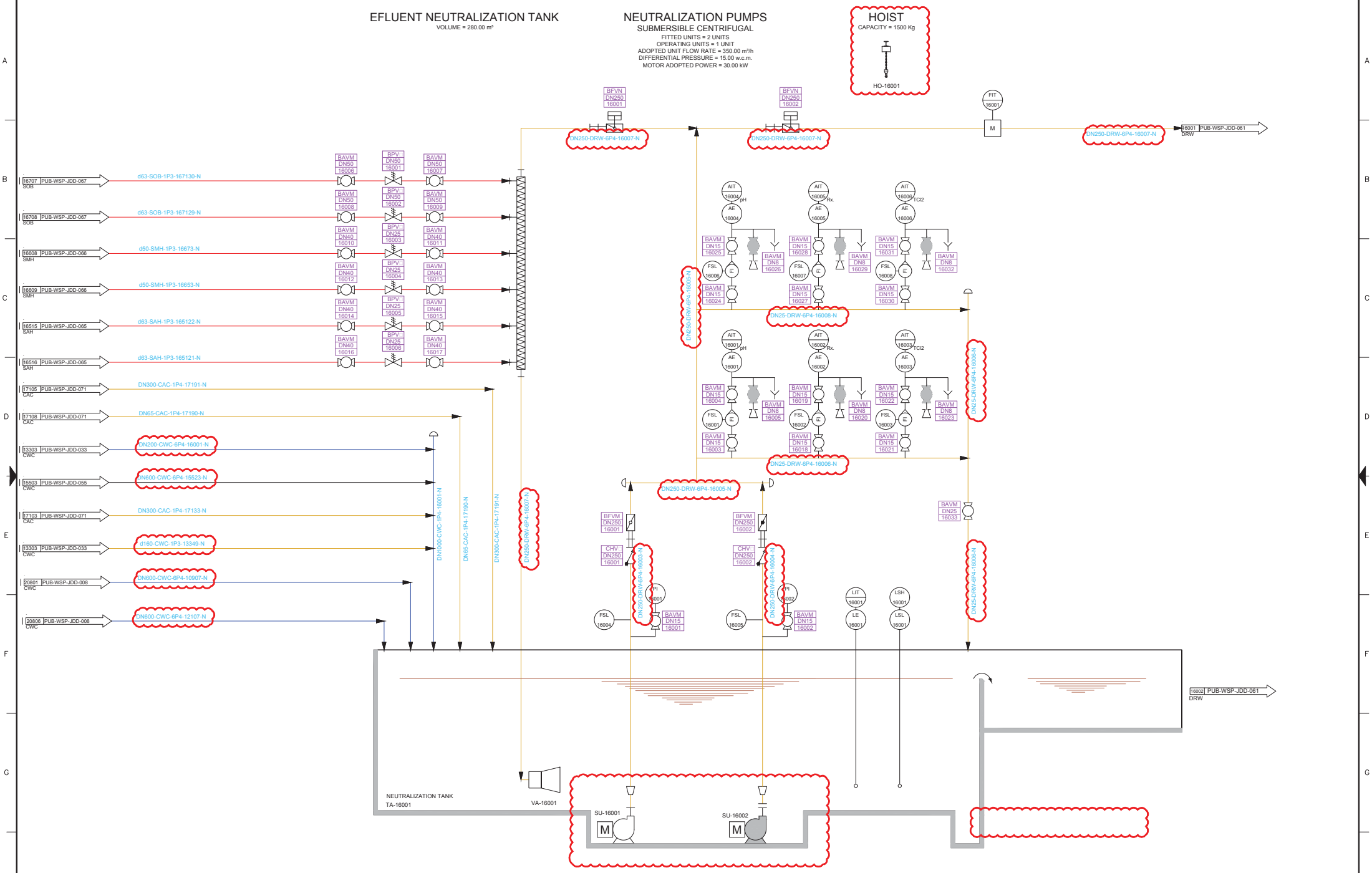
PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
PRODUCT WATER DISTRIBUTION PIPELINES

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-059

FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 48

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

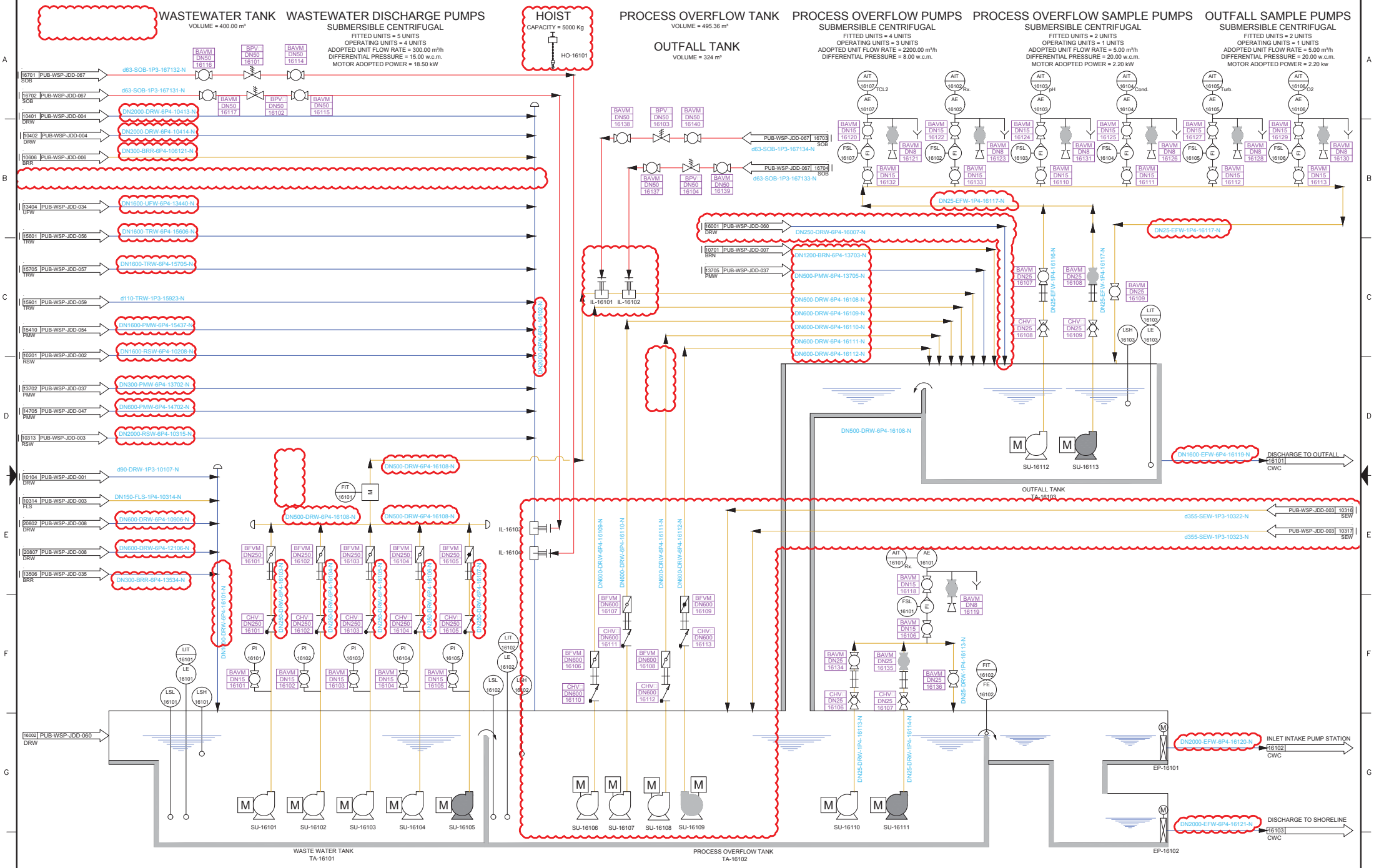
PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
NEUTRALIZATION SYSTEM

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-060

FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 74

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
WASTE DISCHARGE

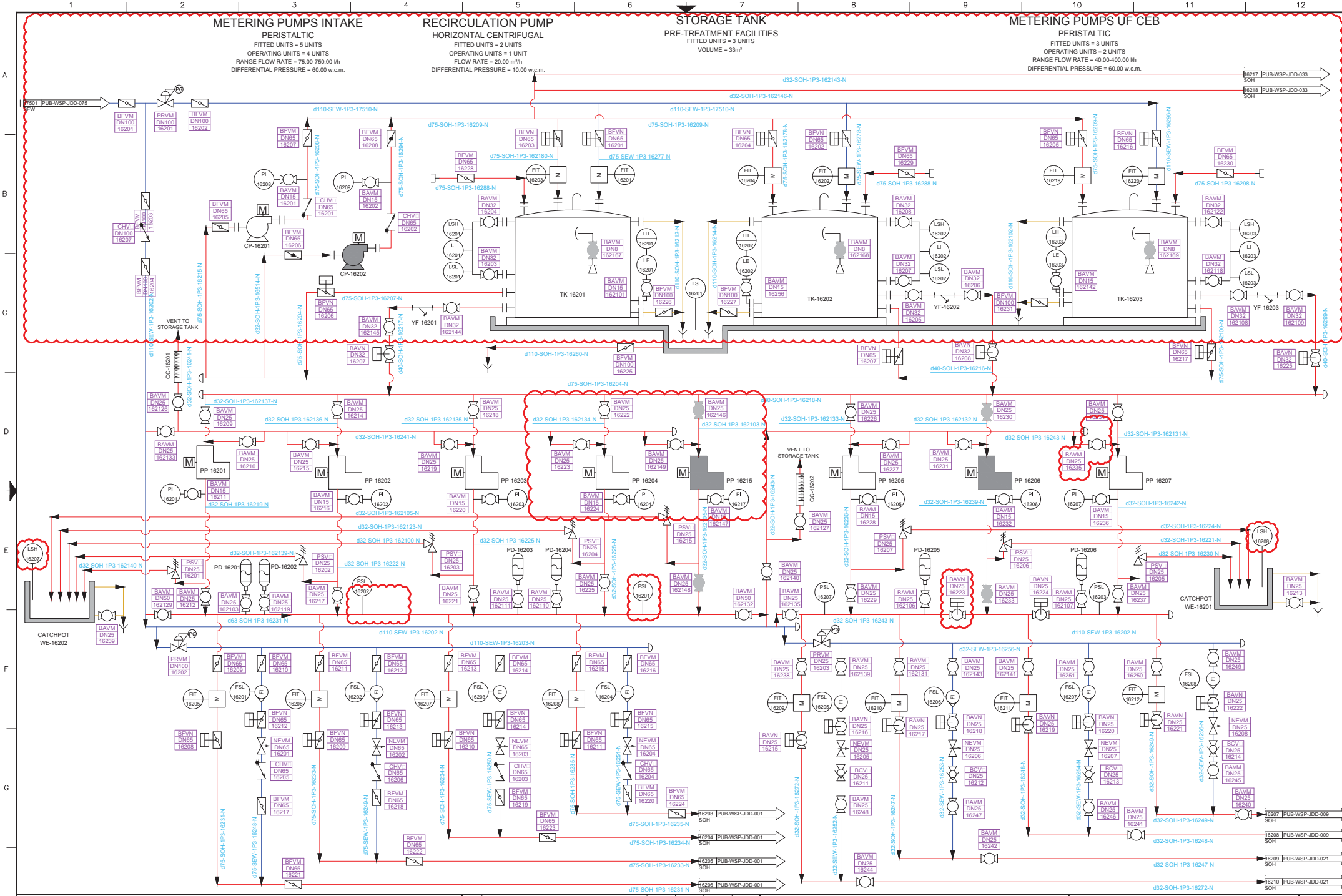
REFERENCE :
TDI-P-15-60

DRAWING Nº :
PUB-WSP-JDD-061

FORMAT
A1

SHEET 1
OF 1

DIN A1 (841 x 594)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 31

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

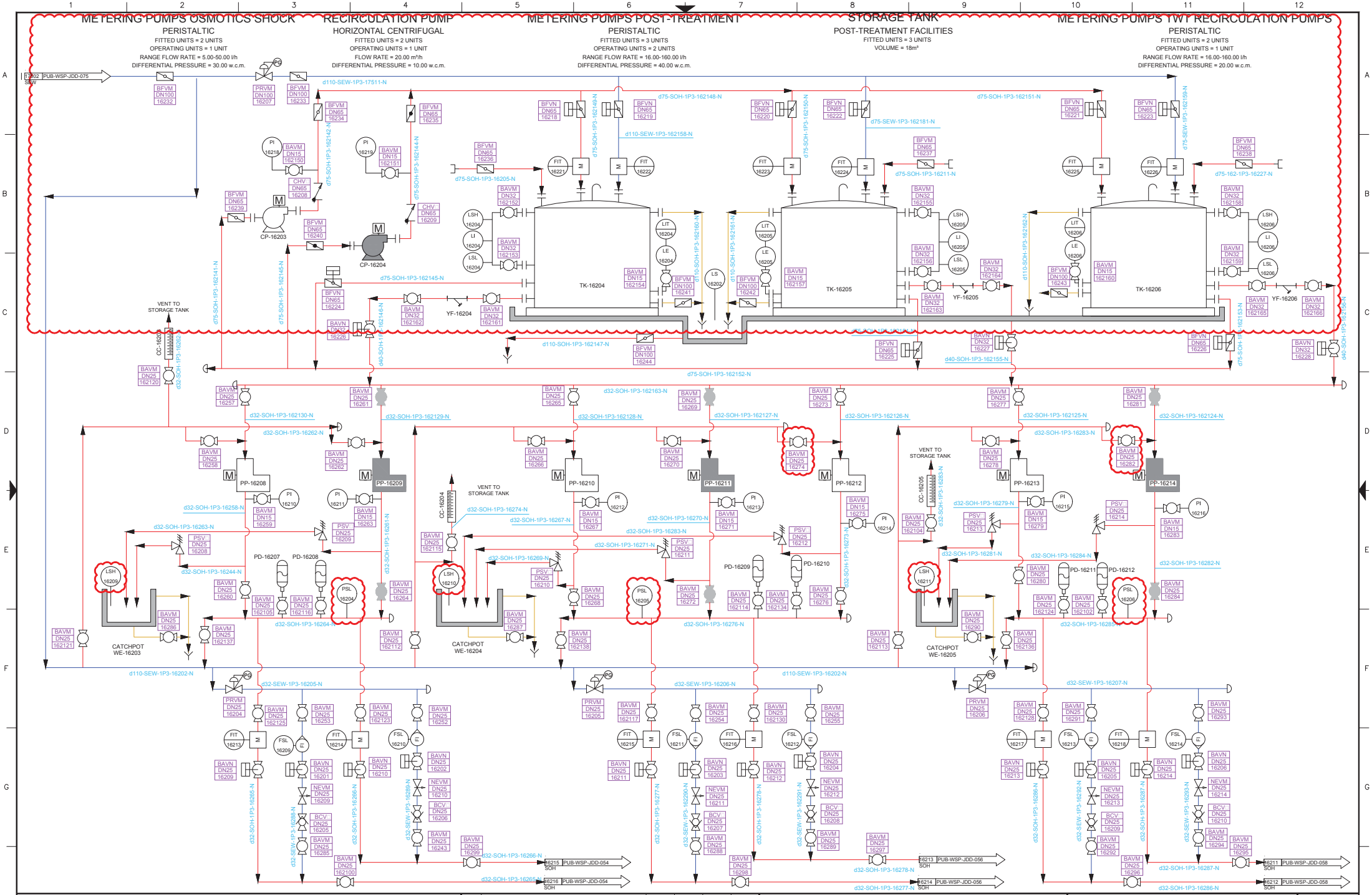
PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
CHEMICALS. SODIUM HYPOCHLORITE

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-062

FORMAT A1 | SHEET 1 OF 2

DIN A1 (841 x 594)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 31

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

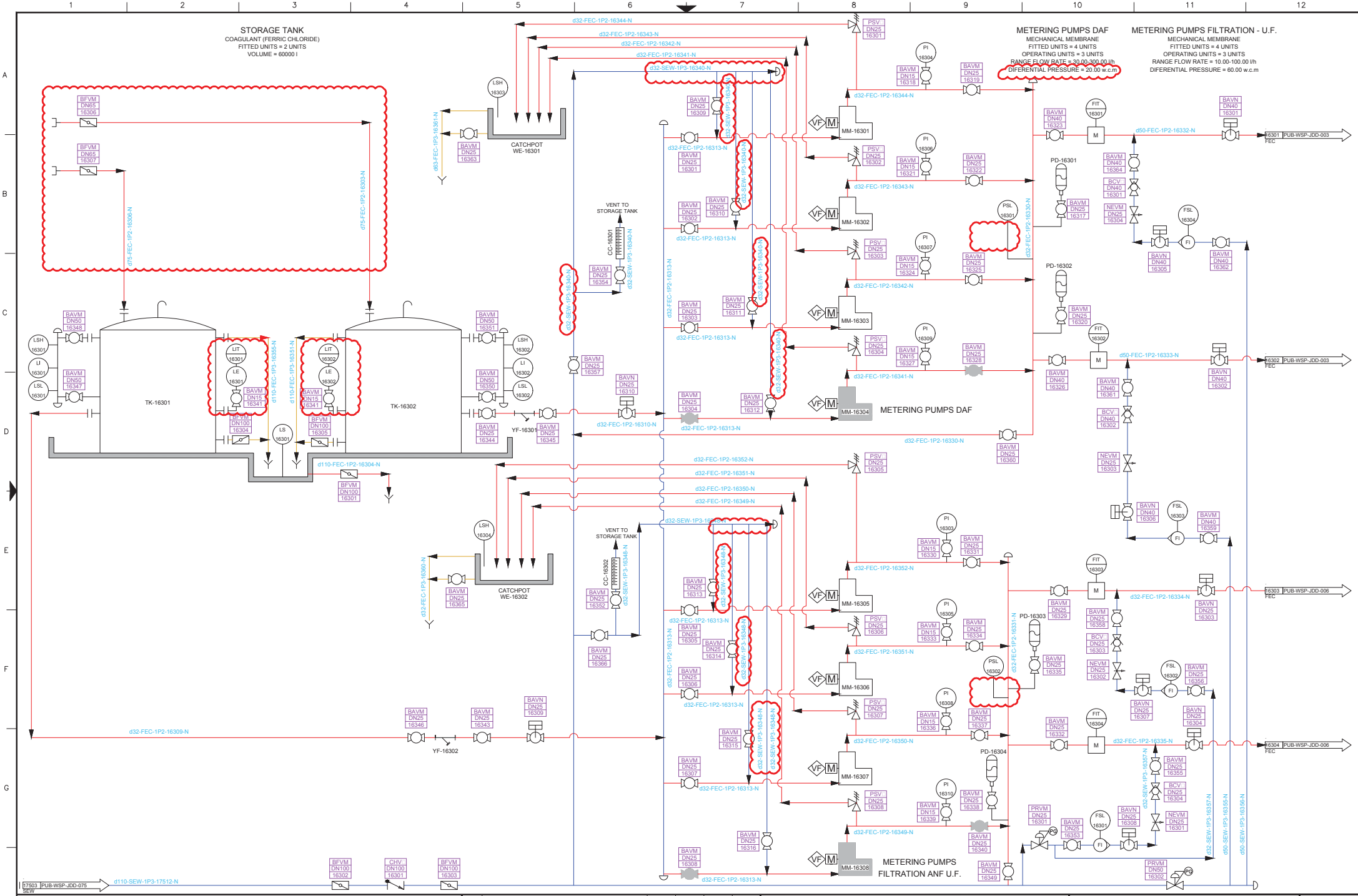
PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
CHEMICALS. SODIUM HYPOCHLORITE

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-062

FORMAT A1 | SHEET 2 OF 2

DIN A1 (841 x 594)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 58

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
CHEMICALS. COAGULANT - FERRIC CHLORIDE

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-063

FORMAT A1 | SHEET 1 OF 1

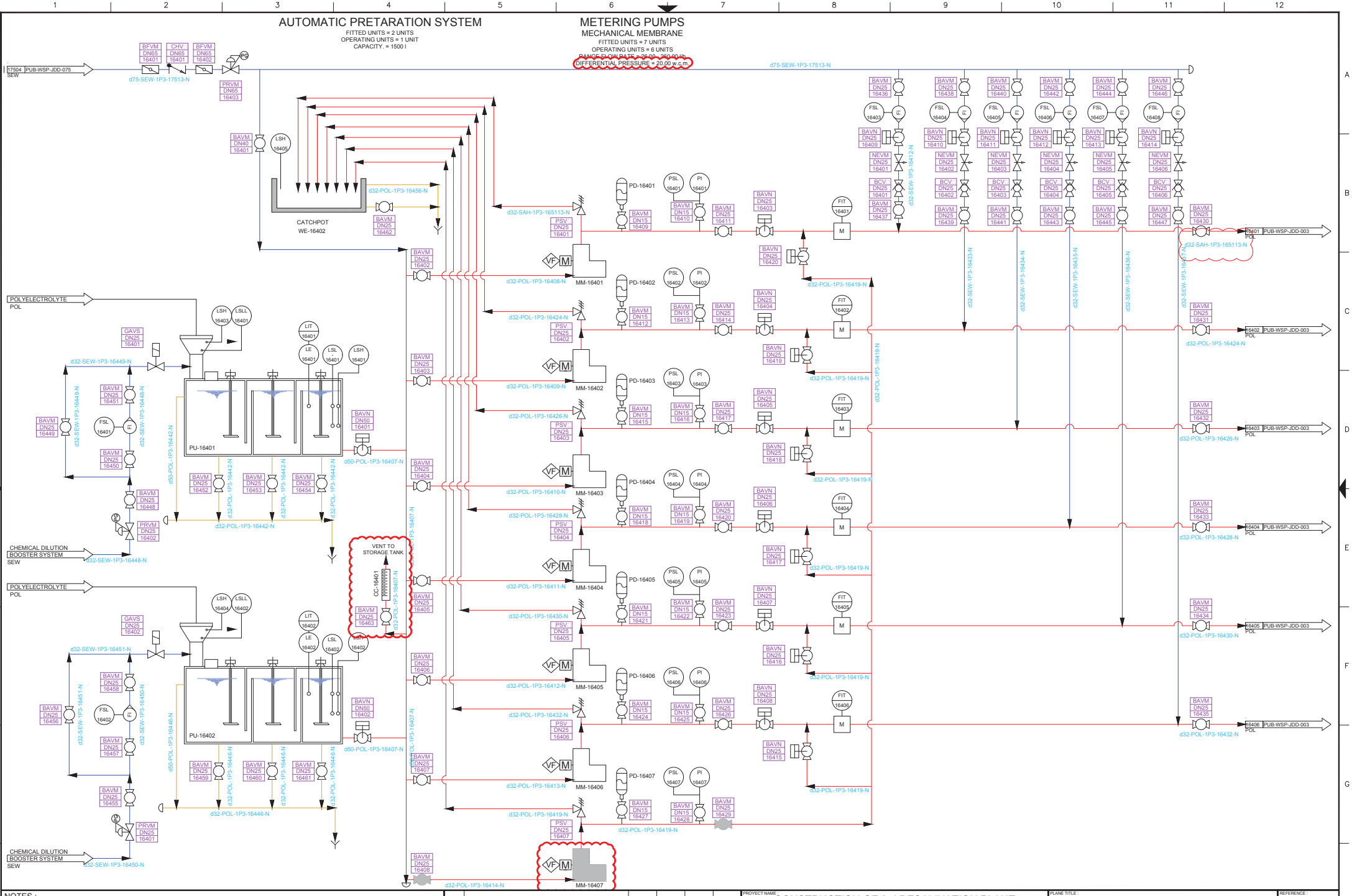
DIN A1 (841 x 594)

AUTOMATIC PRETARATION SYSTEM

FITTED UNITS = 2 UNITS
OPERATING UNITS = 1 UNIT
CAPACITY. = 1500 l

METERING PUMPS

MECHANICAL MEMBRANE
FITTED UNITS = 7 UNITS
OPERATING UNITS = 6 UNITS
RANGE FLOW RATE = 25-00 - 250-00 l/h
DIFFERENTIAL PRESSURE = 20.00 w.c.m



NOTES :
- THIS SHEET CORREPONSE TO AREA: 34

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
CHEMICALS. FLOCCULANT (ANIONIC POLYELECTROLYTE)

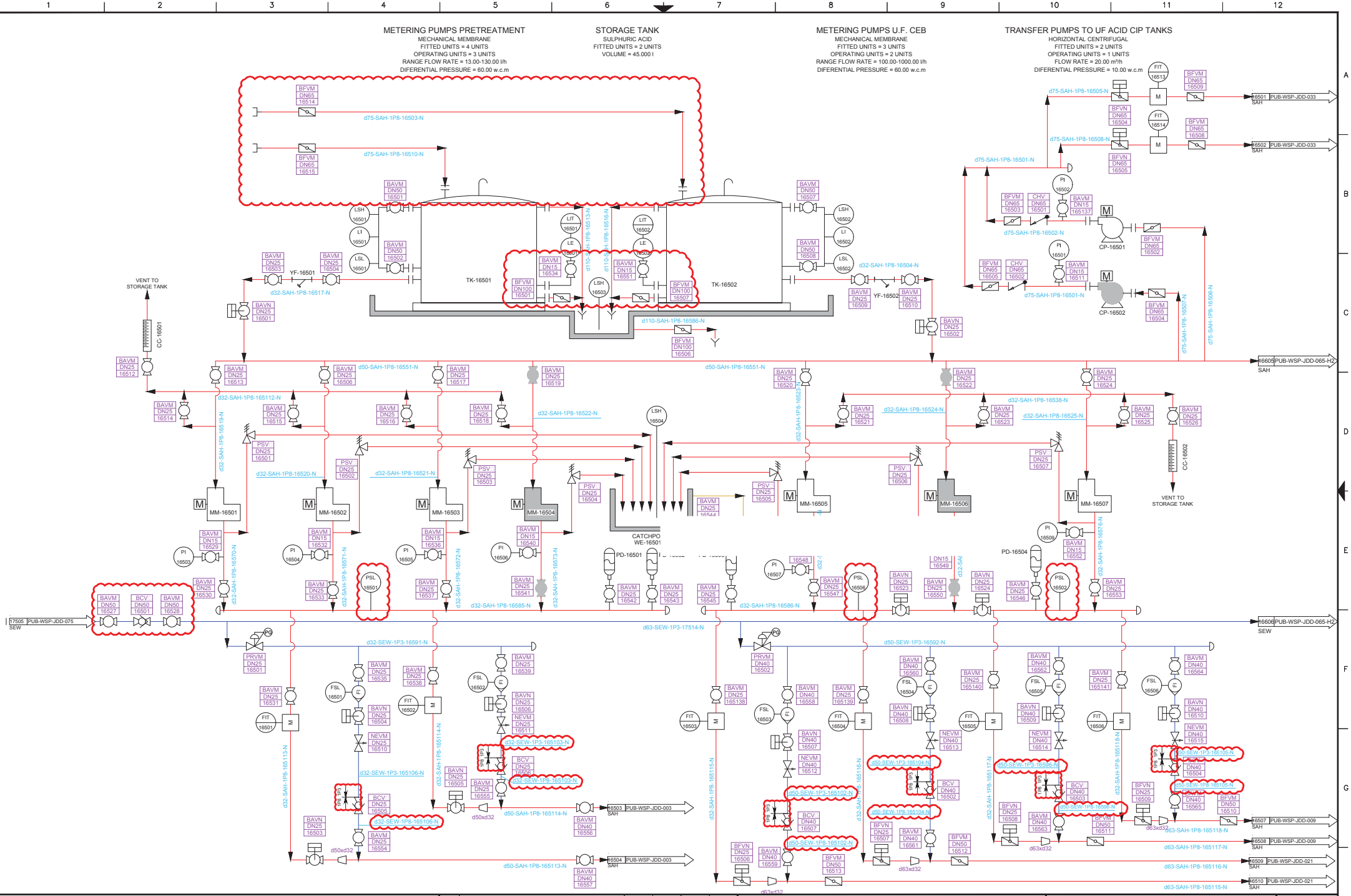
REFERENCE :
TDI-P-15-60

DRAWING Nº :
PUB-WSP-JDD-064

FORMAT A1

SHEET 1 OF 1

DIN A1 (841 x 594)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 37

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

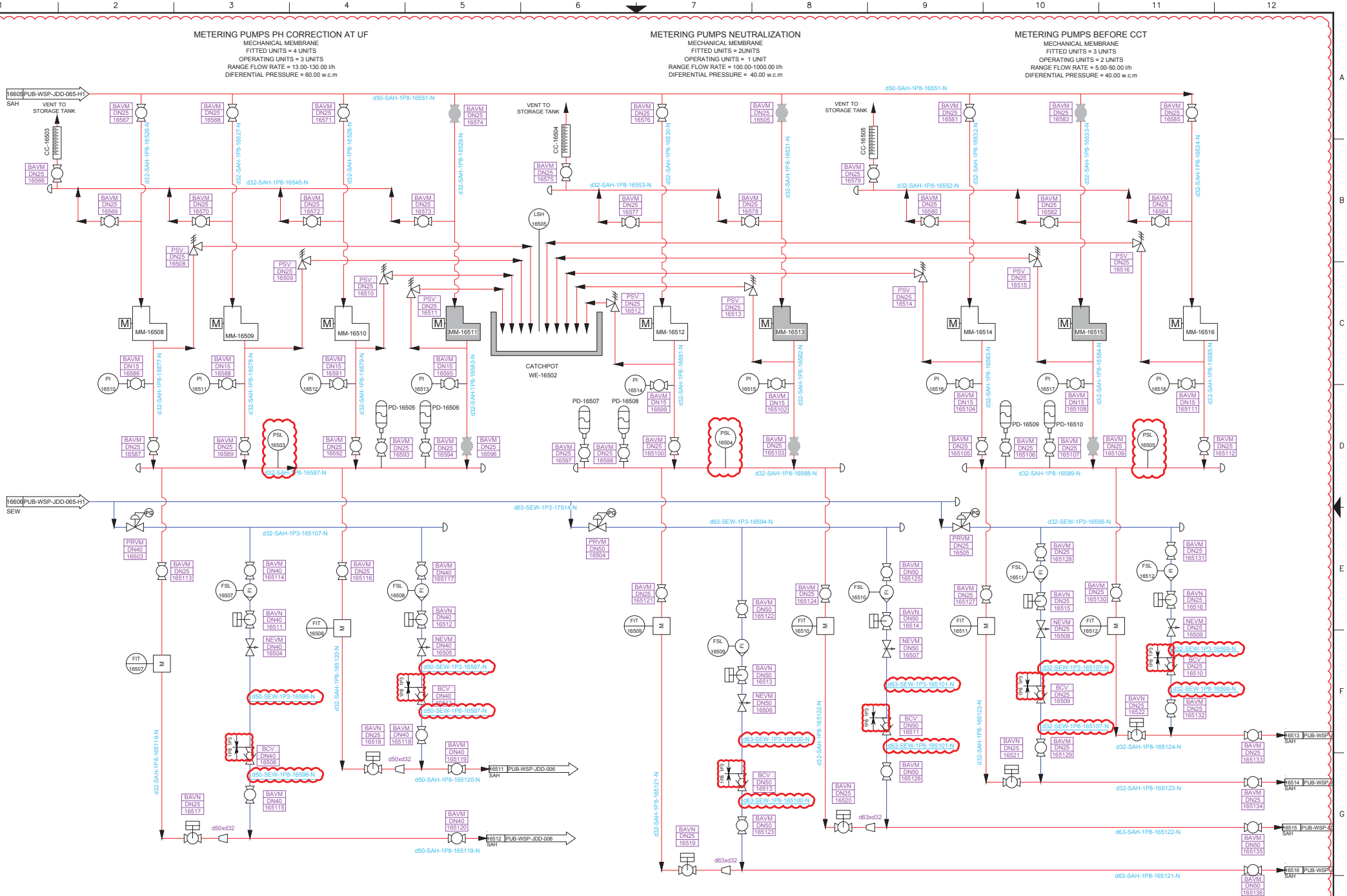
PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
CHEMICALS. SULPHURIC ACID 1

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-065

FORMAT A1 | SHEET 1 OF 2

DIN A1 (841 x 594)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 37

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
CHEMICALS. SULPHURIC ACID 1

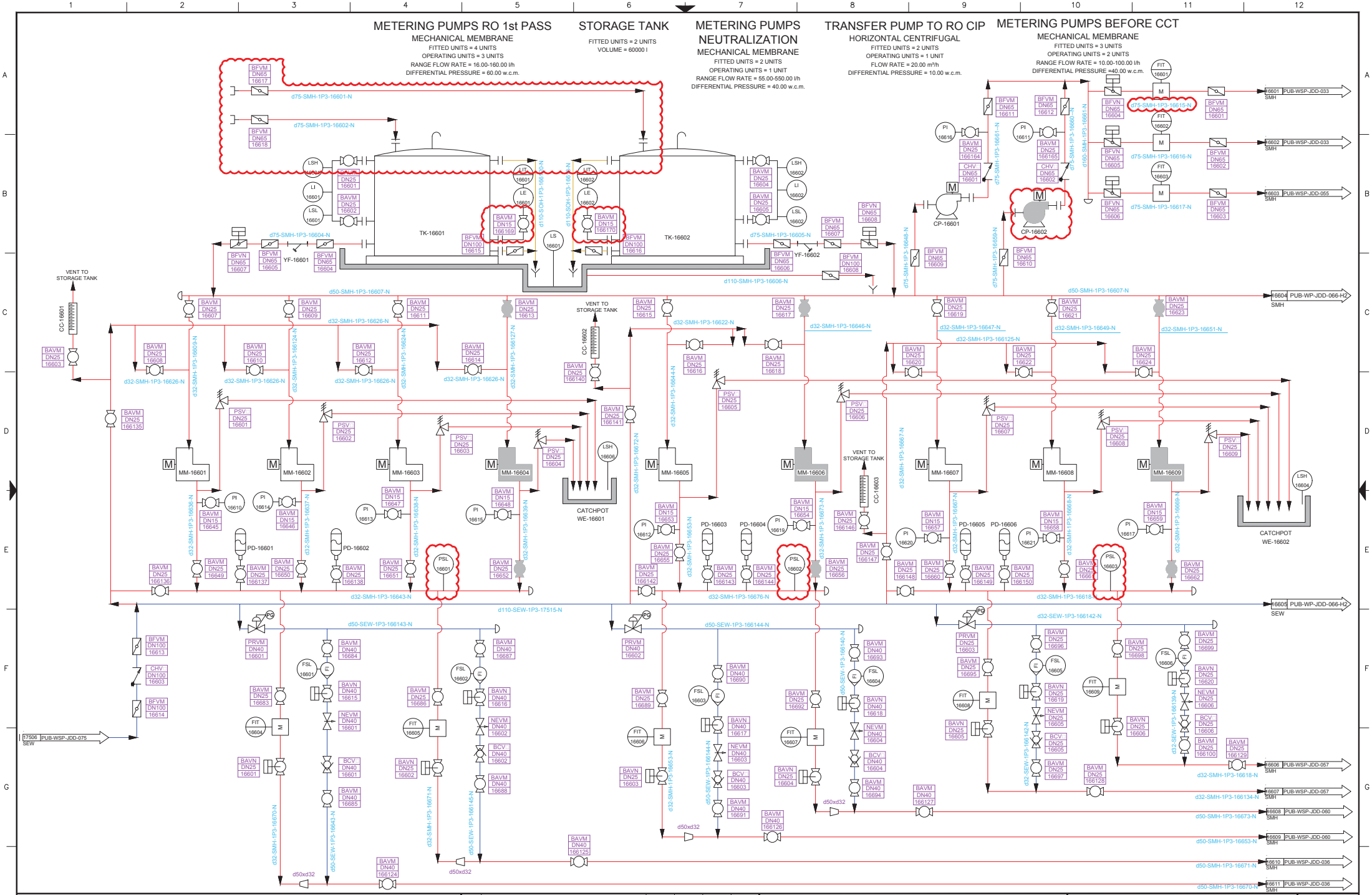
REFERENCE :
TDI-P-15-60

DRAWING Nº :
PUB-WSP-JDD-065

FORMAT A1

SHEET 2 OF 2

DIN A1 (841 x 594)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 36

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
CHEMICALS. SODIUM HYDROXIDE

REFERENCE : TDI-P-15-60

DRAWING N° : PUB-WSP-JDD-066

FORMAT A1 | SHEET 1 OF 2

DIN A1 (841 x 594)

METERING PUMPS UF CEB

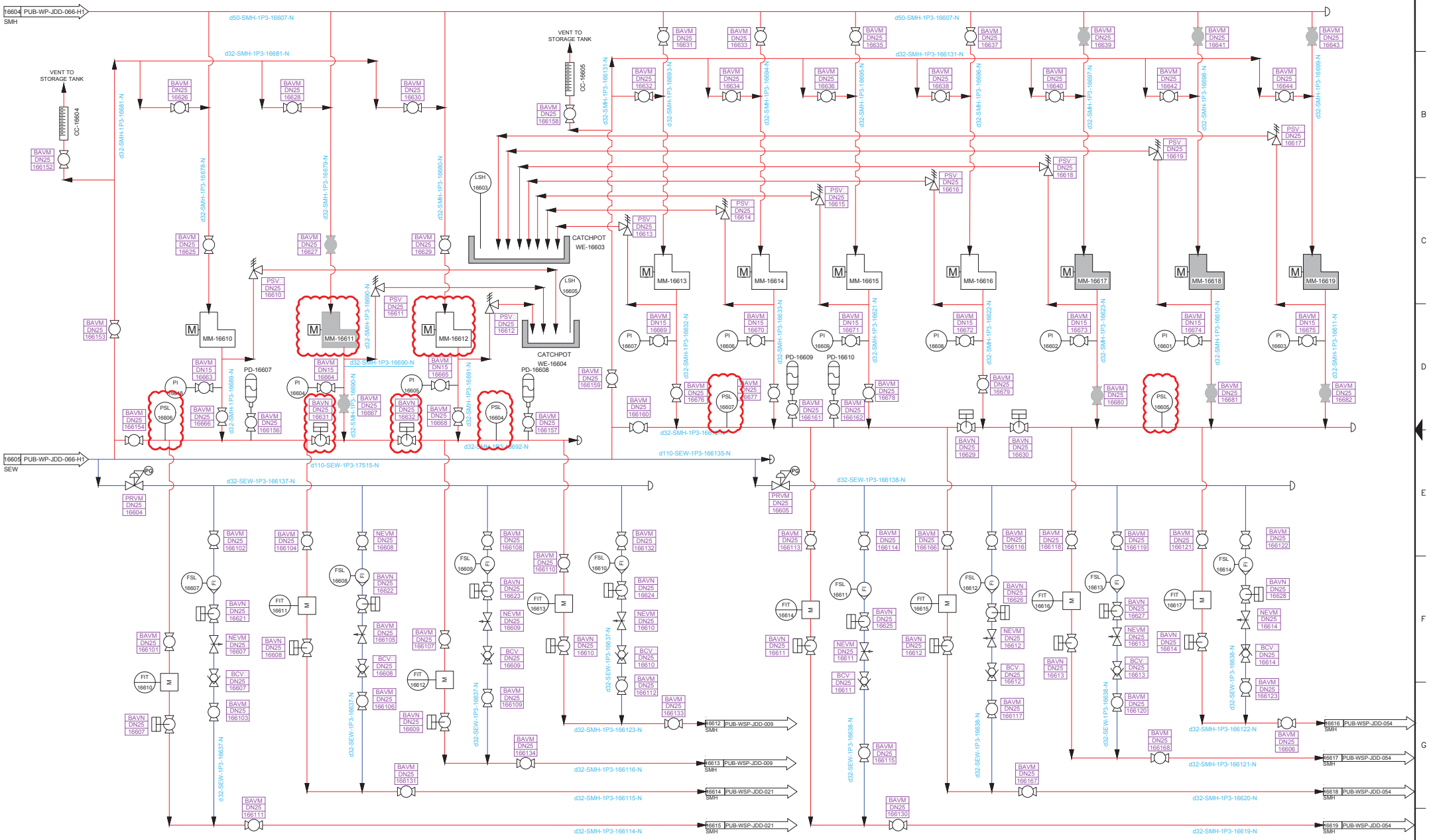
MECHANICAL MEMBRANE

FITTED UNITS = 3 UNITS
OPERATING UNITS = 2 UNITS
RANGE FLOW RATE = 15.00-150.00 l/h
DIFFERENTIAL PRESSURE = 60.00 w.c.m.

METERING PUMPS RO 2nd PASS

MECHANICAL MEMBRANE

FITTED UNITS = 7 UNITS
OPERATING UNITS = 4 UNITS
RANGE FLOW RATE = 5.00-50.00 l/h
DIFFERENTIAL PRESSURE = 20.00 w.c.m.



NOTES :
- THIS SHEET CORREPONSE TO AREA: 36

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

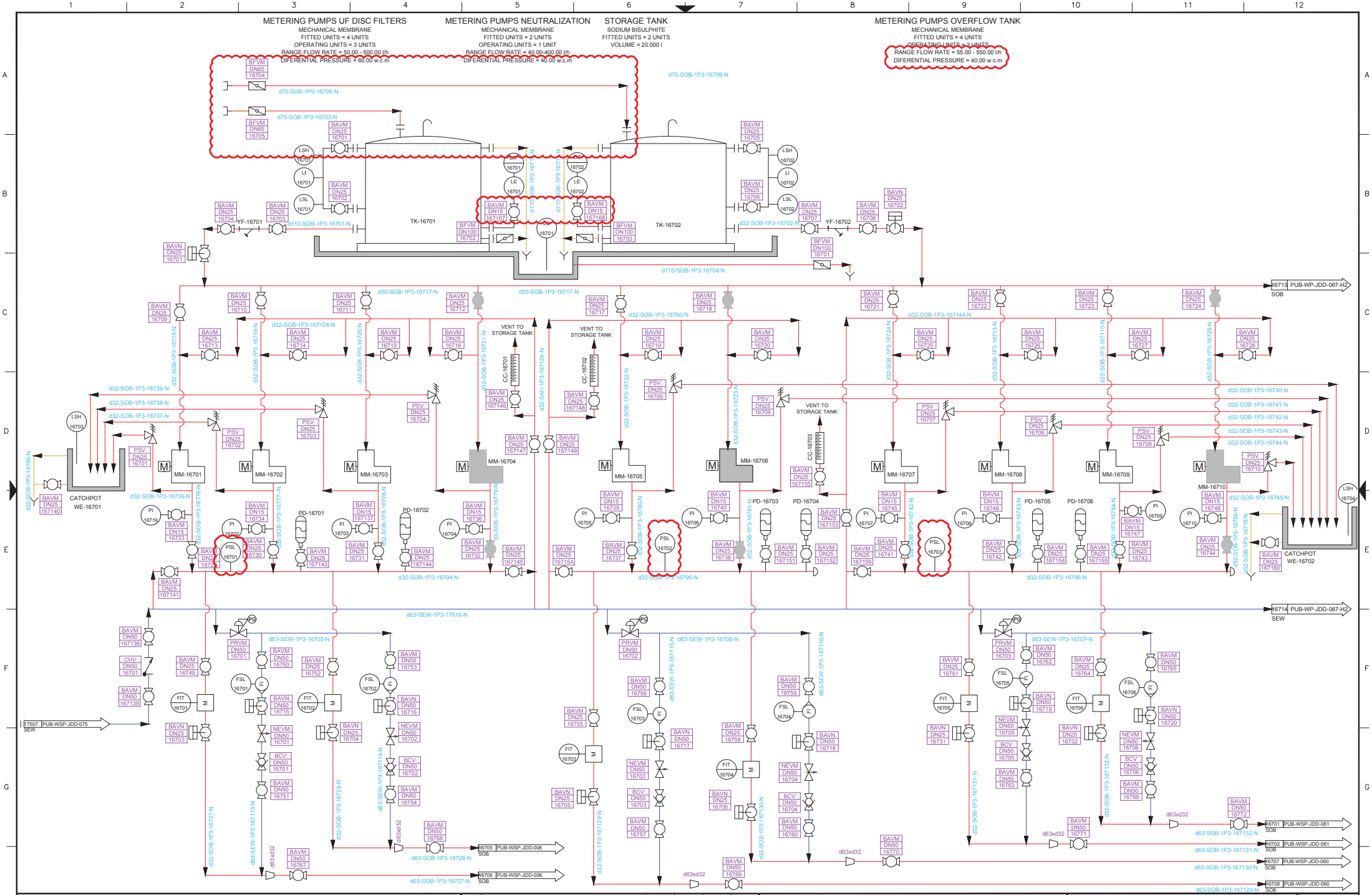
PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
CHEMICALS. SODIUM HYDROXIDE

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-066

FORMAT A1 | SHEET 2 OF 2

DIN A1 (841 x 594)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 39

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
CHEMICALS. SODIUM BISULPHITE

REFERENCE : TDI-P-15-60

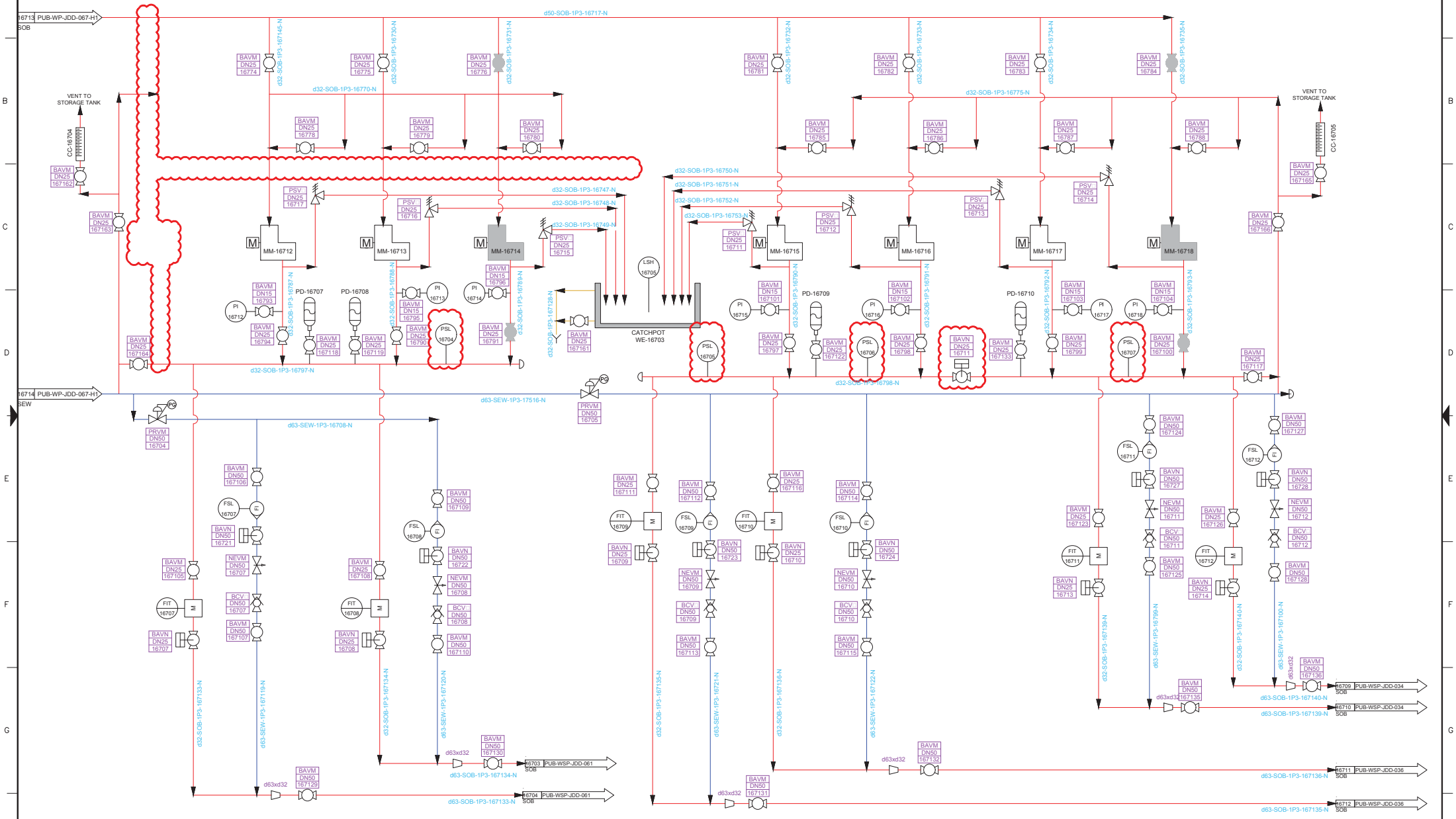
DRAWING Nº : PUB-WSP-JDD-067

FORMAT A1 | SHEET 1 OF 2

DIN A1 (841 x 594)

METERING PUMPS WASTE WATER TANK
MECHANICAL MEMBRANE
FITTED UNITS = 3 UNITS
OPERATING UNITS = 2 UNITS
RANGE FLOW RATE = 10.00 - 100.00 l/h
DIFERENTIAL PRESSURE = 40.00 w.c.m

METERING PUMPS TO RO FEED TRAIN & CLEANING FILTERS
MECHANICAL MEMBRANE
FITTED UNITS = 4 UNITS
OPERATING UNITS = 3 UNITS
RANGE FLOW RATE = 50.00 - 500.00 l/h
DIFERENTIAL PRESSURE = 60.00 w.c.m



NOTES :
- THIS SHEET CORREPONSE TO AREA: 39

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

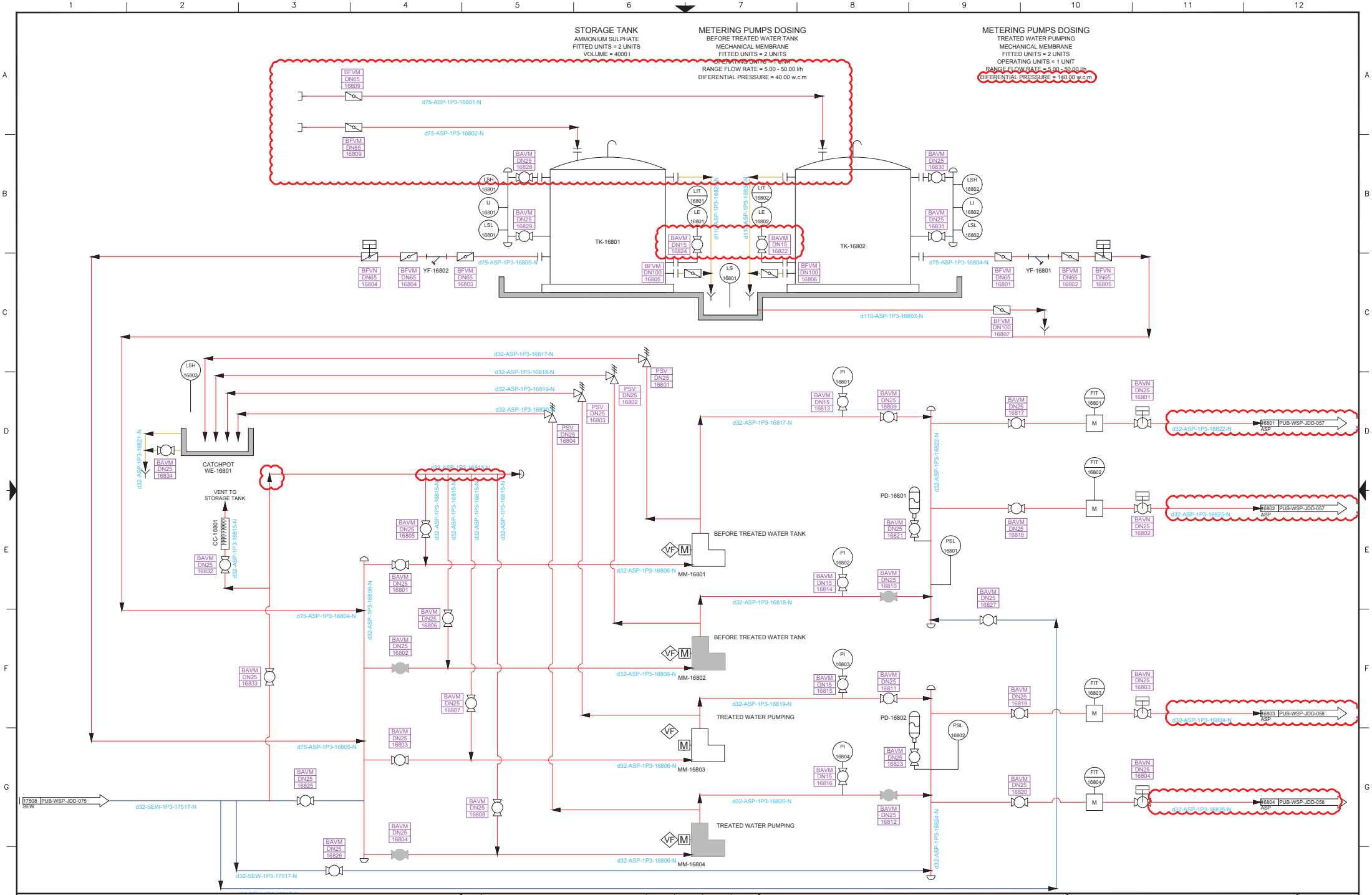
PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
CHEMICALS. SODIUM BISULPHITE

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-067

FORMAT A1 | SHEET 2 OF 2

DIN A1 (841 x 594)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 53

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

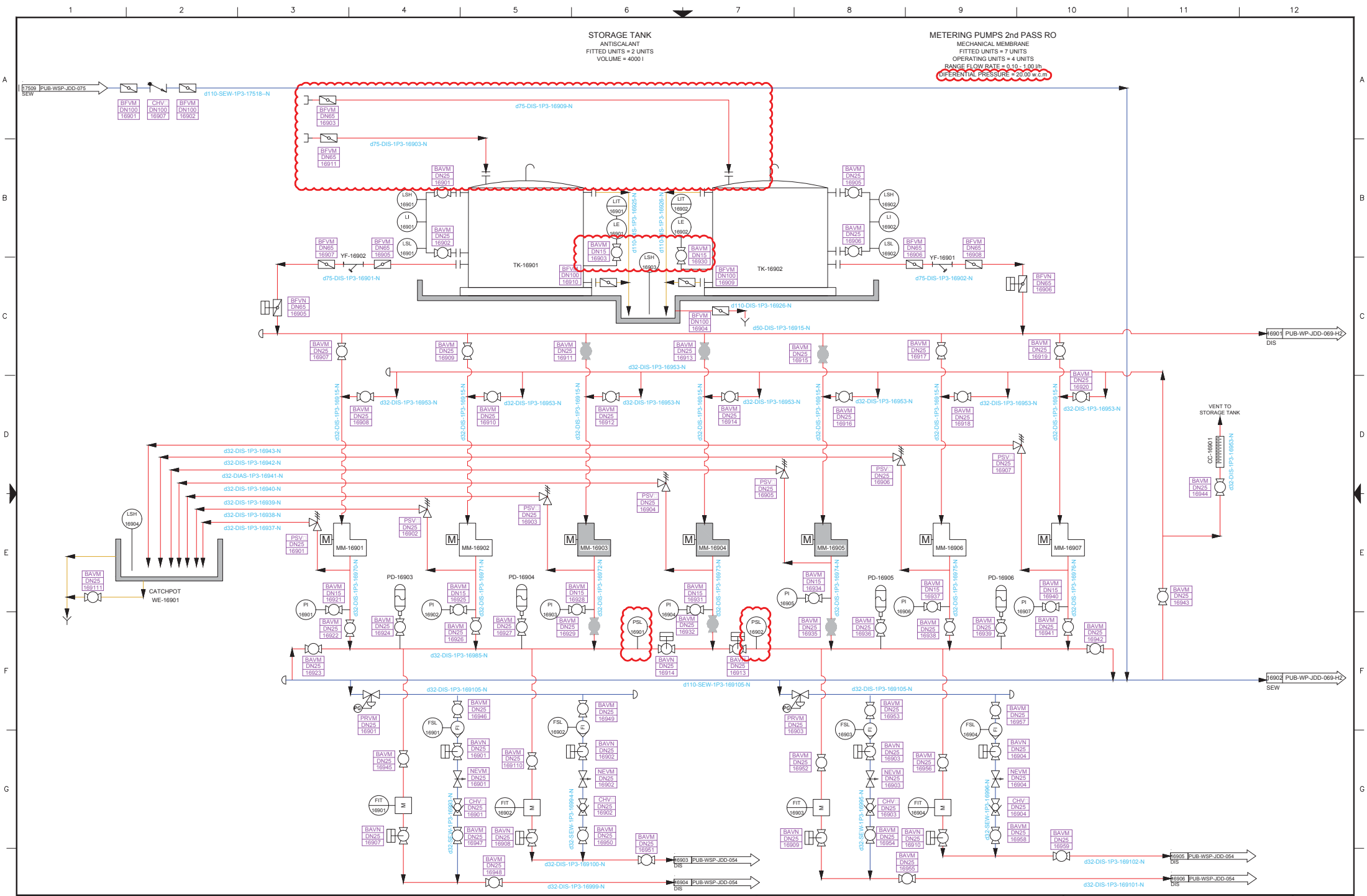
PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
CHEMICALS. AMMONIUM SULPHATE

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-068

FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 38

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
CHEMICALS. ANTISCALANT

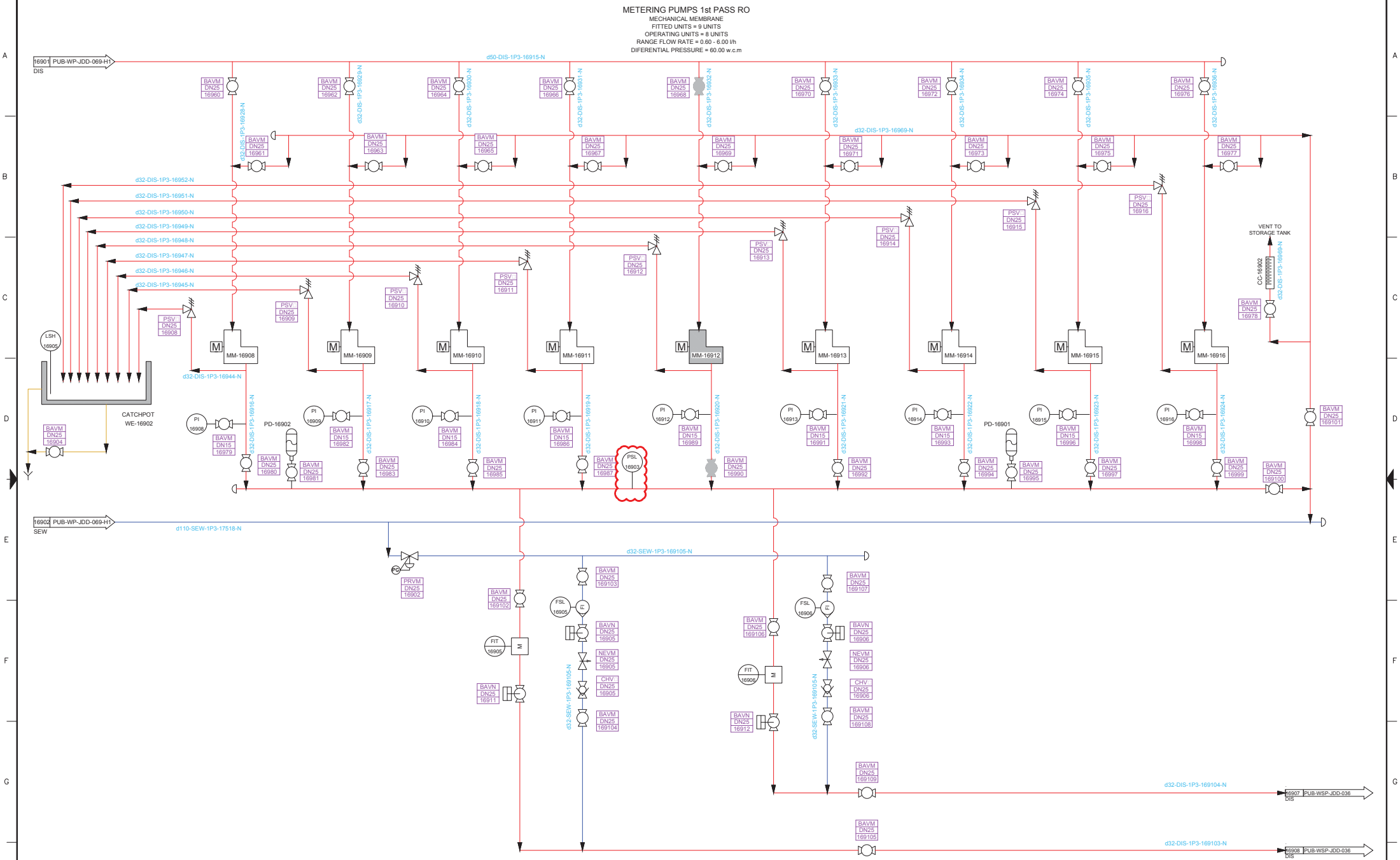
REFERENCE :
TDI-P-15-60

DRAWING Nº :
PUB-WSP-JDD-069

FORMAT
A1

SHEET 1 OF 2

DIN A1 (841 x 594)



NOTES :
- THIS SHEET CORREPONSE TO AREA: 38

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
CHEMICALS. ANTISCALANT

REFERENCE : TDI-P-15-60

DRAWING N° : PUB-WSP-JDD-069

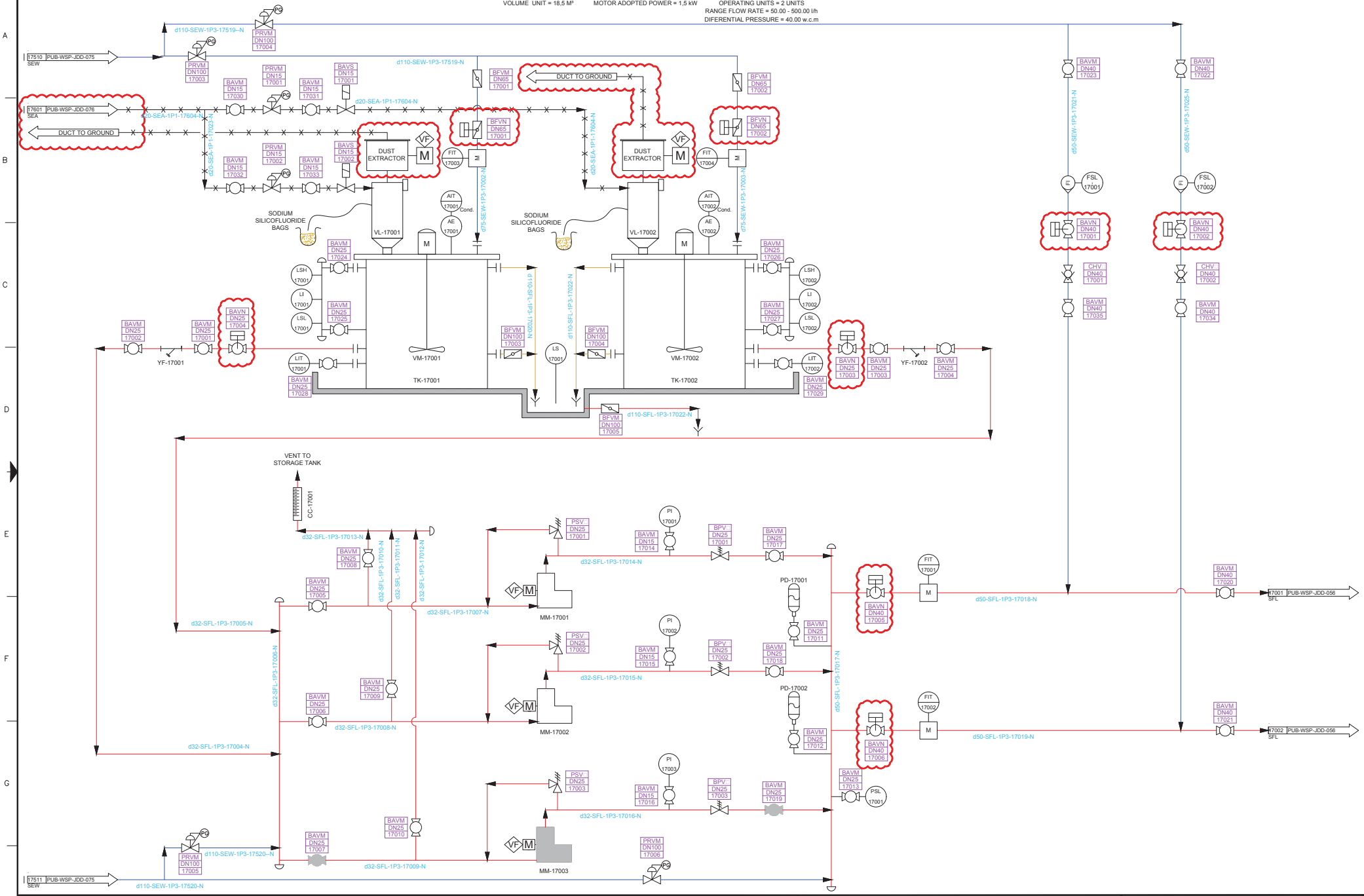
FORMAT A1 | SHEET 2 OF 2

DIN A1 (841 x 594)

DILUTION TANK
SILICOFLUORIDE
FITTED UNITS = 1+1 UNITS
VOLUME UNIT = 18,5 M³

SILICOFLUORIDE MIXER
FITTED UNITS PER TANK = 3 UNITS
OPERATING UNITS PER TANK = 1 UNITS
MOTOR ADOPTED POWER = 1,5 kW

METERING PUMPS
MECHANICAL MEMBRANE
FITTED UNITS = 3 UNITS
OPERATING UNITS = 2 UNITS
RANGE FLOW RATE = 50.00 - 500.00 l/h
DIFERENTIAL PRESSURE = 40.00 w.c.m



NOTES :
- THIS SHEET CORREPONSE TO AREA: 56

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
CHEMICALS. SILICOFLUORIDE

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-070

FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)

STORAGE SILO
FITTED UNITS = 1 UNIT
OPERATING UNITS = 1 UNIT
USEFUL UNITARY VOLUME = 81.00m³

VOLUMETRIC FEEDER
FITTED UNITS = 1 UNIT
OPERATING UNITS = 1 UNIT
UNITARY CAPACITY = 400 Kg/h

LIME SLURRY TANK
FITTED UNITS = 1 UNIT
OPERATING UNITS = 1 UNIT
UNITARY VOLUME = 4.00 m³

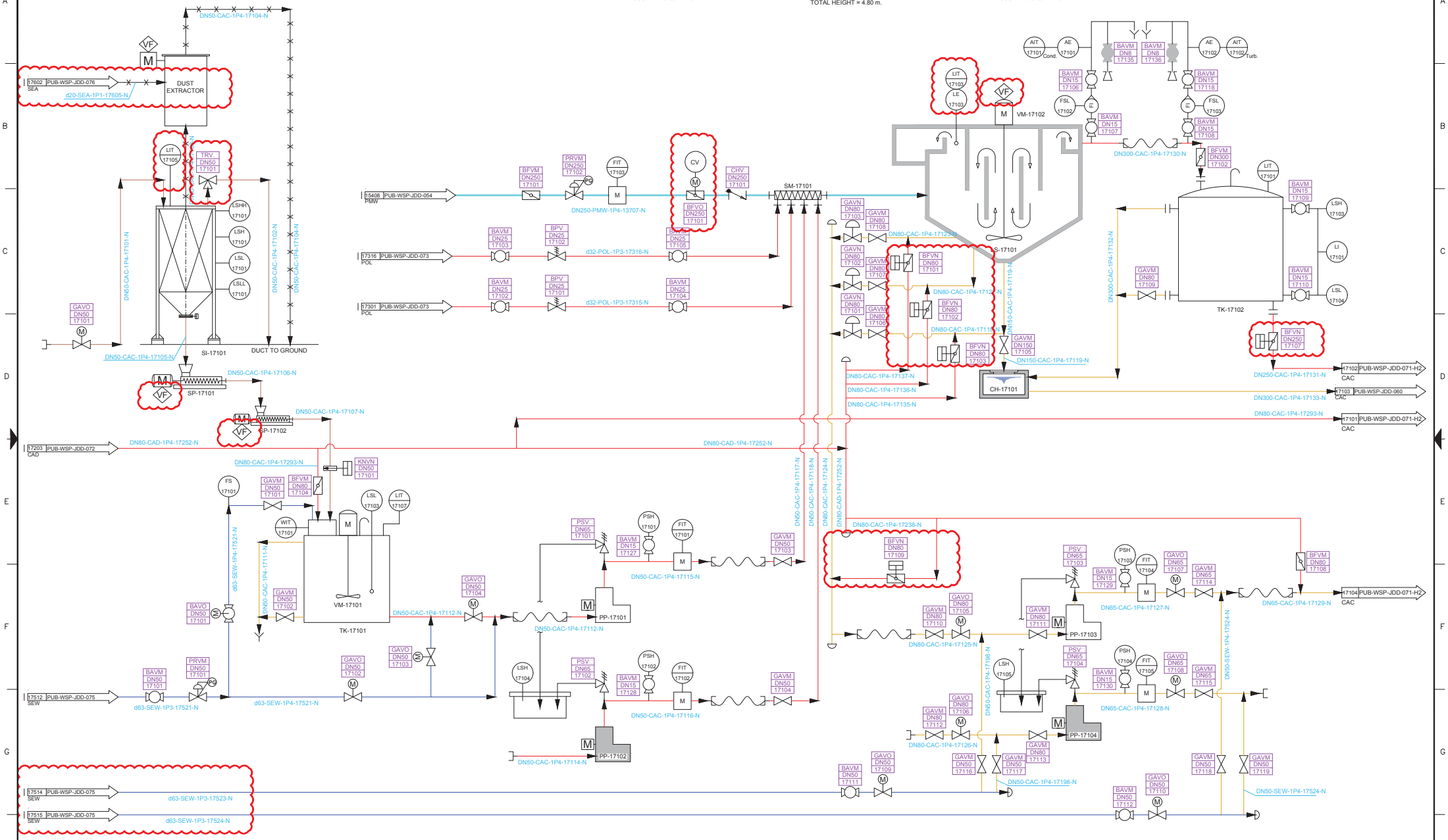
TANK MIXER
FITTED UNITS PER TANK= 1 UNIT
OPERATING UNITS = 1 UNIT
POWER = 1.50 kW

LIME SLURRY PUMPS
PERISTALTIC
FITTED UNITS = 2 UNITS
OPERATING UNITS = 1 UNIT
FLOW RATE = 10.00 m³/h
DIFFERENTIAL PRESSURE = 15.00 m.w.c.

LIME SATURATOR
FITTED UNITS = 1 UNIT
OPERATING UNITS = 1 UNIT
DIAMETER = 12.00 m.
CYLINDRICAL HEIGHT = 2.66 m.
CONICAL HEIGHT = 2.14 m.
TOTAL HEIGHT = 4.80 m.

SATURATOR SLUDGE PUMPS
PERISTALTIC
FITTED UNITS = 2 UNITS
OPERATING UNITS = 1 UNIT
FLOW RATE = 8.00 m³/h
DIFFERENTIAL PRESSURE = 60.00 m.w.c.

LIME WATER TANK
FITTED UNITS = 1 UNIT
OPERATING UNITS = 1 UNIT
VOLUME = 20000 l.



NOTES :
- THIS SHEET CORREPONSE TO AREA: 35

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
CHEMICALS. LIME

REFERENCE :
TDI-P-15-60

DRAWING Nº :
PUB-WSP-JDD-071

FORMAT
A1

SHEET 1 OF 2

DIN A1 (841 x 594)

STORAGE SILO
FITTED UNITS = 1 UNIT
OPERATING UNITS = 0 UNIT
USEFUL UNITARY VOLUME = 81.00m³

VOLUMETRIC FEEDER
FITTED UNITS = 1 UNIT
OPERATING UNITS = 0 UNIT
UNITARY CAPACITY = 400 Kg/h

LIME SLURRY TANK
FITTED UNITS = 1 UNIT
OPERATING UNITS = 0 UNIT
UNITARY VOLUME = 4.00 m³

TANK MIXER
FITTED UNITS PER TANK= 1 UNIT
OPERATING UNITS = 0 UNIT
POWER = 1.50 kW

LIME SLURRY PUMPS
PERISTALTIC
FITTED UNITS = 2 UNITS
OPERATING UNITS = 0 UNIT
FLOW RATE = 10.00 m³/h
DIFFERENTIAL PRESSURE = 15.00 m.w.c.

LIME SATURATOR
FITTED UNITS = 1 UNIT
OPERATING UNITS = 0 UNIT
DIAMETER = 12.00 m.
CYLINDRICAL HEIGHT = 2.66 m.
CONICAL HEIGHT = 2.14 m.
TOTAL HEIGHT = 4.80 m.

SATURATOR SLUDGE PUMPS
PERISTALTIC
FITTED UNITS = 2 UNITS
OPERATING UNITS = 0 UNIT
FLOW RATE = 8.00 m³/h
DIFFERENTIAL PRESSURE = 60.00 m.w.c.

LIME WATER TANK
FITTED UNITS = 1 UNIT
OPERATING UNITS = 1 UNIT
VOLUME = 20000 l.

LIME SATURATED WATER PUMPS
HORIZONTAL CENTRIFUGAL ANTIABRASIVE
FITTED UNITS = 2 UNITS
OPERATING UNITS = 1 UNIT
FLOW RATE = 225.00 m³/h
DIFFERENTIAL PRESSURE = 15.00 m.w.c.
ADOPTED MOTOR POWER = 22 kW

NOTES :
- THIS SHEET CORREPONSE TO AREA: 35

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
CHEMICALS. LIME

REFERENCE :
TDI-P-15-60

DRAWING Nº :
PUB-WSP-JDD-071

FORMAT
A1

SHEET 2 OF 2

DIN A1 (841 x 594)

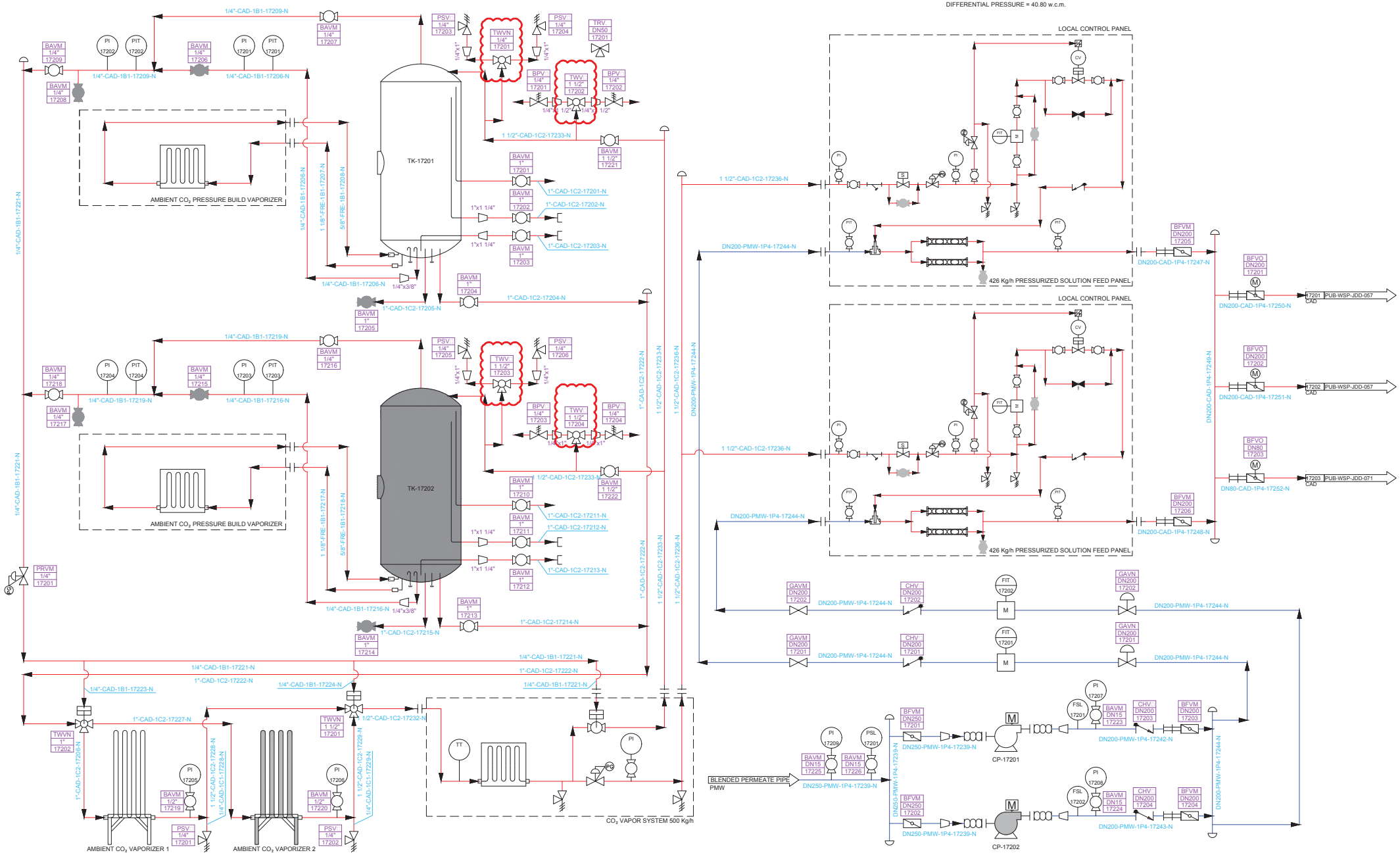
CARBON DIOXIDE STORAGE TANK

FITTED UNITS = 2 UNITS
OPERATING UNITS = 1 UNIT
UNIT USEFUL VOLUME = 46.45 MT.
TYPE = VACUUM JACKETED

CO_2 DILUTION PUMPS

HORIZONTAL CENTRIFUGAL

FITTED UNITS = 2 UNITS
OPERATING UNITS = 1 UNIT
ADOPTED UNIT FLOW RATE = 210.00 m³/h
DIFFERENTIAL PRESSURE = 40.80 w.c.m.



NOTES :
- THIS SHEET CORREPONSE TO AREA: 55

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
CHEMICALS. CARBON DIOXIDE

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-072

FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)

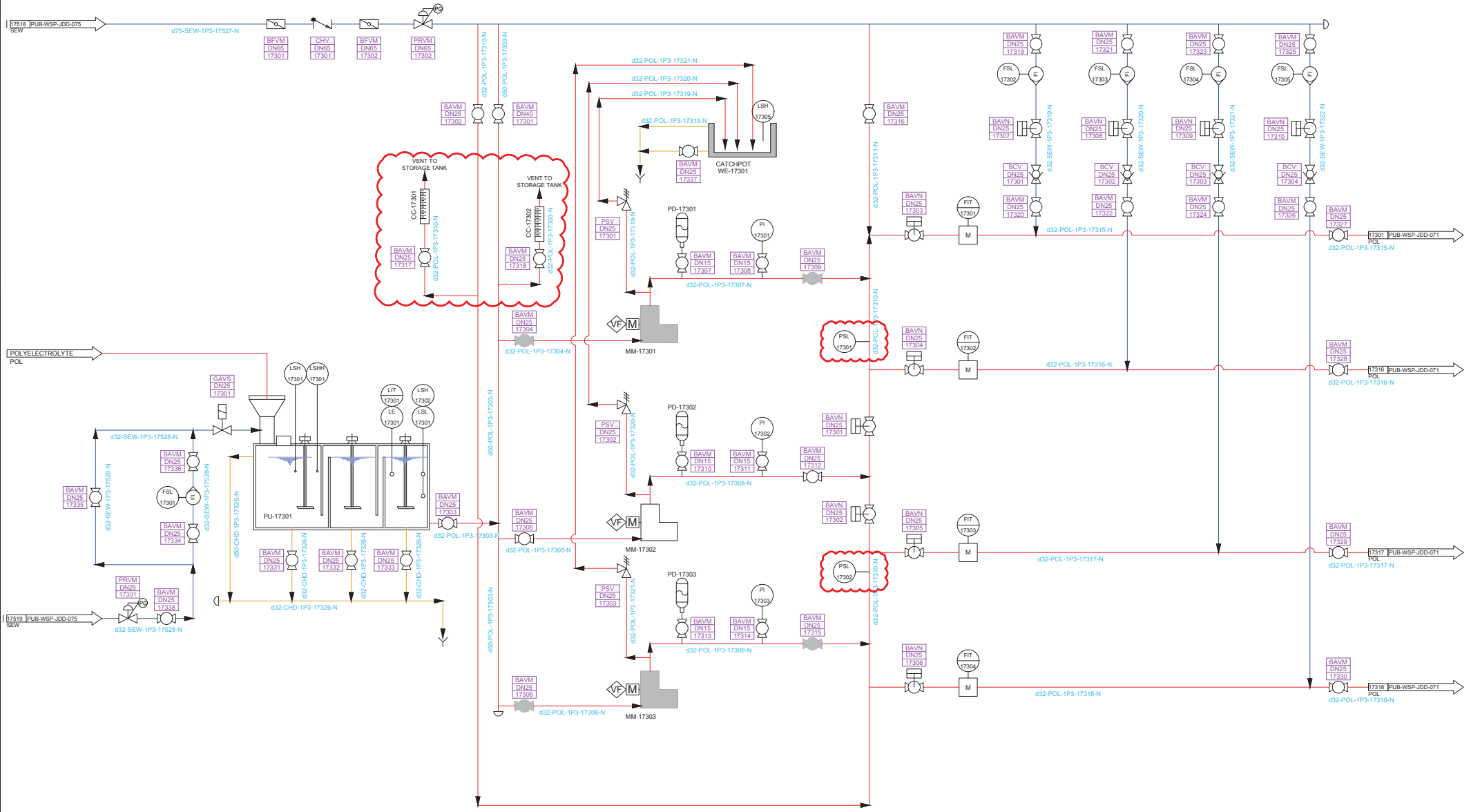
POLYELECTROLYTE COMPACT UNIT

FITTED UNITS = 1 UNIT
OPERATING UNITS = 1 UNIT
CAPACITY. = 225 L

METERING PUMPS

MECHANICAL MEMBRANE

FITTED UNITS = 3 UNITS
OPERATING UNITS = 1 UNIT
RANGE FLOW RATE = 15.00 - 150.00 l/h
DIFFERENTIAL PRESSURE = 60.00 w.c.m.



NOTES :
- THIS SHEET CORREPONSE TO AREA: 34

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
CHEMICALS. FLOCCULANT FOR SATURATORS

REFERENCE : TDI-P-15-60

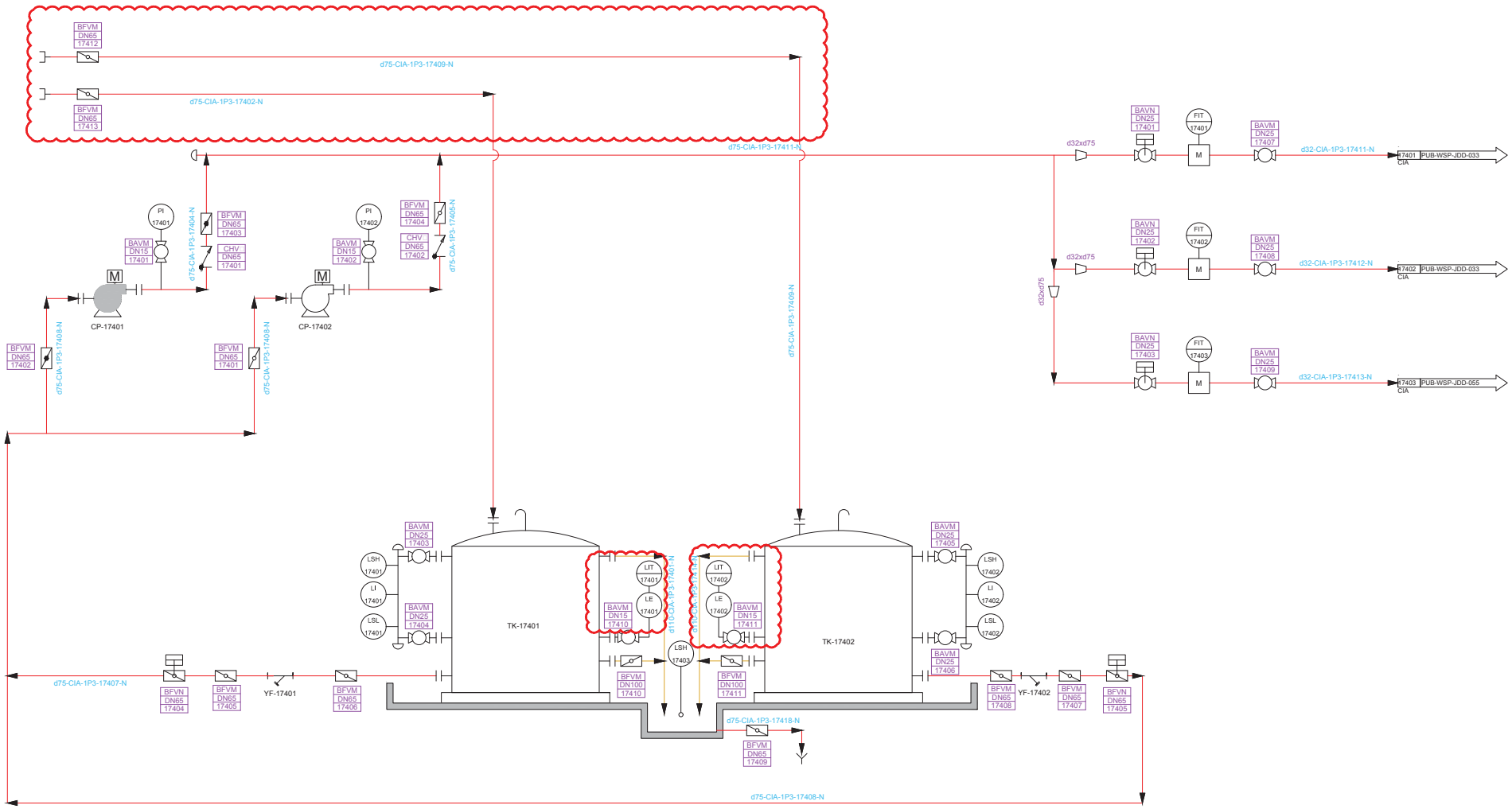
DRAWING Nº : PUB-WSP-JDD-073

FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)

TRANSFER PUMPS
HORIZONTAL CENTRIFUGAL
FITTED UNITS = 2 UNITS
OPERATING UNITS = 1 UNIT
FLOW RATE = 5.00 m³/h
DIFERENTIAL PRESSURE = 10.00 w.c.m

STORAGE TANK
CITRIC ACID
FITTED UNITS = 2 UNITS
VOLUME = 4000 l



NOTES :
- THIS SHEET CORREPONSE TO AREA: 54

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME:
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
CHEMICAL. CITRIC ACID

REFERENCE :
TDI-P-15-60

DRAWING Nº :
PUB-WSP-JDD-074

FORMAT
A1

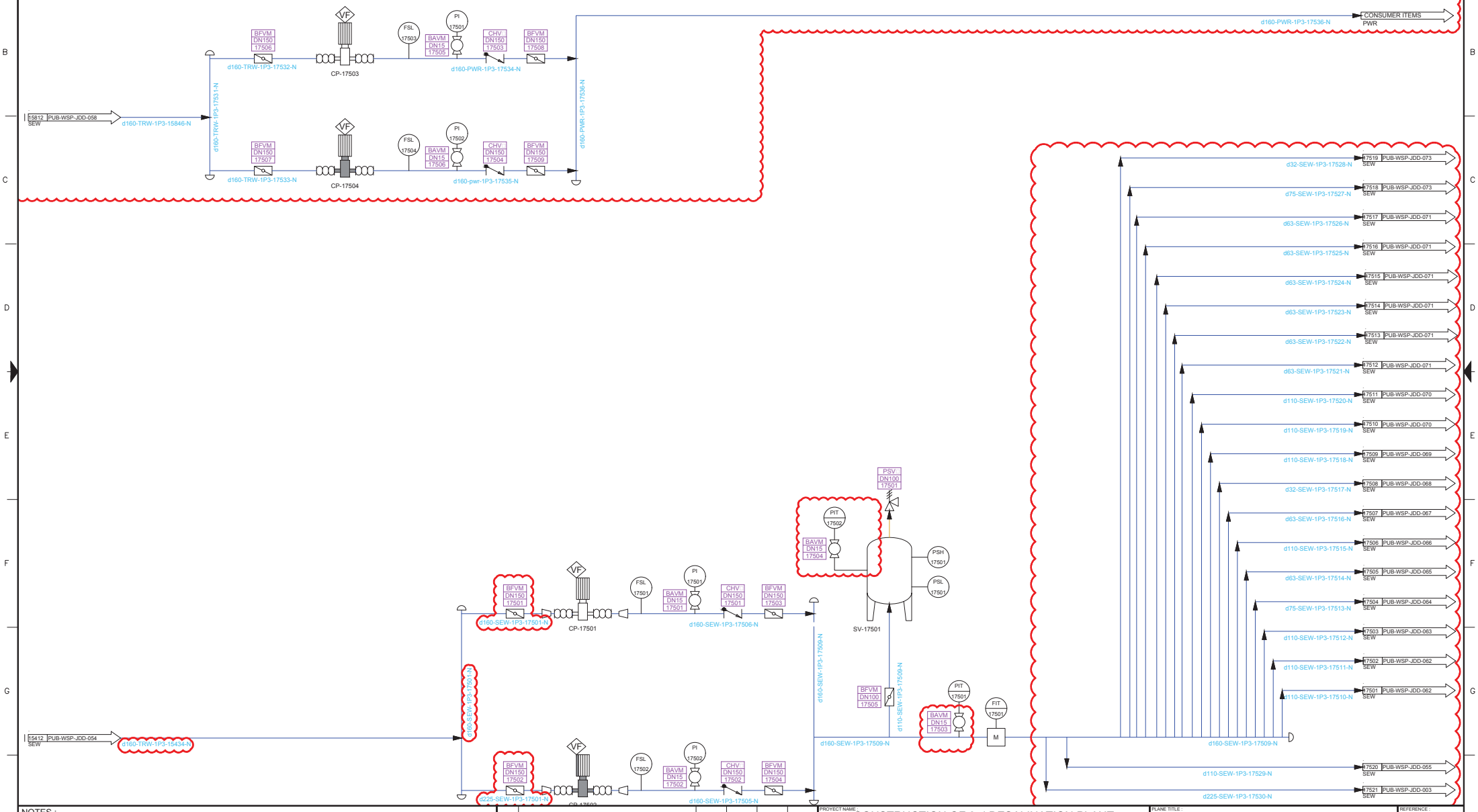
SHEET 1
OF 1

DIN A1 (841 x 594)

DRINKING WATER PUMPS
VERTICAL CENTRIFUGAL
FITTED UNITS = 2 UNITS
OPERATING UNITS = 1 UNIT
FLOW RATE = 20.00 m³/h
DIFFERENTIAL PRESSURE = 7.00 m.w.c.

SERVICE WATER PUMPS
VERTICAL CENTRIFUGAL
FITTED UNITS = 2 UNITS
OPERATING UNITS = 1 UNIT
FLOW RATE = 50.00 m³/h
DIFFERENTIAL PRESSURE = 7.00 m.w.c.

WATER HAMMER SURGE VESSEL



NOTES :
- THIS SHEET CORREPONSE TO AREA:

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME :
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
SERVICE WATER

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-075

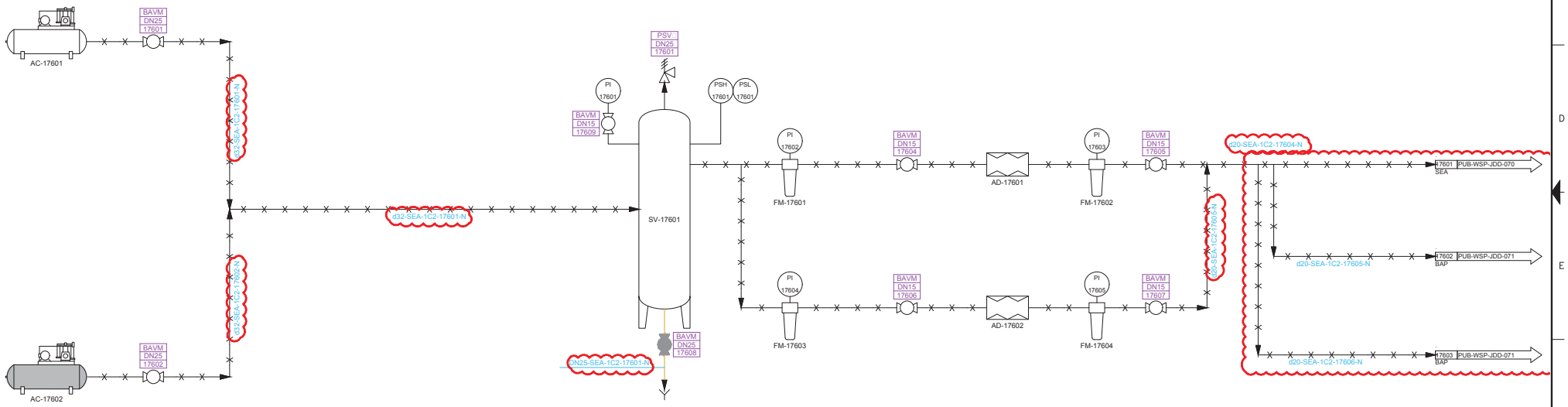
FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)

COMPRESSORS
TYPE: ROTATIVE LOBES (FREE OIL)
~~TYPE: ROTATIVE LOBES (OIL)~~
OPERATING UNITS = 1 UNIT
FLOW RATE ADOPTED = 80.00 Nm³/h
PRESSURE HEAD = 8.00 kg/cm²

PRESSURE VESSEL
FITTED UNITS = 1 UNIT
VOLUME UNIT = 500.00 l
MAX. PRESSURE = 8 Kg/cm²

REFIGERATION DRYER



NOTES :
- THIS SHEET CORREPONSE TO AREA:

REV.	DESCRIPTION	DATE	DRAWING	REVISED	APROVAL
B	COMMENT INCORPORATED AND RELEASED FOR APPROVAL	16/04/26	JRN	PAM	RFD
A	FOR APPROVAL	16/02/12	JRN	PAM	RFD

REVISION

PROYECT NAME
CONSTRUCTION OF 3rd DESALINATION PLANT
TUAS (SINGAPORE)

PLANE TITLE :
SWRO DESALINATION PLANT
PIPING AND INSTRUMENTATION DIAGRAMS
SERVICE AIR

REFERENCE : TDI-P-15-60

DRAWING Nº : PUB-WSP-JDD-076

FORMAT A1 | SHEET 1 OF 1

DIN A1 (841 x 594)

ANNEX II: DATASHEETS

ORP meter data sheet

1	MANUFACTURER										
2	MODEL										
3	ITEM Nº	REVISION	1	01	2	01	3	01	4	01	
4	SERVICE		Intake sample		Intake sample		UF/MF feed sample		RO disc filters feed		
5	LINE SIZE AND SPECIFICATION		d32/1P3		d32/1P3		d32/1P3		DN1600/1P4		
6	PROCESS DATA	FLUID	RSW (Raw seawater)		RSW (Raw seawater)		FTW (Filtered water)		UFW (Ultrafiltrated water)		
7		HUMIDITY (%) : MINIMUM / MAXIMUM	80	99	80	99	80	99	80	99	
8		TEMPERATURE (ºC): MiNIMUM / MAXIMUM	26	32	26	32	26	32	26	32	
9		PRESSURE (bara) OPERATION / MAXIMUM	2	10	2	10	2	10	3,5	10	
10		REDOX (mV) OPERATION	170		170		170		170		
11		REDOX (mV) MIN. / MAX.	-1500	1500	-1500	1500	-1500	1500	-1500	1500	
12		FLOW (m3/h) MINIMUM / MAXIMUM	0	26	0	26	0	26	0	26	
13		DENSITY (kg/m3)	1030		1030		1030		1030		
14		AMBIENT TEMPERATURE (ºC): MINIMUM / MAXIMUM	5	50	5	50	5	50	5	50	
15	SAMPLING	IN PROCESS LINE	NA		NA		NA		NA		
16		IN SAMPLING LINE	YES		YES		YES		YES		
17											
18											
19											
20	PROBE	TAG NUMBER	AE10201		AE10205		AE10606		AE13501		
21		MODEL	Note 6		Note 6		Note 6		Note 6		
22		TYPE	Electrodes		Electrodes		Electrodes		Electrodes		
23		MOUNTING	In sensor jar (Note 1)		In sensor jar (Note 1)		In sensor jar (Note 1)		In sensor jar (Note 1)		
24		PROBE LENGTH	Note 6		Note 6		Note 6		Note 6		
25		ADJUSTABLE RANGE MEASURE	YES		YES		YES		YES		
26		REFERENCE ELECTRODE	YES (Calomel)		YES (Calomel)		YES (Calomel)		YES (Calomel)		
27		PROCESS CONNECTION	1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		
28		ELECTROLYTE	Note 2		Note 2		Note 2		Note 2		
29		TEMPERATURE COMPENSATION	YES		YES		YES		YES		
30		ELECTRODE MATERIAL	Glass		Glass		Glass		Glass		
31		WETTED PARTS	Note 6		Note 6		Note 6		Note 6		
32		CABLE LENGTH TO TRANSMITTER	Vendor specified (note 3)		Vendor specified (note 3)		Vendor specified (note 3)		Vendor specified (note 3)		
33		ELECTRICAL CONNECTION	Note 6		Note 6		Note 6		Note 6		
34		ENCLOSURE PROTECTION	IP65		IP65		IP65		IP65		
35		HAZARDOUS AREA PROTECTION	NA		NA		NA		NA		
36											
37	TRANSMITTER	TAG NUMBER	AIT10201		AIT10205		AIT10606		AIT13501		
38		MODEL	Note 6		Note 6		Note 6		Note 6		
39		MOUNTING	In panel (Note 1)		In panel (Note 1)		In panel (Note 1)		In panel (Note 1)		
40		SPAN	Adjustable, min. 300 mV		Adjustable, min. 300 mV		Adjustable, min. 300 mV		Adjustable, min. 300 mV		
41		ACCURACY	±2 mV or better		±2 mV or better		±2 mV or better		±2 mV or better		
42		REPEATABILITY	±2 mV or better		±2 mV or better		±2 mV or better		±2 mV or better		
43		RESPONSE TIME	<= 15 seg		<= 15 seg		<= 15 seg		<= 15 seg		
44		POWER SUPPLY	230 Vac, 50 Hz		230 Vac, 50 Hz		230 Vac, 50 Hz		230 Vac, 50 Hz		
45		OUTPUT SIGNAL	Profibus (Note 4)		Profibus (Note 4)		Profibus (Note 4)		Profibus (Note 4)		
46		WIRES INPUTS	1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		
47		HOUSING SEAL	Note 6		Note 6		Note 6		Note 6		
48		ENCLOSURE PROTECTION	IP67		IP67		IP67		IP67		
49		HAZARDOUS AREA PROTECTION	NA		NA		NA		NA		
50											
51	ACCESORIES	DIGITAL LOCAL INDICATOR — INTEGRATED / INDEPENDENT	INTEGRATED		INTEGRATED		INTEGRATED		INTEGRATED		
52		SCALE mV	-1500	1500	-1500	1500	-1500	1500	-1500	1500	
53		FLOW VESSEL — MODEL	Note 6		Note 6		Note 6		Note 6		
54		MATERIAL	Note 6		Note 6		Note 6		Note 6		
55		CONNECTIONS Size	NPT	Note 6	NPT	Note 6	NPT	Note 6	NPT	Note 6	
56	PIPING AND INSTR. DIAGRAM. Number		PUB-WSP-JDD-002		PUB-WSP-JDD-002		PUB-WSP-JDD-006		PUB-WSP-JDD-035		
57											
58											
59											

60	NOTES	(1) See PUB-WSP-ISA-001 (process connection diagram)	UNITS
61		(2) Completely detailed in the manufacturer catalogue.	PRESSURE: bara
62		(3) Supplier provide transmitter with display away from the Sensor, with connection cable (Remote version).	TEMPERATURE: ºC
63		(4) As general rule standard communication protocol shall be Profibus PA. Also Profibus DP could be accepted. If Profibus protocol is not available, HART protocol could be accepted.	FLOW: m3/h
64		(5) In addition, a fault relay shall provide indication of any probe or analyser fault.	DENSITY: kg / m^3
65		(6) The supplier has to complete the datasheets according to Instruments use and process condition (fluid, pressure, temperature and flow).	ORP (Redox value): mV
66			

O2 meter data sheet

1	MANUFACTURER										
2	MODEL										
3	ITEM Nº	REVISION	1	01	2	01	3	01	4	01	
4	SERVICE		Intake sample		Outfall sample						
5											
6	LINE SIZE AND SPECIFICATION		d32/1P3		DN25/1P4						
7	PREOCESS DATA	FLUIDE	RSW (Raw seawater)		CWC (Clean water chemistry)						
8		HUMIDITY (%) : MINIMUM MAXIMUM	80	99	80	99					
9		TEMPERATURE (ºC): MINIMUM MAXIMUM	26	32	26	32					
10		PRESSURE (bara) OPERATION MAXIMUM	2	10	2	10					
11		O2 (mg/l) OPERATION									
12		O2 (mg/l) MIN. / MAX.									
13		FLOW (l/h) MINIMUM/ MAXIMUM	0	1482	0	1482					
14		DENSITY (kg/m³)	1000		1000						
15		AMBIENT TEMPERATURE (ºc): MINIMUM/MAXIMUM	5	50	5	50					
16	PROBE	TAG NUMBER	AE10210		AE16106						
17		MODEL	Note 4		Note 4						
18		TYPE	Electrochemical		Electrochemical						
19		MOUNTING	In sensor jar (Note 1)		In sensor jar (Note 1)						
20		PROCESS CONNECTION	1/2" NPT		1/2" NPT						
21		PROBE LENGTH	Note 4		Note 4						
22		PROBE MATERIAL	Note 4		Note 4						
23		CATHODE	PLATINUM		PLATINUM						
24		ELECTROLYTE	GEL		GEL						
25		ENCLOSURE PROTECTION	IP 65		IP 65						
26		HAZARDOUS PROTECTION	NA		NA						
27		SENSOR RANGE (mg/l)	0	0	0	0					
28		REPEATABILITY	±1% saturation or better		±1% saturation or better						
29		ACCURACY	±1% saturation or better		±1% saturation or better						
30		RESPONSE TIME	≤ 15 seconds		≤ 15 seconds						
31		CABLE LENGTH TO TRANSMITTER	Vendor specified (Note 2)		Vendor specified (Note 2)						
32	TRANSMETTEUR	TAG NUMBER	AIT10210		AIT16106						
33		MODEL	Note 4		Note 4						
34		MOUNTING	In panel (Note 1)		In panel (Note 1)						
35		SPAN	Note 4		Note 4						
36		POWER SUPPLY	230 Vac 50Hz		230 Vac 50Hz						
37		OUTPUT SIGNAL	Profibus (Note 3)		Profibus (Note 3)						
38		AUTOMATIC COMPENSATION	Temperature, altitude and salinity		Temperature, altitude and salinity						
39		WIRES INPUT	1/2" NPT		1/2" NPT						
40		MATERIAL	Note 4		Note 4						
41		ENCLOSURE PROTECTION	IP 66/67		IP 66/67						
42		HAZARDOUS AREA PROTECTION	NA		NA						
43		DIGITAL LOCAL INDICATOR INTEGRATED / INDEPENDENT	INTEGRATED		INTEGRATED						
44		DIGITAL LOCAL INDICATOR SCALE	0	0	0	0					
45	PIPPING AND INST. DIAGRAM. Number		PUB-WSP-JDD-002		PUB-WSP-JDD-061						
46											
47											

48	NOTES (1) See PUB-WSP-ISA-001 (process connection diagram)	UNITS
49	(2) Supplier provide transmitter with display away from the Sensor, with connection cable (Remote version).	PRESSURE: bara
50	(3) As general rule standard communication protocol shall be Profibus PA. Also Profibus DP could be accepted. If Profibus protocol is not available, HART protocol could be accepted.	TEMPERATURE: ºC
51	(4) The supplier has to complete the datasheets according to Instruments use and process condition (fluid, pressure, temperature and flow).	FLOW: m3/h
52		DENSITY: kg / m^3
53		O2: mg/l
54		
55		
56		
57		
58		
59		
60		
61		

Turbidity meter data sheet

1	MANUFACTURER										
2	MODEL										
3	ITEM Nº	REVISION	1	01	2	01	3	01	4	01	
4	SERVICE		Intake sample		Post coagulation sample		UF feed sample		UF/MF feed sample		
5	LINE SIZE AND SPECIFICATION		d32/1P3		d32/1P3		d32/1P3		d32/1P3		
6	PROCESS	FLUID	RSW (raw seawater)		RSW (raw seawater)		CLW (Clarified water)		FTW (Filtered water)		
7											
8		HUMIDITY (%) : MINIMUM	MAXIMUM	80	99	80	99	80	99	80	99
9		TEMPERATURE (ºC): MiNIMUM / MAXIMUM		26	32	26	32	26	32	26	32
10		PRESSURE (bara) OPERATION / MAXIMUM		2	10	2	10	2	10	2	10
11		NTU OPERATION		14,00		1,00		1,00		1,00	
12		NTU MIN. / MAX.		0,1	100	0,02	100	0,02	100	0,02	100
13		FLOW (l/h) MINIMUM / MAXIMUM		0	78	0	78	0	78	0	78
14		DENSITY (kg/m3)		995,72		995,72		995,72		995,72	
15		AMBIENT TEMPERATURE (ºC)		5	50	5	50	5	50	5	50
16	SAMPLING	IN PROCESS LINE		NA		NA		NA		NA	
17		IN SAMPLING LINE		YES		YES		YES		YES	
18											
19											
20											
21	PROBE TURBIDITY METER	TAG NUMBER		AE10203		AE10301		AE10401		AE10603	
22		MODEL		Note 4		Note 4		Note 4		Note 4	
23		TYPE		90º scattered light		90º scattered light		90º scattered light		90º scattered light	
24		MOUNTING		In sensor jar (Note 1)		In sensor jar (Note 1)		In sensor jar (Note 1)		In sensor jar (Note 1)	
25		PROBE LENGTH		Note 4		Note 4		Note 4		Note 4	
26		ADJUSTABLE RANGE MEASURE		YES		YES		YES		YES	
27		LIGHT SOURCE		LASER		LASER		LASER		LASER	
28		CONNECTION TYPE		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT	
29		TEMPERATURE COMPENSATION		YES		YES		YES		YES	
30		SENSOR CARRIER PLATE		Note 4		Note 4		Note 4		Note 4	
31		CABLE LENGTH TO TRANSMITTER		Vendor specified (note 2)		Vendor specified (note 2)		Vendor specified (note 2)		Vendor specified (note 2)	
32		ELECTRICAL CONNECTION		Note 4		Note 4		Note 4		Note 4	
33		ENCLOSURE PROTECTION		IP65		IP65		IP65		IP65	
34		HAZARDOUS PROTECTION AREA		NA		NA		NA		NA	
35											
36	TRANSMITTER	TAG NUMBER		AIT10203		AIT10301		AIT10401		AIT10603	
37		MODEL		Note 4		Note 4					
38		MOUNTING		PANEL MOUNT		PANEL MOUNT		PANEL MOUNT		PANEL MOUNT	
39		MEASURE RANGE		0 - 100 (NTU)		0 - 100 (NTU)		0 - 100 (NTU)		0 - 100 (NTU)	
40		ACCURACY		From 0 to 20 NTU: ±2 % of reading or ±0,02 NTU Above 20 NTU: ±5% of reading		From 0 to 20 NTU: ±2 % of reading or ±0,02 NTU Above 20 NTU: ±5% of reading		From 0 to 20 NTU: ±2 % of reading or ±0,02 NTU Above 20 NTU: ±5% of reading		From 0 to 20 NTU: ±2 % of reading or ±0,02 NTU Above 20 NTU: ±5% of reading	
41		REPEATABILITY		0% of reading or ±0,003 NTU wichever is grea		0% of reading or ±0,003 NTU wichever is grea		0% of reading or ±0,003 NTU wichever is grea		0% of reading or ±0,003 NTU wichever is grea	
42		RESPONSE TIME		<= 5 seg		<= 5 seg		<= 5 seg		<= 5 seg	
43		POWER SUPPLY		230 Vac, 50 hz		230 Vac, 50 hz		230 Vac, 50 hz		230 Vac, 50 hz	
44		OUTPUT SIGNAL		Profibus (Note 3)		Profibus (Note 3)		Profibus (Note 3)		Profibus (Note 3)	
45		SUSPENDED SOLIDS READING (mg/l)		YES		YES		YES		YES	
46		WIRES INPUTS		Note 4		Note 4		Note 4		Note 4	
47		HOUSING SEAL		Note 4		Note 4		Note 4		Note 4	
48		ENCLOSURE PROTECTION		IP65		IP65		IP65		IP65	
49		HAZARDOUS PROTECTION AREA		NA		NA		NA		NA	
50	ACCESORIES	DIGITAL LOCAL INDICATOR	INTEGRATED / INDEPENDENT	INTEGRAL		INTEGRAL		INTEGRAL		INTEGRAL	
51			SCALE	0 - 100 (NTU)		0 - 100 (NTU)		0 - 100 (NTU)		0 - 100 (NTU)	
52		BUBBLE TRAP		YES		YES		YES		YES	
53		SELF CLEANING DEVICE		YES		YES		YES		YES	
54		FLOW VESSEL	MODEL	Note 4		Note 4		Note 4		Note 4	
55			MATERIAL	Note 4		Note 4		Note 4		Note 4	
56			CONNECTIONS Size	NPT	Note 4	NPT	Note 4	NPT	Note 4	NPT	Note 4
57	PIPING AND INSTR. DIAGRAM. Number			PUB-WSP-JDD-002		PUB-WSP-JDD-003		PUB-WSP-JDD-004		PUB-WSP-JDD-006	
58											
59											
60											
61	NOTES	(1) See PUB-WSP-ISA-001 (process connection diagram)									
62		(2) Supplier provide transmitter with display away from the Sensor, with connection cable (Remote version).									
63		(3) As general rule standard communication protocol shall be Profibus PA. Also Profibus DP could be accepted. If Profibus protocol is not available, HART protocol could be accepted.									
64		(4) The supplier has to complete the datasheets according to Instruments use and process condition (fluid, pressure, temperature and flow).									
65											
66											
67											

Conductivity meter data sheet

1	MANUFACTURER														
2	MODEL														
3	ITEM N°	REVISION	1	01	2	01	3	01	4	01	5	01			
4															
5	SERVICE		Intake sample		RO discfilter sample		RO discfilter sample		1st pass RO rack 1 inlet		1st pass RO rack 1 permeate to flushing tanks				
6															
7	LINE SIZE AND SPECIFICATION		d32/1P3		d32/1P3		d32/1P3		16"/6C1		DN300/1P4				
8	PROCESS	FLUID	RSW (raw seawater)		UFW (Ultrafiltrated water)		UFW (Ultrafiltrated water)		UFW (Ultrafiltrated water)		PMW (Permeated water)				
9															
10		TEMPERATURE (ºC): MiNIMUM / MAXIMUM	26	32	26	32	26	32	26	32	26	32			
11		PRESSURE (bara) OPERATION MAXIMUM	2	10	2	10	2	10	65,8	100	1,7	10			
12		COND. OPERATION (µS/cm)	54600		23,08		23,08		4000		150-500				
13		COND. (µS/cm) MIN. / MAX.	0	81900	11,54	46,1	11,54	46,1	0,2	200000	0,2	200000			
14		FLOW (l/h): MINIMUM / MAXIMUM	0	39	0	39	0	39	0	39	0	39			
15		DENSITY (kg /m3)	1030		1030		1030		1030		1030				
16		AMBIENT TEMPERATURE (ºC)	5	50	5	50	5	50	5	50	5	50			
17		HUMIDITY (%) : MINIMUM / MAXIMUM	80	99	80	99	80	99	80	99	80	99			
18	SAMPL.	IN PROCESS LINE	NA		NA		NA		NA		NA				
19		IN SAMPLING LINE	YES		YES		YES		YES		YES				
20															
21	PROBE	TAG NUMBER	AE10206		AE13605		AE13610		AE13802		AE13804				
22		MODEL	Note 6		Note 6		Note 6		Note 6		Note 6				
23		TYPE	Electrodes		Electrodes		Electrodes		Electrodes		Electrodes				
24		MOUNTING	In sensor jar (Note 1)		In sensor jar (Note 1)		In sensor jar (Note 1)		In sensor jar (Note 1)		In sensor jar (Note 1)				
25		PROBE LENGTH	Note 6		Note 6		Note 6		Note 6		Note 6				
26		ADJUSTABLE RANGE MEASURE	YES		YES		YES		YES		YES				
27		REFERENCE ELECTRODE	Note 6		Note 6		Note 6		Note 6		Note 6				
28		SENSOR CONNECTION TYPE	1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT						
29		ELECTROLYTE	Note 2		Note 2		Note 2		Note 2		Note 2				
30		TEMPERATURE COMPENSATION	YES		YES		YES		YES		YES				
31		ELECTRODE MATERIAL	Note 6		Note 6		Note 6		Note 6		Note 6				
32		WETTED PARTS	Note 6		Note 6		Note 6		Note 6		Note 6				
33		CABLE LENGTH TO TRANSMITTER	Vendor specified (note 3)		Vendor specified (note 3)		Vendor specified (note 3)		Vendor specified (note 3)		Vendor specified (note 3)				
34		ELECTRICAL CONNECTION	Note 6		Note 6		Note 6		Note 6		Note 6				
35		ENCLOSURE PROTECTION	IP67		IP67		IP67		IP67		IP67				
36		HAZARD PROTECTION AREA	NA		NA		NA		NA		NA				
37															
38	TRANSMITTER	TAG NUMBER	AIT10206		AIT13605		AIT13610		AIT13802		AIT13804				
39		MODEL	Note 6		Note 6		Note 6		Note 6		Note 6				
40		MOUTING	In panel (Note 1)		In panel (Note 1)		In panel (Note 1)		In panel (Note 1)		In panel (Note 1)				
41		MEASURE RANGE (µS/cm)	0	81900	11,54	46,1	11,54	46,1	0,2	200000	0,2	200000			
42		ACCURACY	±1,0% of fsd or better		±1,0% of fsd or better		±1,0% of fsd or better		±1,0% of fsd or better		±1,0% of fsd or better				
43		REPEATABILITY	±0,5% of fsd or better		±0,5% of fsd or better		±0,5% of fsd or better		±0,5% of fsd or better		±0,5% of fsd or better				
44		RESPONSE TIME	<= 7 seg		<= 7 seg		<= 7 seg		<= 7 seg		<= 7 seg				
45		POWER SUPPLY	230 Vac, 50 Hz		230 Vac, 50 Hz		230 Vac, 50 Hz		230 Vac, 50 Hz		230 Vac, 50 Hz				
46		OUTPUT SIGNAL	Profibus (Note 4)		Profibus (Note 4)		Profibus (Note 4)		Profibus (Note 4)		Profibus (Note 4)				
47		WIRES INPUTS	1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT				
48		HOUSING SEAL	Note 6		Note 6		Note 6		Note 6		Note 6				
49		ENCLOSURE PROTECTION	IP67		IP68		IP68		IP68		IP67				
50		HAZARDOUS AREA PROTECTION	NA		NA		NA		NA		NA				
51															
52	ACCESORIES	DIGITAL LOCAL INDICATOR — INTEGRATED / INDEPENDENT	INTEGRATED		INTEGRATED		INTEGRATED		INTEGRATED		INTEGRATED				
53		DIGITAL LOCAL INDICATOR — SCALE (µS/cm)	0	81900	11,54	46,1	11,54	46,1	0,2	200000	0,2	200000			
54		FLOW VESSEL — MODEL	Note 6		Note 6		Note 6		Note 6		Note 6				
55		FLOW VESSEL — MATERIAL	Note 6		Note 6		Note 6		Note 6		Note 6				
56		FLOW VESSEL — CONNECTIONS Size	NPT	Note 6	NPT	Note 6	NPT	Note 6	NPT	Note 6	NPT	Note 6			
57	PIPING AND INSTR. DIAGRAM. Number		PUB-WSP-JDD-002		PUB-WSP-JDD-036		PUB-WSP-JDD-036		PUB-WSP-JDD-038		PUB-WSP-JDD-038				
58															
59															
60															

61	NOTES	(1) See PUB-WSP-ISA-001 (process connection diagram)
62		(2) Completely detailed in the manufacturer catalogue.
63		(3) Supplier provide transmitter with display away from the Sensor, with connection cable (Remote version).
64		(4) As general rule standard communication protocol shall be Profibus PA. Also Profibus DP could be accepted. If Profibus protocol is not available, HART protocol could be accepted.
65		(5) In addition, a relay alarm output to indicate cell fouling other serious fault condition.
66		(6) The supplier has to complete the datasheets according to Instruments use and process condition (fluid, pressure, temperature and flow).
67		

UNITS	
PRESSURE:	BARA
TEMPERATURE:	ºC
FLOW:	m3/h
DENSITY:	Kg / m^3
CONDUCTIVITYITY:	µS/cm
ÁREA:	cm^2

pH meter data sheet

1	MANUFACTURER										
2	MODEL										
3	ITEM Nº	REVISION	1	01	2	01	3	01	4	01	
4	SERVICE		Intake sample		Post coagulation sample		UF feed sample		UF/MF feed sample		
5	LINE SIZE AND SPECIFICATION		d32/1P3		d32/1P3		d32/1P3		d32/1P3		
6	PROCESS	FLUID	RSW (Raw seawater)		RSW (Raw seawater)		CLW (Clarified water)		FTW (FItered water)		
7											
8		TEMPERATURE: (ºC) MiNIMUM	MAXIMUM	26	32	26	32	26	32	26	32
9		PRESSURE (bara) OPERATION	MAXIMUM	2	10	2	10	2	10	2	10
10		pH OPERATION		7,2		7		7,3-8,0		7	
11		pH MIN. / MAX.		5	11	5	11	0	14	5	11
12		FLOW (l/h): MINIMUM	MAXIMUM	0	26	0	26	0	26	0	26
13		DENSITY (kg/m3)		1030		995,72		995,72		1030	
14		AMBIENT TEMPERATURE (ºC)		5	50	5	50	5	50	5	50
15		HUMIDITY (%) : MINIMUM	MAXIMUM	80	99	80	99	80	99	80	99
16	SAMPLING	IN PROCESS LINE		NA		NA		NA		NA	
20		IN SAMPLING LINE		YES		YES		YES		YES	
21											
22											
23											
24	PROBE PH / REDOX	TAG NUMBER		AE10207		AE10302		AE10402		AE10602	
25		MODEL		Note 7		Note 7		Note 7		Note 7	
26		TYPE		Electrode		Electrode		Electrode		Electrode	
27		MOUNTING		In sensor jar (Note 1)		In sensor jar (Note 1)		In sensor jar (Note 1)		In sensor jar (Note 1)	
28		PROBE LENGTH		Note 7		Note 7		Note 7		Note 7	
29		ADJUSTABLE RANGE MEASURE		YES		YES		YES		YES	
30		REFERENCE ELECTRODE		YES (calomel)		YES (calomel)		YES (calomel)		YES (calomel)	
31		SENSOR CONNECTION TYPE		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT	
32		ELECTROLYTE		Note 2		Note 2		Note 2		Note 2	
33		TEMPERATURE COMPENSATION		YES (pt100)		YES (pt100)		YES (pt100)		YES (pt100)	
34		ELECTRODE MATERIAL		Glass		Glass		Glass		Glass	
35		HOUSING, ELECTRODE SHAFT		Note 7		Note 7		Note 7		Note 7	
36		CABLE LENGTH TO TRANSMITTER		Vendor specified (Note 3)		Vendor specified (Note 3)		Vendor specified (Note 3)		Vendor specified (Note 3)	
37		ELECTRICAL CONNECTION		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT	
38		ENCLOSURE PROTECTION		IP65		IP65		IP65		IP65	
39		HAZARDOUS PROTECTION AREA		NA		NA		NA		NA	
40											
41	TRNASMITTER	TAG NUMBER		AIT10207		AIT10302		AIT10402		AIT10602	
42		MODEL		Note 7		Note 7		Note 7		Note 7	
43		MOUTING		In panel (Note 1)		In panel (Note 1)		In panel (Note 1)		In panel (Note 1)	
44		MEASURE RANGE		0 -14		0 - 14		0- 14		0 - 14	
45		ACCURACY		±0,05 pH or better		±0,05 pH or better		±0,05 pH or better		±0,05 pH or better	
46		REPEATABILITY		±0,01 pH or better		±0,01 pH or better		±0,01 pH or better		±0,01 pH or better	
47		RESPONSE TIME		<= 15 seg		<= 15 seg		<= 15 seg		<= 15 seg	
48		POWER SUPPLY		230 Vac, 50 Hz		230 Vac, 50 Hz		230 Vac, 50 Hz		230 Vac, 50 Hz	
49		OUTPUT SIGNAL		Profibus (Note 4, note 5)		Profibus (Note 4)		Profibus (Note 4)		Profibus (Note 4)	
50		ELECTRICAL CONNECTION		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT	
51		HOUSING SEAL		Note 7		Note 7		Note 7		Note 7	
52		ENCLOSURE PROTECTION		IP65		IP65		IP65		IP65	
53		HAZARDOUS PROTECTION AREA		NA		NA		NA		NA	
54											
55	ACCESORIES	DIGITAL LOCAL INDICATOR	INTEGRATED / INDEPENDENT	INTEGRAL		INTEGRAL		INTEGRAL		INTEGRAL	
56			SCALE	0 - 14		0 - 14		0 - 14		0 - 14	
57		FLOW VESSEL	MODEL	Note 7		Note 7		Note 7		Note 7	
58			MATERIAL	Note 7		Note 7		Note 7		Note 7	
59			CONNECTIONS Size	NPT	Note 7	NPT	Note 7	NPT	Note 7	NPT	Note 7
60	PIPING AND INSTR. DIAGRAM. Number			PUB-WSP-JDD-002		PUB-WSP-JDD-003		PUB-WSP-JDD-004		PUB-WSP-JDD-006	
61											
62											
63											

64	NOTES	(1) See PUB-WSP-ISA-001 (process connection diagram)
65		(2) Completely detailed in the manufacturer catalogue.
66		(3) Supplier provide transmitter with display away from the Sensor, with connection cable (Remote version).
67		(4) As general rule standard communication protocol shall be Profibus PA. Also Profibus DP could be accepted. If Profibus protocol is not available, HART protocol could be
68		(5) Analyser shall provide temperature measuring.
69		(6) In addition, a fault relay shall provide indication of any probe or analyser fault.
70		(7) The supplier has to complete the datasheets according to Instruments use and process condition (fluid, pressure, temperature and flow).

UNITS	
PRESSURE:	BARA
TEMPERATURE:	ºC
FLOW:	m3/h
DENSITY:	Kg / m^3
VISCOSITY:	cP
ÁREA:	cm^2

Particle counter data sheet

1	MANUFACTURER										
2	MODEL										
3	ITEM Nº	REVISION	1	01	2	01	3	01	4	01
4	SERVICE		UF/MF filtrate sample		UF/MF filtrate sample					
5	LINE SIZE AND SPECIFICATION		d32/1P3		d32/1P3					
6	PROCESS	FLUID	UFW (Ultrafiltrated water)		UFW (Ultrafiltrated water)					
7										
8		TEMPERATURE: (ºC) MiNIMUM	MAXIMUM	26	32	26	32				
9		PRESSURE (bara) OPERATION	MAXIMUM	2	10	2	10				
10		PARTICLES NUMBER OPERATION		7,2		7,2					
11		PARTICLES NUMBER MIN. / MAX.		5	11	5	11				
12		FLOW (l/h) MINIMUM	MAXIMUM	0	7,8	0	7,8				
13		DENSITY (kg/m3)		1030		1030					
14		AMBIENT TEMPERATURE (ºC)		5	50	5	50				
15		HUMIDITY (%) : MINIMUM	MAXIMUM	80	99	80	99				
16	SAMPLING	IN PROCESS LINE		NA		NA					
20		IN SAMPLING LINE		YES		YES					
21											
22											
23											
24	PARTICLE COUNTER	TAG NUMBER		AIT10807		AIT10809					
25		TYPE		Laser-diode		Laser-diode					
26		MOUNTING		Wall mounted		Wall mounted					
27		ADJUSTABLE SIZE RANGE		YES (by software)		YES (by software)					
28		ADJUSTABLE COUNT PERIOD		YES (by software)		YES (by software)					
29		ADJUSTABLE FLOW RATE		YES (by software)		YES (by software)					
30		PROCESS CONNECTION		1/2" NPT flexible tubbing Quick connenting fitting		1/2" NPT flexible tubbing Quick connenting fitting					
31		PARTICLE SIZE		1 - 750 µm		1 - 750 µm					
32		FLOW RATE		7,8 l/h		7,8 l/h					
33		NUMBER OF PARTICLE SIZE RANGES		4 (adjustable)		4 (adjustable)					
34		POWER SUPPLY		230 Vac, 50 Hz		230 Vac, 50 Hz					
35		OUTPUT SIGNAL		Profibus (Note 1)		Profibus (Note 1)					
36		INDICATORS		ower, countig, cleaning sensor , alarr		ower, countig, cleaning sensor , alarr					
37		ELECTRICAL CONNECTION		1/2" NPT		1/2" NPT					
38		HOUSING MATERIAL		Note 2		Note 2					
39		ENCLOSURE PROTECTION		IP66		IP66					
40		HAZARDOUS PROTECTION AREA		NA		NA					
41											
42	ACCESORIES	DIGITAL LOCAL INDICATOR	INTEGRATED / INDEPENDENT	INTEGRATED		INTEGRATED					
43			SCALE	5	11	5	11				
44		SAMPLE LINE		YES		YES					
45		BUBBLE TRAP		YES		YES					
46		SAMPLE ROTAMETER		YES		YES					
47		SOFTWARE		YES		YES					
48											
49	PIPING AND INSTR. DIAGRAM. Number			PUB-WSP-JDD-008		PUB-WSP-JDD-008					
50											
51											
52											

53	NOTES	(1) As general rule standard communication protocol shall be Profibus PA. Also Profibus DP could be accepted. If Profibus protocol is not available, HART protocol could be accepted.	UNITS
54		(2)The supplier has to complete the datasheets according to Instruments use and process condition (fluid, pressure, temperature and flow).	PRESSURE: BARA
55			TEMPERATURE: ºC
56			FLOW: m3/h
57			DENSITY: Kg / m^3
58			VISCOSITY: cP
59			ÁREA: cm^2

On-line total organic carbon analyser data sheet

1	MANUFACTURER										
2	MODEL										
3	ITEM Nº	REVISION	1	01	2	01	3	01	4	01	
4	SERVICE		TWT sample								
5	LINE SIZE AND SPECIFICATION		d32/1P3								
6	PROCESS	FLUID	TRW (Treated water)								
7											
8		TEMPERATURE: (ºC) MiNIMUM / MAXIMUM	MAXIMUM	26	32						
9		PRESSURE (bara) OPERATION / MAXIMUM	MAXIMUM	2	10						
10		TOC (ppb) OPERATION		7,2							
11		TOC (ppb) MIN. / MAX.		5	11						
12		FLOW (l/h) MINIMUM / MAXIMUM	MAXIMUM	0	3,9						
13		DENSITY (kg/m3)		1030							
14		AMBIENT TEMPERATURE (ºC)		5	50						
15		HUMIDITY (%) : MINIMUM	MAXIMUM	80	99						
16	SAMPLING	IN PROCESS LINE		NA							
17		IN SAMPLING LINE		YES							
18											
19											
20											
21	TOC ANALYSER	TAG NUMBER		AIT15812							
22		TYPE		UV radiation/persulfate oxidation and membrane-based conductometric method							
23		MOUNTING		Wall mounted							
24		OPERATION		Fully automated							
25		ANALYSIS TIME		4 minutes or faster							
26		EXCEEDANCE TRACKING		Note 2							
27		PROCESS CONNECTION		1/2" NPT Tubbing							
28		PARTICLE SIZE		Note 2							
29		MEASURING RANGE		0,03 ppb - 50 ppm							
30		ACCURACY		±2% or ±5 ppb							
31		REPEATABILITY		Note 2							
32		LOWER LIMIT OF DETECTION		Note 2							
33		POWER SUPPLY		230 Vac, 50 Hz							
34		OUTPUT SIGNAL		Profibus (Note 1)							
35		ELECTRICAL CONNECTION		1/2" NPT							
36		HOUSING MATERIAL		Note 2							
37		ENCLOSURE PROTECTION		IP45 or better							
38		HAZARDOUS PROTECTION AREA		NA							
39											
40	ACCESORIES	DISPLAY	INTEGRATED / INDEPENDENT	INTEGRATED							
41			TYPE	Note 2							
42		SAMPLE LINE		YES							
43		MICROCONTROLLER		YES							
44		REAGENTS, CHEMICALS, GASES & CONSUMABLES		YES							
45											
46											
47	PIPING AND INSTR. DIAGRAM. Number			PUB-WSP-JDD-058							
48											
49											
50											
51	NOTES	(1) As general rule standard communication protocol shall be Profibus PA. Also Profibus DP could be accepted. If Profibus protocol is not available, HART protocol cou									UNITS
52		(2) The supplier has to complete the datasheets according to Instruments use and process condition (fluid, pressure, temperature and flow).									PRESSURE: BARA
53											TEMPERATURE: ºC
54											FLOW: m3/h
55											DENSITY: Kg / m^3
56											VISCOSITY: cP
57											ÁREA: cm^2

Chlorine meter data sheet

1	MANUFACTURER										
2	MODEL										
3	ITEM Nº	REVISION	5	01	6	01	7	01	8	01	
4	SERVICE		RO disc filter sample		Pre chlorinaton chamber sample		Chloramination sample		Chloramination sample		
5	LINE SIZE AND SPECIFICATION		d32/1P3		DN25/1P4		DN25/1P4		DN25/1P4		
6	PROCESS	FLUID	UFW (Ultrafiltrated water)		PMW (Permeated water)		TRW (Treated water)		TRW (Treated water)		
7											
8		HUMIDITY (%) : MINIMUM	MAXIMUM	80	99	80	99	80	99	80	99
9		TEMPERATURE (ºC): MiNIMUM	MAXIMUM	26	32	26	32	26	32	26	32
10		PRESSURE (bara): OPERATION	MAXIMUM	2	10	2	10	2	10	2	10
11		CL (ppm) OPERATION		4,00		4,00		1,00		1,00	
12		CL (ppm) MIN. / MAX.		0,20	10,00	0,20	10,00	0,01	5,00	0,01	5,00
13		FLOW (l/h) MINIMUM	MAXIMUM	0,00	3,90	0,00	3,90	0,00	3,90	0,00	3,90
14		DENSITY (kg/m3)		995,69		995,69		995,69		995,69	
15		AMBIENT TEMPERATURE (ºC): MINIMUM	MAXIMUM	5	50	5	50	5	50	5	50
16	SAMPLING	IN LINE		YES		YES		YES		YES	
17		FLOW VESSEL		NA		NA		NA		NA	
18		SAMPLE FLOW-RATE ADJUSTABLE		YES		YES		YES		YES	
19		BUFFER SOLUTION FOR pH VARIATIONS		YES		YES		YES		YES	
20											
21	PROBE	TAG NUMBER		AE13609		AE15603		AE15706		AE15707	
22		MODEL		Note 6		Note 6		Note 6		Note 6	
23		TYPE		Amperometric		Amperometric		Amperometric		Amperometric	
24		ANALYSIS VARIABLE		Active chlorine (Note 5)		Free chlorine		Free chlorine		Total chlorine (Note 5)	
25		MOUNTING		FLOW VESSEL, in sampling line		FLOW VESSEL, in sampling line		FLOW VESSEL, in sampling line		FLOW VESSEL, in sampling line	
26		PROBE LENGTH		NA		NA		NA		NA	
27		ADJUSTABLE MEASURE RANGE		YES		YES		YES		YES	
28		REFERENCE ELECTRODE		YES		YES		YES		YES	
29		CONNECTION TYPE		1/2" NPT		1/2" NPT		1/2" NPT			
30		ELECTROLYTE		Note 1		Note 1		Note 1		Note 1	
31		TEMPERATURE COMPENSATION		YES		YES		YES		YES	
32		ELECTRODE MATERIAL		Note 6		Note 6		Note 6		Note 6	
33		CABLE LENGTH TO TRANSMITTER		Vendor specified (Note 3)		Vendor specified (Note 3)		Vendor specified (Note 3)		Vendor specified (Note 3)	
34		INPUT WIRES		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT	
35		ENCLOSURE PROTECTION		IP67		IP67		IP67		IP67	
36		HAZARDOUS AREA PROTECTION		NA		NA		NA		NA	
37											
38	TRANSMITTER	TAG NUMBER		AIT13609		AIT15603		AIT15706		AIT15707	
39		MODEL		Note 6		Note 6		Note 6		Note 6	
40		MOUNTING		Panel mount		Panel mount		Panel mount		Panel mount	
41		MEASURE RANGE (ppm)		0	15	0	15	0	7,5	0	7,5
42		ACCURACY		±1% of full scale or better		±1% of full scale or better		±1% of full scale or better		±1% of full scale or better	
43		REPEATABILITY		±2% of full scale at fixed temperature & pH		±2% of full scale at fixed temperature & pH		±2% of full scale at fixed temperature & pH		±2% of full scale at fixed temperature & pH	
44		RESPONSE TIME		Note 6		Note 6		Note 6		Note 6	
45		POWER SUPPLY		230 Vac, 50 Hz		230 Vac, 50 Hz		230 Vac, 50 Hz		230 Vac, 50 Hz	
46		OUTPUT SIGNAL		Profibus (Note 4)		Profibus (Note 4)		Profibus (Note 4)		Profibus (Note 4)	
47		INPUT WIRES		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT	
48		HOUSING SEAL		Note 6		Note 6		Note 6		Note 6	
49		ENCLOSURE PROTECTION		IP65		IP65		IP65		IP65	
50		HAZARDOUS AREA PROTECTION		NA		NA		NA		NA	
51											
52	ACCESORIES	LOCAL DIGITAL INDICATOR	INTEGRATED / INDEPENDENT	INTEGRAL		INTEGRAL		INTEGRAL		INTEGRAL	
53			SCALE ppm	0	15	0	15	0	7,5	0	7,5
54		FLOW VESSEL	MODEL	Note 6		Note 6		Note 6		Note 6	
55			MATERIAL	Note 6		Note 6		Note 6		Note 6	
56			CONNECTIONS Size	NPT	Note 6	NPT	Note 6	NPT	Note 6	NPT	Note 6
57	PIPING AND INSTR. DIAGRAM. Number			PUB-WSP-JDD-036		PUB-WSP-JDD-056		PUB-WSP-JDD-057		PUB-WSP-JDD-057	
58											
59											
60											
61	NOTES	(1) Completely detailed in the manufacturer catalogue.									
62		(2) See PUB-WSP-ISA-001 (process connection diagram)									
63		(3) Supplier provide transmitter with display away from the Sensor, with connection cable (Remote version).									
64		(4) As general rule standard communication protocol shall be Profibus PA. Also Profibus DP could be accepted. If Profibus protocol is not available, HART protocol could be accepted.									
65		(5) Add potasium iodide to reagent to convert free chlorine measurement in total chlorine.									
66		(6) The supplier has to complete the datasheets according to Instruments use and process condition (fluid, pressure, temperature and flow).									
67											

Hydrocarbon meter data sheet

1	MANUFACTURER										
2	MODEL										
3	ITEM Nº	REVISION	1	01	2	01	3	01	4	01	
4	SERVICE		Intake sample		UF/MF feed sample						
5	LINE SIZE AND SPECIFICATION		d32/1P3		d32/1P3						
6	PROCESS DATA	FLUID	RSW (Raw seawater)		FTW (Filtered water)						
7		TEMPERATURE (ºC): MiNIMUM / MAXIMUM	26	32	26	32					
8		HUMIDITY (%) : MINIMUM / MAXIMUM	80	99	80	99					
9		PRESSURE (bara) OPERATION / MAXIMUM	2	10	2	10					
10		HC (mm) OPERATION	170		170						
11		HC (mm) MIN. / MAX.	-1500	1500	-1500	1500					
12		FLOW (l/h) OPERATION / MAXIMUM	0	1300	0	1300					
13		DENSITY (kg/m3)	1030		1030						
14		AMBIENT TEMPERATURE (ºC): MINIMUM / MAXIMUM	5	50	5	50					
15	SAMPLING	IN PROCESS LINE	NA		NA						
16		IN SAMPLING LINE	YES		YES						
17											
18											
19											
20	PROBE	TAG NUMBER	AE10209		AE10605						
21		MODEL	Note 2		Note 2						
22		TYPE	UV fluorescence		UV fluorescence						
23		LIGHT SOURCE	Xenon flashlamp		Xenon flashlamp						
24		DETECTOR	UV photodiode		UV photodiode						
25		MOUNTING	Flow cell with wall mounted mounting panel		Flow cell with wall mounted mounting panel						
26		PROBE LENGTH	Note 2		Note 2						
27		ADJUSTABLE RANGE MEASURE	YES		YES						
28		PROCESS CONNECTION	1/2" NPT Tubbing		1/2" NPT Tubbing						
29		MATERIAL	Stainless steel		Stainless steel						
30		CABLE LENGTH TO TRANSMITTER	Vendor specified (note 1)		Vendor specified (note 1)						
31		ELECTRICAL CONNECTION	Plug connector		Plug connector						
32		ENCLOSURE PROTECTION	IP65		IP65						
33		HAZARDOUS AREA PROTECTION	NA		NA						
34											
35	TRANSMITTER	TAG NUMBER	AIT10209		AIT10605						
36		MODEL	Note 2		Note 2						
37		MOUNTING	In panel		In panel						
38		MEASURING RANGE	0-5000 ppb (µg/l) (PAH) 0,1-150ppm (mg/l) (oil)		0-5000 ppb (µg/l) (PAH) 0,1-150ppm (mg/l) (oil)						
39		RESOLUTION	0,1 ppb		0,1 ppb						
40		REPRODUCTIBILITY	2,5% of measured value		2,5% of measured value						
41		RESPONSE TIME	Note 2		Note 2						
42		POWER SUPPLY	230 Vac, 50 Hz		230 Vac, 50 Hz						
43		OUTPUT SIGNAL	Profibus (Note 3)		Profibus (Note 3)						
44		WIRES INPUTS	1/2" NPT		1/2" NPT						
45		HOUSING SEAL	Note 2		Note 2						
46		ENCLOSURE PROTECTION	IP66		IP66						
47		HAZARDOUS AREA PROTECTION	NA		NA						
48											
49	ACCESORIES	DIGITAL LOCAL INDICATOR — INTEGRATED / INDEPENDENT	INTEGRATED		INTEGRATED						
50		DIGITAL LOCAL INDICATOR — SCALE	0	2250	0	2250					
51		FLOW VESSEL — MODEL	Note 2		Note 2						
52		FLOW VESSEL — MATERIAL	Note 2		Note 2						
53		FLOW VESSEL — CONNECTIONS	Inlet: tubbing Ø 8 mm Outlet: tubbing Ø 6 mm		Inlet: tubbing Ø 8 mm Outlet: tubbing Ø 6 mm						
54	PIPING AND INSTR. DIAGRAM. Number		PUB-WSP-JDD-002		PUB-WSP-JDD-006						
55											
56											
57											

58	NOTES	(1) Supplier provide transmitter with display away from the Sensor, with connection cable (Remote version).
59		(2) The supplier has to complete the datasheets according to Instruments use and process condition (fluid, pressure, temperature and flow).
60		(3) As general rule standard communication protocol shall be Profibus PA. Also Profibus DP could be accepted. If Profibus protocol is not available, HART protocol could be accepted.
61		
62		
63		
64		

UNITS
PRESSURE: bara
TEMPERATURE: ºC
FLOW: m3/h
DENSITY: kg / m^3
ORP (Redox value): mV

Algae monitor data sheet

1	MANUFACTURER										
2	MODEL										
3	ITEM Nº	REVISION	1	01	2	01	3	01	4	01	
4	SERVICE		Intake sample		UF/MF feed sample						
5	LINE SIZE AND SPECIFICATION		d32/1P3		d32/1P3						
6	PROCESS	FLUID	RSW (Raw seawater)		FTW (Filtered water)						
7											
8		TEMPERATURE: (ºC) MiNIMUM / MAXIMUM	26	32	26	32					
9		PRESSURE (bara) OPERATION / MAXIMUM	2	10	2	10					
10		CHLOROPHYLL (µg/l) OPERATION	7,2		7,2						
11		CHLOROPHYLL (µg/l) MIN. / MAX.	0	200	0	200					
12		FLOW (l/h) MINIMUM / MAXIMUM	0	148	0	148					
13		DENSITY (kg/m3)	1030		1030						
14		AMBIENT TEMPERATURE (ºC)	5	50	5	50					
15		HUMIDITY (%) : MINIMUM / MAXIMUM	80	99	80	99					
16	SAMPLING	IN PROCESS LINE	NA		NA						
20		IN SAMPLING LINE	YES		YES						
21											
22											
23											
24	PARTICLE COUNTER	TAG NUMBER	AIT10208		AIT10604						
25		TYPE	Chlorophyll fluorescence		Chlorophyll fluorescence						
26		MOUNTING	Panel mounted		Panel mounted						
27		RANGE	0 - 200 µg/l Chlorophyll		0 - 200 µg/l Chlorophyll						
28		ACCURACY	±0,2 µg/l or 3% of reading		±0,2 µg/l or 3% of reading						
29		REPEATABILITY	±3% of reading		±3% of reading						
30		PROCESS CONNECTION	1/2" NPT		1/2" NPT						
31		DATA STORAGE	20000 points		20000 points						
32		POWER SUPPLY	230 Vac, 50 Hz		230 Vac, 50 Hz						
33		OUTPUT SIGNAL	Profibus (Note 1) (Note 4)		Profibus (Note 1) (Note 4)						
34		ELECTRICAL CONNECTION	1/2" NPT		1/2" NPT						
35		HOUSING MATERIAL	Note 3		Note 3						
36		ENCLOSURE PROTECTION	IP66		IP66						
37		HAZARDOUS PROTECTION AREA	NA		NA						
38											
39											
40	ACCESORIES	DIGITAL LOCAL INDICATOR — INTEGRATED / INDEPENDENT	INTEGRATED		INTEGRATED						
41		DIGITAL LOCAL INDICATOR — SCALE µg/l	2	200	2	200					
42		INLET/OUTLET PLUMBING KIT	YES		YES						
43		CALIBRATION KIT	YES		YES						
44		FLOWCELL BRUSHES	YES		YES						
45		COMMUNICATION CABLE	YES		YES						
46											
47	PIPING AND INSTR. DIAGRAM. Number		PUB-WSP-JDD-002		PUB-WSP-JDD-006						
48											
49											
50											

51	NOTES	(1) High & High High alarms shall be available as volt-free contacts.
52		(2) Aditional volt-free contacts shall be provided for system failed indication.
53		(3) The supplier has to complete the datasheets according to Instruments use and process condition (fluid, pressure, temperature and flow).
54		(4) As general rule standard communication protocol shall be Profibus PA. Also Profibus DP could be accepted. If Profibus protocol is not available, HART protocol could be accepted.
55		
56		
57		

UNITS	
PRESSURE:	BARA
TEMPERATURE:	ºC
FLOW:	m3/h
DENSITY:	Kg / m^3
VISCOSITY:	cP
ÁREA:	cm^2

Fluoride meter data sheet

1	MANUFACTURER										
2	MODEL										
3	ITEM Nº	REVISION	1	01	2	01	3	01	4	01	
4	SERVICE		Post chlorination chamber sample		Treated water tanks sample		Treated water tanks sample				
5	LINE SIZE AND SPECIFICATION		d32/1P3		d32/1P3		d32/1P3				
6	PROCESS	FLUID	TRW (Treated water)		TRW (Treated water)		TRW (Treated water)				
7											
8		TEMPERATURE (ºC): MiNIMUM / MAXIMUM	26	32	26	32	26	32			
9		HUMIDITY (%) : MINIMUM /MAXIMUM	80	99	80	99	80	99			
10		PRESSURE (bara) OPERATION / MAXIMUM	2	10	2	10	2	10			
11		FLUORIDE (mg/l) OPERATION	1,00		1,00		1,00				
12		FLUORIDE (mg/l) MIN. / MAX.	0,02	100	0,02	100	0,02	100			
13		FLOW (l/h) MINIMUM / MAXIMUM	0	3,12	0	3,12	0	3,12			
14		DENSITY (kg/m3)	995,72		995,72		995,72				
15		AMBIENT TEMPERATURE (ºC)	5	50	5	50	5	50			
16	SAMPLING	IN PROCESS LINE	NA		NA		NA				
17		IN SAMPLING LINE	YES		YES		YES				
18											
19											
20											
21	PROBE	TAG NUMBER	AE15604		AE15801		AE15802				
22		MODEL	Note 4		Note 4		Note 4				
23		TYPE	Ion selective		Ion selective		Ion selective				
24		MOUNTING	In panel		In panel		In panel				
25		PROBE LENGTH	Note 4		Note 4		Note 4				
26		ACCURACY	Not exceeding 10% of the result or 1,5 mgF/l		Not exceeding 10% of the result or 1,5 mgF/l		Not exceeding 10% of the result or 1,5 mgF/l				
27		STANDARD DEVIATION	Not exceeding 10% of the result or 1,5 mgF/l		Not exceeding 10% of the result or 1,5 mgF/l		Not exceeding 10% of the result or 1,5 mgF/l				
28		LIMIT OF DETECTION	Not greater than 0,20 mgF/l		Not greater than 0,20 mgF/l		Not greater than 0,20 mgF/l				
29		ADJUSTABLE RANGE MEASURE	YES		YES		YES				
30		AUTOMATIC CALIBRATION	YES		YES		YES				
31		PROCESS CONNECTION	1/2" NPT tubbing compression fitting		1/2" NPT tubbing compression fitting		1/2" NPT tubbing compression fitting				
32		SENSOR MATERIALS	Ultem/ryton/HDPE (junction)		Ultem/ryton/HDPE (junction)		Ultem/ryton/HDPE (junction)				
33		CABLE LENGTH TO TRANSMITTER	Vendor specified (note 2)		Vendor specified (note 2)		Vendor specified (note 2)				
34		ELECTRICAL CONNECTION	1/2" NPT		1/2" NPT		1/2" NPT				
35		ENCLOSURE PROTECTION	IP65		IP65		IP65				
36		HAZARDOUS PROTECTION AREA	NA		NA		NA				
37	TRANSMITTER	TAG NUMBER	AIT15604		AIT15801		AIT15802				
38		MODEL	Note 4		Note 4		Note 4				
39		MOUNTING	PANEL MOUNT		PANEL MOUNT		PANEL MOUNT				
40		MEASURE RANGE	0 - 1,5 (ppm)		0 - 1,5 (ppm)		0 - 1,5 (ppm)				
41		ACCURACY	±5 % or better of full scale		±5 % or better of full scale		±5 % or better of full scale				
42		REPEATABILITY	±2 % or better of reading		±2 % or better of reading		±2 % or better of reading				
43		RESPONSE TIME	<= 80 sec		<= 80 sec		<= 80 sec				
44		POWER SUPPLY	230 Vac, 50 hz		230 Vac, 50 hz		230 Vac, 50 hz				
45		OUTPUT SIGNAL	Profibus (Note 2) (Note 5)		Profibus (Note 2) (Note 5)		Profibus (Note 2) (Note 5)				
46		SUSPENDED SOLIDS READING (mg/l)	YES		YES		YES				
47		WIRES INPUTS	1/2" NPT		1/2" NPT		1/2" NPT				
48		HOUSING SEAL	Note 4		Note 4		Note 4				
49		ENCLOSURE PROTECTION	IP65		IP65		IP65				
50		HAZARDOUS PROTECTION AREA	NA		NA		NA				
51	ACCESORIES	DIGITAL LOCAL INDICATOR — INTEGRATED / INDEPENDENT	INTEGRAL		INTEGRAL		INTEGRAL				
52		DIGITAL LOCAL INDICATOR — SCALE	0	150	0	150	0	150			
53											
54		FLOW VESSEL — MODEL	Note 4		Note 4		Note 4				
55		FLOW VESSEL — MATERIAL	Note 4		Note 4		Note 4				
56		FLOW VESSEL — CONNECTIONS Size	NPT	Note 4	NPT	Note 4	NPT	Note 4			
57	PIPING AND INSTR. DIAGRAM. Number		PUB-WSP-JDD-056		PUB-WSP-JDD-058		PUB-WSP-JDD-058				
58											
59											
60											
61	NOTES	(1) Supplier provide transmitter with display away from the Sensor, with connection cable (Remote version).									
62		(2) Analyser shall be provided with High and Low adjustable alarms and system fail as volt-free contacts.									
63		(3) Alarm for loss of water sample shall also generated.									
64		(4) The supplier has to complete the datasheets according to Instruments use and process condition (fluid, pressure, temperature and flow).									
65		(5) As general rule standard communication protocol shall be Profibus PA. Also Profibus DP could be accepted. If Profibus protocol is not available, HART protocol could be accepted.									
66											
67											

Residual chlorine meter (multi sensor validation system) data sheet

1	MANUFACTURER								
2	MODEL								
3	ITEM Nº	REVISION	1	01	2	01	3	01	
5	SERVICE		Chlorine contact chamber outlet sample						
6	LINE SIZE AND SPECIFICATION		d32/1P3						
7	PROCESS	FLUID	TRW (Treated water)						
8									
9		HUMIDITY (%) : MINIMUM / MAXIMUM	80		99				
10		TEMPERATURE (ºC): MiNIMUM / MAXIMUM	26		32				
11		PRESSURE (bara): OPERATION / MAXIMUM	2		10				
12		CL (ppm) OPERATION	4,00						
13		CL (ppm) MIN. / MAX.	0,20		10,00				
14		FLOW (l/h) MINIMUM / MAXIMUM	0,00		39,00				
15		DENSITY (kg/m3)	995,69						
16		AMBIENT TEMPERATURE (ºC): MINIMUM / MAXIMUM	5		50				
17	SAMPLING	IN LINE	YES						
18		FLOW VESSEL	NA						
19		SAMPLE FLOW-RATE ADJUSTABLE	YES						
20		AUTOMATIC TEMPERATURE COMPENSATION	YES						
21									
22	PROBE	TAG NUMBER	AE15606		AE15607		AE15608		
23		MODEL	Note 6		Note 6		Note 6		
24		TYPE	Amperometric		Amperometric		Amperometric		
25		ANALYSIS VARIABLE	Free chlorine		Free chlorine		Free chlorine		
26		MOUNTING	FLOW VESSEL, in sampling line		FLOW VESSEL, in sampling line		FLOW VESSEL, in sampling line		
27		PROBE LENGTH	NA		NA		NA		
28		ADJUSTABLE MEASURE RANGE	YES		YES		YES		
29		REFERENCE ELECTRODE	YES		YES		YES		
30		CONNECTION TYPE	1/2" NPT		1/2" NPT		1/2" NPT		
31		ELECTROLYTE	Note 1		Note 1		Note 1		
32		BUFFER SOLUTION FOR pH VARIATIONS	YES		YES		YES		
33		ELECTRODE MATERIAL	Note 6		Note 6		Note 6		
34		CABLE LENGTH TO TRANSMITTER	Vendor specified (Note 3)		Vendor specified (Note 3)		Vendor specified (Note 3)		
35		INPUT WIRES	1/2" NPT		1/2" NPT		1/2" NPT		
36		ENCLOSURE PROTECTION	IP67		IP67		IP67		
37		HAZARDOUS AREA PROTECTION	NA		NA		NA		
38									
39	TRANSMITTER	TAG NUMBER	AIT15606						
40		TYPE	Triplication controller and indicator unit. Continuous comparing and averaging of the three residual samples. It shall analyze the three incoming signals and displays an average reading.						
41		MODEL	Note 6						
42		MOUNTING	Panel mount						
43		MEASURE RANGE (ppm)	0		5				
44		OVERALL ACCURACY	±2% of full scale or better at fixed temeprature & pH						
45		REPEATABILITY	Note 6						
46		RESPONSE TIME	Note 6						
47		POWER SUPPLY	230 Vac, 50 Hz						
48		OUTPUT SIGNAL	Profibus (Note 4)						
49		INPUT WIRES	1/2" NPT						
50		HOUSING SEAL	PLASTIC						
51		ENCLOSURE PROTECTION	IP66						
52		HAZARDOUS AREA PROTECTION	NA						
53	ACCESORIES	DISPLAYS — INTEGRATED / INDEPENDENT	INTEGRATED						
54		DISPLAYS — TYPE	Four digital LCD						
55		FLOW VESSEL — MODEL	Note 1						
56		FLOW VESSEL — MATERIAL	Note 6						
57		FLOW VESSEL — CONNECTIONS Size	NPT		Note 6				
58		MICROPROCESSOR	YES						
59	PIPING AND INSTR. DIAGRAM. Number		PUB-WSP-JDD-056						
60									
61									
62									
63	NOTES	(1) Completely detailed in the manufacturer catalogue.							
64		(2) See PUB-WSP-ISA-001 (process connection diagram)							
65		(3) Supplier provide transmitter with display away from the Sensor, with connection cable (Remote version).							
66		(4) As general rule standard communication protocol shall be Profibus PA. Also Profibus DP could be accepted. If Profibus protocol is not available, HART protocol could be accepted.							
67		(5) Analyser shall display error messages if any measured signal deviates from the others and if all the three measured signals spread apart beyonfd the tolerance b							
68		(6) The supplier has to complete the datasheets according to Instruments use and process condition (fluid, pressure, temperature and flow).							
69									

Ammonium analyzer data sheet

1	MANUFACTURER											
2	MODEL											
3	ITEM Nº	REVISION	1	01	2	01	3	01	4	01		
4	SERVICE		Chloramination sample		Treated water tanks sample		Treated water tanks sample					
5	LINE SIZE AND SPECIFICATION		DN25/1P4		d32/1P3		d32/1P3					
6	PROCESS	FLUID	TRW (Treated water)		TRW (Treated water)		TRW (Treated water)					
7												
8		TEMPERATURE: (ºC) MiNIMUM / MAXIMUM	26	32	26	32	26	32				
9		PRESSURE (bara) OPERATION / MAXIMUM	2	10	2	10	2	10				
10		AMMONIA (ml/m^3) OPERATION	7,2		7,2		7,2					
11		AMMONIA (ml/m3) MIN. / MAX.	5	11	5	11	5	11				
12		FLOW (l/h) MINIMUM / MAXIMUM	0	3,12	0	3,12	0	3,12				
13		DENSITY (kg/m3)	1030		1030		1030					
14		AMBIENT TEMPERATURE (ºC)	5	50	5	50	5	50				
15		HUMIDITY (%) : MINIMUM / MAXIMUM	80	99	80	99	80	99				
16	SAMPLING	IN PROCESS LINE	NA		NA		NA					
20		IN SAMPLING LINE	YES		YES		YES					
21												
22												
23												
24	PARTICLE COUNTER	TAG NUMBER	AIT15705		AIT15809		AIT15810					
25		TYPE	Gas-sensitive electrode		Gas-sensitive electrode		Gas-sensitive electrode					
26		MOUNTING	Panel mounted		Panel mounted		Panel mounted					
27		RANGE ml/m3	25	35	25	35	25	35				
28		VERIFICATION LIMIT	0,05 mg/l NH4-N		0,05 mg/l NH4-N		0,05 mg/l NH4-N					
29		ACCURACY	±0,05 mg/l or 3% of reading		±0,05 mg/l or 3% of reading		±0,05 mg/l or 3% of reading					
30		REPRODUCTIBILITY	±0,05 mg/l or 2% of reading		±0,05 mg/l or 2% of reading		±0,05 mg/l or 2% of reading					
31		RESPONSE TIME	5 minutes		5 minutes		5 minutes					
32		PROCESS CONNECTION	1/2" NPT		1/2" NPT		1/2" NPT					
33		POWER SUPPLY	230 Vac, 50 Hz		230 Vac, 50 Hz		230 Vac, 50 Hz					
34		OUTPUT SIGNAL	Profibus (Note 1) (Note 4)		Profibus (Note 1) (Note 4)		Profibus (Note 1) (Note 4)					
35		AUTOMATIC CALIBRATION	YES		YES		YES					
36		ELECTRICAL CONNECTION	1/2" NPT		1/2" NPT		1/2" NPT					
37		HOUSING MATERIAL	ASA/PC UV-resistant		ASA/PC UV-resistant		ASA/PC UV-resistant					
38		ENCLOSURE PROTECTION	IP66		IP66		IP66					
39		HAZARDOUS PROTECTION AREA	NA		NA		NA					
40												
41	ACCESORIES	DIGITAL LOCAL INDICATOR / INTEGRATED / INDEPENDENT	INTEGRATED		INTEGRATED		INTEGRATED					
42		SCALE ml/m3	0	16,5	0	16,5	0	16,5				
43		COMMUNICATION CABLE	YES		YES		YES					
44		REAGENTS	YES		YES		YES					
45												
46												
47												
48	PIPING AND INSTR. DIAGRAM. Number		PUB-WSP-JDD-057		PUB-WSP-JDD-058		PUB-WSP-JDD-058					
49												
50												
51												

52	NOTES	(1) High & High High alarms shall be available as volt-free contacts.	UNITS
53		(2) Aditional volt-free contacts shall be provided for system failed indication.	PRESSURE: BARA
54		(3) The supplier has to complete the datasheets according to Instruments use and process condition (fluid, pressure, temperature and flow).	TEMPERATURE: ºC
55		(4) As general rule standard communication protocol shall be Profibus PA. Also Profibus DP could be accepted. If Profibus protocol is not available, HART protocol could be accepted.	FLOW: m3/h
56			DENSITY: Kg / m^3
57			VISCOSITY: cP
58			ÁREA: cm^2

Electromagnetic flowmeters
data sheet

1	MANUFACTURER											
2	MODEL Nº											
3	ITEM Nº	REVISION	57	01	58	01	59	01	60	01		
4	SERVICE		1st pass RO rack 3 permeated water to flushing tank		1st pass RO rack 3 ultrafiltrated water to energy recovery system		1st pass RO rack 3 ultrafiltrated water return from energy recovery system		1st pass RO rack 3 brine to disc filters backwash tanks			
5												
6	LINE SIZE AND SPECIFICATION		300/1P4		400/1P4		16"/6C1		400/1P4			
7	PROCESS DATA	FLUID	PMW (permeated water)		UFW (ultrafiltrated water)		UFW (ultrafiltrated water)		BRN (brine)			
8	PROCESS DATA / FLOWS	MAXIMUN (m3/h)	504		790		790		790			
9	PROCESS DATA / FLOWS	OPERATION (m3/h)	504		790		790		790			
10	PROCESS DATA / FLOWS	MINIMUN (m3/h)	0		0		0		0			
11	PROCESS DATA	WORKING CONDITIONS DENSITY (kg/m3)	1027		1027		1027		1027			
12	PROCESS DATA	HUMIDITY (%) : MINIMUM	MAXIMUM	80	99	80	99	80	99	80	99	
13	PROCESS DATA	TEMPERATURE (ºC): NORMAL	MAXIMUM	26	32	26	32	26	32	26	32	
14	PROCESS DATA	PRESSURE (bara): NORMAL	MAXIMUM	1,7	10	4	10	59,8	100	1	10	
15	PROCESS DATA	CONDUCTIVITY (µS/cm)		Maximum 3750 - 4040		Maximum 3750 - 4040		Maximum 3750 - 4040		Maximum 3750 - 4040		
16	PROCESS DATA	AMBIENT TEMPERATURE (ºC)		5	50	5	50	5	50	5	50	
17	SENSOR	TAG NUMBER		FE14003		FE14004		FE14005		FE14006		
18	SENSOR	MODEL										
19	SENSOR	SENSOR-CONVERTER: INTEG. / INDEP.		Independent - Remote version		Independent - Remote version		Independent - Remote version		Independent - Remote version		
20	SENSOR	MEASURE RANGE m3/h		0 - 504		0 - 790		0 - 790		0 - 790		
21	SENSOR	NOMINAL SIZE		DN300		DN400		16"		DN200		
22	SENSOR	PROCESS CONNECTION		FLANGES BS 4504		FLANGES BS 4504		FLANGES BS 4504		FLANGES BS 4504		
23	SENSOR / MATERIAL	SURROUND		NBR		NBR		NBR		NBR		
24	SENSOR / MATERIAL	MEASURE TUBE	FLANGES	Stainless Steel	Carbon Steel	Stainless Steel	Carbon Steel	Stainless Steel	Carbon Steel	Stainless Steel	Carbon Steel	
25	SENSOR / MATERIAL	COVER GASKET		EPDM		EPDM		EPDM		EPDM		
26	SENSOR / MATERIAL	ELECTRODES		Stainless Steel / 316L		Stainless Steel / 316L		Stainless Steel / 316L		Stainless Steel / 316L		
27	SENSOR	ENCLOSURE PROTECTION		IP67		IP67		IP67		IP67		
28	SENSOR	POWER SUPPLY		From Transmitter		From Transmitter		From Transmitter		From Transmitter		
29	SENSOR	ELECTRICAL CONNECTIONS		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		
30	SENSOR	HAZAROUS AREA PROTECTION		-----		-----		-----				
31	SENSOR											
32	TRANSMITTER	TAG NUMBER		FIT14003		FIT14004		FIT14005		FIT14006		
33	TRANSMITTER	MODEL										
34	TRANSMITTER	MOUNTING		On support (note 4)		On support (note 4)		On support (note 4)		On support (note 4)		
35	TRANSMITTER	ENCLOSURE PROTECTION		not less than IP65		not less than IP65		not less than IP65		not less than IP65		
36	TRANSMITTER	HAZARDOUS AREA PROTECTION		NA		NA		NA		NA		
37	TRANSMITTER	POWER SUPPLY		240 Vac, 50 Hz		240 Vac, 50 Hz		240 Vac, 50 Hz		240 Vac, 50 Hz		
38	TRANSMITTER	OUTPUT SIGNAL		PROFIBUS DP (note 3)		PROFIBUS DP (note 3)		PROFIBUS DP (note 3)		PROFIBUS DP (note 3)		
39	TRANSMITTER	ELECTRICAL CONNECTION		1/2"NPT		1/2"NPT		1/2"NPT		1/2"NPT		
40	TRANSMITTER	ACCURACY (SENSOR-CONVERTER)		5 to 30% of scale setting: 0,5% 30 to 100% of scale setting: 0,25%		5 to 30% of scale setting: 0,5% 30 to 100% of scale setting: 0,25%		5 to 30% of scale setting: 0,5% 30 to 100% of scale setting: 0,25%		5 to 30% of scale setting: 0,5% 30 to 100% of scale setting: 0,25%		
41	TRANSMITTER	REPEATABILITY		better than ±0,2% of true value		better than ±0,2% of true value		better than ±0,2% of true value		better than ±0,2% of true value		
42	TRANSMITTER / TOTALIZ	Nº of DIGITS	LAST DIGIT	Adjustable	Adjustable	Adjustable	Adjustable	Adjustable	Adjustable	Adjustable	Adjustable	
43	TRANSMITTER / TOTALIZ	ZERO FLOW		Adjustable		Adjustable		Adjustable		Adjustable		
44	TRANSMITTER / TOTALIZ											
45	ACCESOR.	MEASURE CABLE SUPPLY:SELLE	OTHERS	YES	NA	YES	NA	YES	NA	YES	NA	
46	ACCESOR.	CABLE LENGTH (SENSOR-CONVERT.)		Vendor specified (note 1)		Vendor specified (note 1)		Vendor specified (note 1)		Vendor specified (note 1)		
47	ACCESOR.	SIGNAL OUTPUT INDICATOR		In Transmitter		In Transmitter		In Transmitter		In Transmitter		
48	ACCESOR.	TOTALIZER INCLUDED IN TRANSMITTER		YES		YES		YES		YES		
49	ACCESOR.	GROUNDING RING		YES		YES		NO		YES		
50	PIPING AND INSTR. DIAGRAM. Number			PUB-WSP-JDD-040		PUB-WSP-JDD-040		PUB-WSP-JDD-040		PUB-WSP-JDD-040		
51	WIRING DIAGRAM. Number											
52												
53	APPLICABLES NOTES			1, 2,3,4		1, 2,3,4		1, 2,3,4		1, 2,3, 4		
54	(1) Supplier provide transmitter with display away from the Sensor, with connection cable (Remote version).									UNITS		
55	(2) Integrates indicator transmitter.									FLOW: m3/h		
56	(3) Minimun signal: Flow, counter (totalizer) and empty pipe detection.									PRESSURE: Bara		
57	(4) See PUB-WSP-ISA-001 (process connection diagram)									TEMPERATURE: ºC		
58	The supplier has to complete the datasheets according to Instruments use and process condition (fluid, pressure, temperature and flow).									LENGTH: m		
59										DENSITY : kg/m^3		
60												
61												
62												
63												
64												
65												
66												
67												

Vortex flowmeters
data sheet

1	MANUFACTURER										
2	MODEL Nº										
3	POSITION Nº	REV	5	01	6	01	7	01	8	01	
4 5	SERVICE		2nd pass 1st stage RO rack 3 permeate		2nd pass 2nd stage RO rack 3 permeate		2nd pass 1st stage RO rack 4 permeate		2nd pass 2nd stage RO rack 4 permeate		
6	LINE SIZE AND SPECIFICATION		350/1P4		200/1P4		350/1P4		200/1P4		
7	PROCESS DATA	FLUID	PMW (Permeated water)		PMW (Permeated water)		PMW (Permeated water)		PMW (Permeated water)		
8	PROCESS DATA / FLOWS	MAXIMUN	720		254		720		254		
9	PROCESS DATA / FLOWS	OPERATION	720		254		720		254		
10	PROCESS DATA / FLOWS	MINIMUN	0		0		0		0		
11	PROCESS DATA	WORKING CONDITIONS DENSITY (kg/m3)	1000		1000		1000		1000		
12	PROCESS DATA	TEMPERATURE (ºC): NORMAL	MAXIMUM	26	32	26	32	26	32	26	32
13	PROCESS DATA	PRESSURE (bara): NORMAL	MAXIMUM	1,7	10	1,7	10	1,7	10	1,7	10
14	PROCESS DATA	HUMIDITY (%) : MINIMUM	MAXIMUM	80	99	80	99	80	99	80	99
15	PROCESS DATA	AMBIENT TEMPERATURE (ºC)	MIN/MAX	5	35	5	35	5	35	5	35
16	SENSOR	TAG NUMBER		FE15002		FE15003		FE15102		FE15103	
17	SENSOR	MODEL									
18	SENSOR	SENSOR-CONVERTER: INTEG. / INDEP.		Independent - Remote version		Independent - Remote version		Independent - Remote version		Independent - Remote version	
19	SENSOR	MEASURED RANGE	m3/h	0 - 720		0 - 254		0 - 720		0 - 254	
20	SENSOR	NOMINAL SIZE		DN350		DN200		DN350		DN200	
21	SENSOR	PROCESS CONNECTION		FLANGES BS 4504		FLANGES BS 4504		FLANGES BS 4504		FLANGES BS 4504	
22	SENSOR	FLANGES MATERIAL		Stainless steel		Stainless steel		Stainless steel		Stainless steel	
23	SENSOR	ENCLOSURE PROTECTION		IP 65 or better		IP 65 or better		IP 65 or better		IP 65 or better	
24	SENSOR	POWER SUPPLY		From transmitter		From transmitter		From transmitter		From transmitter	
25	SENSOR	MATERIAL		stainless steel		stainless steel		stainless steel		stainless steel	
26	SENSOR	ELECTRICAL CONNECTIONS		M20x1,5		M20x1,5		M20x1,5		M20x1,5	
27	SENSOR	SPAN HAZAROUS AREA PROTECTION		-----		-----		-----		-----	
28	TRANSMITTER	TAG NUMBER		FIT15002		FIT15003		FIT15002		FIT15003	
29	TRANSMITTER	MODEL									
30	TRANSMITTER	MOUNTING		On support (note 4)		On support (note 4)		On support (note 4)		On support (note 4)	
31	TRANSMITTER	ENCLOSURE PROTECTION		IP67		IP67		IP67		IP67	
32	TRANSMITTER	HAZAROUS AREA PROTECTION		NA		NA		NA		NA	
33	TRANSMITTER	POWER SUPPLY		240 Vac, 50 Hz		240 Vac, 50 Hz		240 Vac, 50 Hz		240 Vac, 50 Hz	
34	TRANSMITTER	OUTPUT SIGNAL		4-20mA (note 3)		4-20mA (note 3)		4-20mA (note 3)		4-20mA (note 3)	
35	TRANSMITTER	ELECTRICAL CONNECTION		M20x1,5		M20x1,5		M20x1,5		M20x1,5	
36	TRANSMITTER	ACCURACY (SENSOR-CONVERTER)		±0,75% of reading		±0,75% of reading		±0,75% of reading		±0,75% of reading	
37	TRANSMITTER	REPEATABILITY		±0,2% of rate		±0,2% of rate		±0,2% of rate		±0,2% of rate	
38	TRANSMITTER / TOTALIZ	Nº of DIGITS	LAST DIGIT	Adjustable	Adjustable	Adjustable	Adjustable	Adjustable	Adjustable	Adjustable	Adjustable
39	TRANSMITTER / TOTALIZ	ZERO FLOW		Adjustable		Adjustable		Adjustable		Adjustable	
40	TRANSMITTER / TOTALIZ										
41	ACCESOR.	MESURE CABLE SUPPLY:SELLER	OTHERS	YES	NA	YES	NA	YES	NA	YES	NA
42	ACCESOR.	CABLE LENGTH (SENSOR-CONVERT.)		Vendor specified (note 1)		Vendor specified (note 1)		Vendor specified (note 1)		Vendor specified (note 1)	
43	ACCESOR.	SIGNAL OUTPUT INDICATOR		In Transmitter		In Transmitter		In Transmitter		In Transmitter	
44	ACCESOR.	TOTALIZER INCLUDED IN TRANSMITTER		YES		YES		YES		YES	
45	ACCESOR.	GROUNDING RING		YES		YES		YES		YES	
46	PIPING AND INSTR. DIAGRAM. Number			PUB-WSP-JDD-050		PUB-WSP-JDD-050		PUB-WSP-JDD-051		PUB-WSP-JDD-051	
47	WIRING DIAGRAM. Number										
48											
49	APPLICABLES NOTES										
50	(1) Supplier provide transmitter with display away from the Sensor, with connection cable (Remote version).								UNITS		
51	(2) Integrates indicator transmitter.								FLOW: m3/h		
52	(3)There will also be one digital output signal counter pulse.								PRESSURE: Barg		
53	4) See PUB-WSP-ISA-001 (process connection diagram)								TEMPERATURE: ºC		
54	The supplier has to complete the datasheets according to Instruments use and process condition (fluid, pressure, temperature and flow).								LENGTH: m		
55									DENSITY : kg/m^3		
56											
57											
58											
59											
60											
61											
62											
63											

Thermal mass flowmeters
data sheet

1	MANUFACTURER													
2	MODEL Nº													
3	POSITION Nº		REV	5	01		6	01		7	01		8	01
4	SERVICE			Pressurization DAF 3			Pressurization DAF 3			Pressurization DAF 4			Pressurization DAF 4	
5														
6	LINE SIZE AND SPECIFICATION			1 1/4"/1C2			1 1/4"/1C2			1 1/4"/1C2			1 1/4"/1C2	
7	PROCESS DATA	FLUID		SEA (Service air)			SEA (Service air)			SEA (Service air)			SEA (Service air)	
8		FLOWS MAXIMUN	Nm3/h	310			310			310			310	
9		FLOWS OPERATION	Nm3/h	310			310			310			310	
10		FLOWS MINIMUN	Nm3/h	0			0			0			0	
11		WORKING CONDITIONS DENSITY (kg/m3)		1000			1000			1000			1000	
12		TEMPERATURE (ºC): NORMAL	MAXIMUM	66	72		66	72		66	72		66	72
13		PRESSURE (bara): NORMAL	MAXIMUM	6,5	10		6,5	10		6,5	10		6,5	10
14		HUMIDITY (%) : MINIMUM	MAXIMUM	80	99		80	99		80	99		80	99
15		AMBIENT TEMPERATURE (ºC)	MIN/MAX	5	35		5	35		5	35		5	35
16	SENSOR	TAG NUMBER		FE10511			FE10512			FE10513			FE10514	
17		MODEL												
18		SENSOR-CONVERTER: INTEG. / INDEP.		Independent - Remote version			Independent - Remote version			Independent - Remote version			Independent - Remote version	
19		MEASURED RANGE	Nm3/h	0 - 460			0 - 460			0 - 460			0 - 460	
20		NOMINAL SIZE		1 1/4"			1 1/4"			1 1/4"			1 1/4"	
21		PROCESS CONNECTION		FLANGES BS 4504			FLANGES BS 4504			FLANGES BS 4504			FLANGES BS 4504	
22		FLANGES MATERIAL		Stainless steel			Stainless steel			Stainless steel			Stainless steel	
23		ENCLOSURE PROTECTION		IP 65 or better			IP 65 or better			IP 65 or better			IP 65 or better	
24		POWER SUPPLY		From transmitter			From transmitter			From transmitter			From transmitter	
25		MATERIAL		stainless steel			stainless steel			stainless steel			stainless steel	
26		ELECTRICAL CONNECTIONS		M20x1,5			M20x1,5			M20x1,5			M20x1,5	
27		SPAN HAZAROUS AREA PROTECTION		-----			-----			-----			-----	
28	TRANSMITTER	TAG NUMBER		FIT10511			FIT10512			FIT10513			FIT10514	
29		MODEL												
30		MOUNTING		On support (note 4)			On support (note 4)			On support (note 4)			On support (note 4)	
31		ENCLOSURE PROTECTION		IP65 or better			IP65 or better			IP65 or better			IP65 or better	
32		HAZAROUS AREA PROTECTION		NA			NA			NA			NA	
33		POWER SUPPLY		240 Vac, 50 Hz			240 Vac, 50 Hz			240 Vac, 50 Hz			240 Vac, 50 Hz	
34		OUTPUT SIGNAL		4-20mA (note 3)			4-20mA (note 3)			4-20mA (note 3)			4-20mA (note 3)	
35		ELECTRICAL CONNECTION		M20x1,5			M20x1,5			M20x1,5			M20x1,5	
36		ACCURACY (SENSOR-CONVERTER)		better than ±3% of mass flow			better than ±3% of mass flow			better than ±3% of mass flow			better than ±3% of mass flow	
37		REPEATABILITY		±0,4% of reading velocities above 1 m/			±0,4% of reading velocities above 1 m/			±0,4% of reading velocities above 1 m/			±0,4% of reading velocities above 1 m/	
38		TOTALIZ Nº of DIGITS	LAST DIGIT	Adjustable	Adjustable		Adjustable	Adjustable		Adjustable	Adjustable		Adjustable	Adjustable
39		TOTALIZ ZERO FLOW		Adjustable			Adjustable			Adjustable			Adjustable	
40		TOTALIZ												
41	ACCESOR.	MESURE CABLE SUPPLY:SELLER	OTHERS	YES	NA		YES	NA		YES	NA		YES	NA
42		CABLE LENGTH (SENSOR-CONVERT.)		Vendor specified (note 1)			Vendor specified (note 1)			Vendor specified (note 1)			Vendor specified (note 1)	
43		SIGNAL OUTPUT INDICATOR		In Transmitter			In Transmitter			In Transmitter			In Transmitter	
44		TOTALIZER INCLUDED IN TRANSMITTER		YES			YES			YES			YES	
45		GROUNDING RING		YES			YES			YES			YES	
46	PIPING AND INSTR. DIAGRAM. Number			PUB-WSP-JDD-005 SHEET 3			PUB-WSP-JDD-005 SHEET 3			PUB-WSP-JDD-005 SHEET 3			PUB-WSP-JDD-005 SHEET 3	
47	WIRING DIAGRAM. Number													
48														
49	APPLICABLES NOTES													

50	(1) Supplier provide transmitter with display away from the Sensor, with connection cable (Remote version).	UNITS
51	(2) Integrates indicator transmitter.	FLOW: m3/h
52	(3)There will be two output signals. The main output signal is the 4-20 mA, but there are also one digital output signal counter pulse.	PRESSURE: Barg
53	4) See PUB-WSP-ISA-001 (process connection diagram)	TEMPERATURE: ºC
54	The supplier has to complete the datasheets according to Instruments use and process condition (fluid, pressure, temperature and flow).	LENGTH: m
55		DENSITY : kg/m^3
56		
57		
58		
59		
60		
61		
62		
63		

Rotameter data sheet

1	MANUFACTURER											
2	MODEL											
3	POSICIÓN Nº	REV.	5	01	6	01	7	01	8	01		
4	TAGS		FSL10212		FSL10213		FSL10214		FSL10215			
5	SERVICE		INTAKE SAMPLE ORP		INTEKE SAMPLE COND		INTAKE SAMPLE pH/TEMP		INTAKE SAMPLE ALGAE			
6												
7	LINE SIZE AND SPECIFICATION		d32/1P3		d32/1P3		d32/1P3		d32/1P3			
8	PROCESS	FLUID	RSW (Raw Sea Water)		RSW (Raw Sea Water)		RSW (Raw Sea Water)		RSW (Raw Sea Water)			
9												
10		STATE	LIQUID		LIQUID		LIQUID		LIQUID			
11		TEMPERATURE: MiNIMUM / MAXIMUM	26	32	26	32	26	32	26	32		
12		PRESSURE OPERATION / MAXIMUM	2	10	2	10	2	10	2	10		
13		AMBIENT TEMPERATURE MIN/MAX	5	50	5	50	5	50	5	50		
14		HUMIDITY (%) MIN/MAX	80	99	80	99	80	99	80	99		
15		FLOW OPERATION m^3/h	5		5		5		5			
16	PROBE	MODEL										
17		TYPE	FLOAT		FLOAT		FLOAT		FLOAT			
18		MATERIAL	PVC-U		PVC-U		PVC-U		PVC-U			
19		DIAMETER	DN15		DN15		DN15		DN15			
20		PROCESS CONECTION	NPT 1/2" (Note 2)		NPT 1/2" (Note 2)		NPT 1/2" (Note 2)		NPT 1/2" (Note 2)			
21		O-RING MATERIAL	EPDM		EPDM		EPDM		EPDM			
22		FLOAT MATERIAL	PVDF		PVDF		PVDF		PVDF			
23		AMBIENT PROTECTION	IP-65		IP-65		IP-65		IP-65			
24		SCALE RANGE (m3/h)	0,6	6	0,6	6	0,6	6	0,6	6		
25		PN	10		10		10		10			
26	SWITCH	TYPE	Relay		Relay		Relay		Relay			
27		POWER SUPPLY	24 Vdc (loop powered)		24 Vdc (loop powered)		24 Vdc (loop powered)		24 Vdc (loop powered)			
28		CIRCUIT PROTECT.	DPDT	IP65	DPDT	IP65	DPDT	IP65	DPDT	IP65		
29		HAZARDOUS AREA PROTECTION	NOT APPLY		NOT APPLY		NOT APPLY		NOT APPLY			
30		OUTPUT SIGNAL	24 Vdc		24 Vdc		24 Vdc		24 Vdc			
31		PIPING AND INSTR. DIAGRAM. Number	PUB-WSP-JDD-002		PUB-WSP-JDD-002		PUB-WSP-JDD-002		PUB-WSP-JDD-002			
32	NOTES	1 For those instruments that require piping reductions the manufacturer will provide it.									UNITS	
33		2 See PUB-WSP-ISA-001 (process connection diagram)									PRESSURE: barg	
34		The supplier has to complete the datasheets according to Instruments use and process condition (fluid, pressure, temperature and flow).									TEMPERATURE: ºC	
35											FLOW: m3/h	
36											DENSITY: Kg / m^3	
37											VISCOSITY: cP	
38											SURFACE: cm^2	
39												
40												
41												
42												

Flow Switch data sheet

1	MANUFACTURER																			
2	MODEL Nº																			
3	ITEM Nº	REVISION Nº	1	01	2	01	3	01	4	01	5	01	6	01	7	01	8	01		
4	SERVICE		TRAVELLING BAND SCREEN 1 CLEANING		TRAVELLING BAND SCREEN 2 CLEANING		TRAVELLING BAND SCREEN 3 CLEANING		INTAKE PUMP 1		INTAKE PUMP 2		INTAKE PUMP 3		INTAKE PUMP 4		INTAKE PUMP 5			
5																				
6	LINE SIZE AND SPECIFICATION		d90/1P1		d90/1P1		d90/1P1		800/1P4		800/1P4		800/1P4		800/1P4		800/1P4			
7	DATA PROCESS	FLUID	RSW (Raw Sea Water)		RSW (Raw Sea Water)		RSW (Raw Sea Water)		RSW (Raw Sea Water)		RSW (Raw Sea Water)		RSW (Raw Sea Water)		RSW (Raw Sea Water)		RSW (Raw Sea Water)			
8		FLOW m^3/h	25		25		25		3250		3250		3250		3250		3250			
9		WORKING CODITIONS DENSITY (kg/m3)	1000		1000		1000		1000		1000		1000		1000		1000			
10		HUMIDITY (%) : MINIMUN	MAXIMUM	80	99	80	99	80	99	80	99	80	99	80	99	80	99	80	99	
11		OPERATION PRESSURE	MAXIMUM (bara)	4,5	10	4,5	10	4,5	10	1,6	10	1,6	10	1,6	10	1,6	10	1,6	10	
12		OPERATION TEMP.	MAXIMUM TEMP. ºC	26	32	26	32	26	32	26	32	26	32	26	32	26	32	26	32	
13		MIN AMBIENT TEMP.	MAXIMUM TEMP. ºC	5	50	5	50	5	50	5	50	5	50	5	50	5	50	5	50	
14	ENCLOSURE AND ELEMENT	TAG NUMBER		FSL10101		FSL10102		FSL10103		FLS10201		FLS10202		FLS10203		FLS10204		FLS10205		
15		SET POINT RANGE		0,003 to 1,5 m/s		0,003 to 1,5 m/s		0,003 to 1,5 m/s		0,003 to 1,5 m/s		0,003 to 1,5 m/s		0,003 to 1,5 m/s		0,003 to 1,5 m/s		0,003 to 1,5 m/s		
16		REPEATABILITY		<1% or better		<1% or better		<1% or better		<1% or better		<1% or better		<1% or better		<1% or better		<1% or better		
17		DELAY TIME		< 20 s		< 20 s		< 20 s		< 20 s		< 20 s		< 20 s		< 20 s		< 20 s		
18		HYSTERISIS		< 10% of the selected range		< 10% of the selected range		< 10% of the selected range		< 10% of the selected range		< 10% of the selected range		< 10% of the selected range		< 10% of the selected range		< 10% of the selected range		
19		MEASURE ELEMENT	MATERIAL	Thermal	AISI 316	Thermal	AISI 316	Thermal	AISI 316	Thermal	AISI 316	Thermal	AISI 316	Thermal	AISI 316	Thermal	AISI 316	Thermal	AISI 316	
20		PROCESS CONECTION		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		
21		WETTED PARTS MATERIAL		SS 316		SS 316		SS 316		SS 316		SS 316		SS 316		SS 316		SS 316		
22		ENCLOSURE		Cast alluminium		Cast alluminium		Cast alluminium		Cast alluminium		Cast alluminium		Cast alluminium		Cast alluminium		Cast alluminium		
23		AMBIENT PROTECTION		IP 65		IP 65		IP 65		IP 65		IP 65		IP 65		IP 65		IP 65		
24		HAZARDOUS AREA PROTECTION		NA		NA		NA		NA		NA		NA		NA		NA		
25		MOUNTING		In process line (Note 1)		In process line (Note 1)		In process line (Note 1)		In process line (Note 1)		In process line (Note 1)		In process line (Note 1)		In process line (Note 1)		In process line (Note 1)		
26		WIRING INPUTS		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		
27		TERMINALS: INTERNAL	IN EXTERNAL BOX	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	
28	SWITCHES	MODEL																		
29		QUANTITY	CIRCUITRY	1	DPDT	1	DPDT	1	DPDT	1	DPDT	1	DPDT	1	DPDT	1	DPDT	1	DPDT	
30		RATING		8A	30Vdc	8A	30Vdc	8A	30Vdc	8A	30Vdc	8A	30Vdc	8A	30Vdc	8A	30Vdc	8A	30Vdc	
31		DIFERENTIAL : FIXED	ADJUSTABLE	NA	YES	NA	YES	NA	YES	NA	YES	NA	YES	NA	YES	NA	YES	NA	YES	
32		ADJUSTMENT : INTERNAL	EXTERNAL	NA	YES	NA	YES	NA	YES	NA	YES	NA	YES	NA	YES	NA	YES	NA	YES	
33		ACTION POINT		10 m3/h (Adjustable)		10 m3/h (Adjustable)		10 m3/h (Adjustable)		1500 m3/h (Adjustable)		1500 m3/h (Adjustable)		1500 m3/h (Adjustable)		1500 m3/h (Adjustable)		1500 m3/h (Adjustable)		
34	ACCESORIES	LOCAL INDICATORS		YES (note 2)		YES (note 2)		YES (note 2)		YES (note 2)		YES (note 2)		YES (note 2)		YES (note 2)		YES (note 2)		
35		TEMPERATURE COMPENSATION		YES		YES		YES		YES		YES		YES		YES		YES		
36		FAULT DETECTION		YES		YES		YES		YES		YES		YES		YES		YES		
37		CABLE		YES		YES		YES		YES		YES		YES		YES		YES		
38	PIPING AND INSTR. DIAGRAM. Number			PUB-WSP-JDD-001		PUB-WSP-JDD-001		PUB-WSP-JDD-001		PUB-WSP-JDD-002		PUB-WSP-JDD-002		PUB-WSP-JDD-002		PUB-WSP-JDD-002		PUB-WSP-JDD-002		
39																				
40	APPLICABLE NOTES			1,2		1,2		1,2		1,2		1,2		1,2		1,2		1,2		
41	NOTES	**NOTES**.-																	UNITS	
42		(1) See PUB-WSP-ISA-001 (Process connection diagram)																	FLOW: m3/h	
43		(2) The flow switch shall have indicators for power and switch status																	PRESSURE: Bara	
44		The supplier has to complete the datasheets according to Instruments use and process condition (fluid, pressure, temperature and flow).																	TEMPERATURE: ºC	
45																			LENGTH: m	
46																			DENSITY : kg/m^3	
47																				

Ultrasonic flow transmitter data sheet

1	MANUFACTURER																		
2	MODEL Nº																		
3	POSITION Nº	REVISION Nº		1	00	2	00	3	00	4	00	5	00	6	00	7	00	8	00
4	SERVICE			PROCESS OVERFLOW TANK															
5	LINE SIZE AND SPECIFICATION			NA															
6	DATA PROCESSING	FLUID		CWC (Clean water chemistry)															
7	DATA PROCESSING	PRESSURE (barg)	MIN MAX	0	0														
8	DATA PROCESSING	HUMIDITY (%)	MIN MAX	80	99														
9	DATA PROCESSING	DESIGN TEMPERATURE (ºC)	MIN MAX	26	32														
10	DATA PROCESSING	AMBIENT TEMPERATURE (ºC)	MIN MAX	10	40														
11	SENSOR	TAG NUMBER		FE16102															
12	SENSOR	ELEMENT TYPE OF MEASURE		ULTRASONIC (NON CONTACT)															
13	SENSOR	MOUNTING		SUPPORT (CANTILEVER & MOUNTING FRAME)															
14	SENSOR	CONNECTION TO SUPPORT		THREAD NPT 1 1/2"															
15	SENSOR	SENSOR MATERIAL	SEAL MATERIAL	PVDF	EPDM														
16	SENSOR	CABLE GLAND		PA															
17	SENSOR	ENVIROMENTAL PROTECTION		IP68															
18	SENSOR	AUTOMATIC TEMPERATURE COMPENSATION		YES (integrated temperature sensor)															
19	TRANSMITTER	TAG NUMBER		FIT16102															
20	TRANSMITTER	CALIBRATION RANGE (mm)		0 - 1000															
21	TRANSMITTER	MAXIMUM MEASURING ERROR		±0,2% of the maximum span of the sensor															
22	TRANSMITTER	TYPICAL MEASURING ERROR		Better than ±0,2% + 0,17 % of the mearured distance															
23	TRANSMITTER	MEASURED VALUE RESOLUTION		1 mm															
24	TRANSMITTER	SIGNAL OUTPUT		Profibus															
25	TRANSMITTER	MEASURING FREQUENCY		Max. 3 Hz															
26	TRANSMITTER	POWER SUPPLY (V and nª CONDUCTOR)		24Vcc (2 wires) / shielded															
27	TRANSMITTER	CABLE ENTRY		M20x1,5															
28	TRANSMITTER	CABLE LENGTH TO TRANSMITTER		Vendor specified (Note 1)															
29	TRANSMITTER	ENVIROMENTAL PROTECTION		IP66															
30	TRANSMITTER	HOUSING		PC-FR															
31	TRANSMITTER	DANGEROUS AREAS PROTECTION		NA															
32	TRANSMITTER	MOUNTING		Remote on standard support (Note 2															
33	ACCESORIES	LOCAL DISPLAY WITH PROGRAMMING KEYBOARD		IN TRANSMITTER (Note 1)															
34	ACCESORIES	STILLING WELL		NO															
35	ACCESORIES	MOUNTING PLATE FOR FIELD HOUSING		YES															
36	ACCESORIES	FILTER OF CABLE COMPENSATION		YES															
37	ACCESORIES	MOUNTING SUPPORT		YES															
38																			
39	PIPING AND INSTRUMENTATION DIAGRAM			PUB-WSP-JDD-061															
40	APPLICABLE NOTES			1,2															

41	NOTES	**NOTES**.-
42	NOTES	(1) Supplier provide transmitter with display away from the Sensor, with connection cable (Remote version).
43	NOTES	(2) See PUB-WSP-ISA-001 (process connection diagram)
44	NOTES	The supplier has to complete the datasheets according to Instruments use and process condition (fluid, pressure, temperature and flow).
45	NOTES	
46	NOTES	
47	NOTES	
48	NOTES	

UNIT
PRESSURE: Barg
TEMPERATURE: ºC
LEVEL : meters (mm)

Hydrostatic level transmitter data sheet

1	MANUFACTURER																					
2	MODEL Nº																					
3	POSITION Nº	REVISION Nº			9	00	10	00	11	00	12	00	13	00	14	00	15	00	16	00
4	SERVICE				Sodium hypochlorite storage tank 2 (TK-16202)		Ferric chloride storage tank 1 (TK-16301)		Ferric chloride storage tank 2 (TK-16302)		Polyelectrolite preparattion unit 1 (PU-16401)		Polyelectrolite preparattion unit 2 (PU-16402)		Sulphuric acid storage tank 1 (TK-16501)		Sulphuric acid storage tank 2 (TK-16502)		Sodium hydroxide storage tank 1 (TK-16601)	
5	LINE SIZE AND SPECIFICATION				NA		NA		NA		NA		NA		NA		NA		NA	
6	DATA PROCESS	FLUID			SOH (Sodium hypochlorite)		FEC (Ferric chloride)		FEC (Ferric chloride)		POL (Polyelectrolyte)		POL (Polyelectrolyte)		SAH (Sulphuric acid)		SAH (Sulphuric acid)		SMH (Sodium hydroxide)	
7	DATA PROCESS	PRESSURE (barg)	MIN	MAX	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	DATA PROCESS	DESIGN TEMP. (ºC)	MIN	MAX	-11	50	-11	50	-11	50	-11	50	-11	50	-11	50	-11	50	-11	50
9	DATA PROCESS	HUMIDITY (%)	MIN	MAX	80	99	80	99	80	99	80	99	80	99	80	99	80	99	80	99
10	DATA PROCESS	AMBIENT TEMP. (ºC)	MIN	MAX	5	35	5	35	5	35	5	35	5	35	5	35	5	35	5	35
11	SENSOR	TAG NUMBER			LE16202		LE16301		LE16302		LE16401		LE16402		LE16501		LE16502		LE16601	
12	SENSOR	ELEMENT TYPE OF MEASURE			Hydrostatic		Hydrostatic		Hydrostatic		Hydrostatic		Hydrostatic		Hydrostatic		Hydrostatic		Hydrostatic	
13	SENSOR	SENSOR MATERIAL	SEAL MATERIAL		AISI 316L	EPDM	AISI 316L	EPDM	AISI 316L	EPDM	AISI 316L	EPDM	AISI 316L	EPDM	AISI 316L	EPDM	AISI 316L	EPDM	AISI 316L	EPDM
14	SENSOR	MOUNTING FLANGE HEIGHT			80 mm		120 mm		120 mm		120 mm		80 mm		80 mm		80 mm		120 mm	
15	SENSOR	PROCESS CONNECTION			FLANGED BS EN 1092-1 PN10		FLANGED BS EN 1092-1 PN10		FLANGED BS EN 1092-1 PN10		FLANGED BS EN 1092-1 PN10		FLANGED BS EN 1092-1 PN10		FLANGED BS EN 1092-1 PN10		FLANGED BS EN 1092-1 PN10		FLANGED BS EN 1092-1 PN10	
16	SENSOR	FILLING FLUID			SILICON OIL		SILICON OIL		NO FILLING FLUID		NO FILLING FLUID		NO FILLING FLUID		NO FILLING FLUID		NO FILLING FLUID		SILICON OIL	
17	TRANSMITTER	TAG NUMBER			LIT16202		LIT16301		LIT16302		LIT16401		LIT16402		LIT16501		LIT16502		LIT16601	
18	TRANSMITTER	CALIBRATION RANGE		m	0 - 7		0 - 9		0 - 9		0 - 4		0 - 4		0 - 6		0 - 6		0 - 9	
19	TRANSMITTER	ACCURACY %			±0.25 % fsd or better		±0.25 % fsd or better		±0.25 % fsd or better		±0.25 % fsd or better		±0.25 % fsd or better		±0.25 % fsd or better		±0.25 % fsd or better		±0.25 % fsd or better	
20	TRANSMITTER	SIGNAL OUTPUT			PROFIBUS PA		PROFIBUS PA		PROFIBUS PA		PROFIBUS PA		PROFIBUS PA		PROFIBUS PA		PROFIBUS PA		PROFIBUS PA	
21	TRANSMITTER	OPERATING FREQUENCY			not applies		not applies		not applies		not applies		not applies		not applies		not applies		not applies	
22	TRANSMITTER	POWER SUPPLY			24Vdc, loop-powered		24Vdc, loop-powered		24Vdc, loop-powered		24 Vdc, loop powered		24 Vdc, loop powered		24 Vdc, loop powered		24 Vdc, loop powered		24Vdc, loop-powered	
23	TRANSMITTER	CABLE ENTRY			1/2" NPT F		1/2" NPT F		1/2" NPT F		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT F	
24	TRANSMITTER	CABLE LENGTH TO TRANSMITTER			Vendor specified (Note 1)		Vendor specified (Note 1)		Vendor specified (Note 1)		Vendor specified (Note 1)		Vendor specified (Note 1)		Vendor specified (Note 1)		Vendor specified (Note 1)		Vendor specified (Note 1)	
25	TRANSMITTER	AMBIENT PROTECTION			IP65		IP65		IP65		IP65		IP65		IP65		IP65		IP65	
26	TRANSMITTER	DANGEROUS AREAS PROTECTION			Not applies		Not applies		Not applies		not applies		not applies		not applies		not applies		Not applies	
27	TRANSMITTER	TRANSMITTER MOUNTING			REMOTE (In support, note 2)		REMOTE (In support, note 2)		REMOTE (In support, note 2)		REMOTE (In support, note 2)		REMOTE (In support, note 2)		REMOTE (In support, note 2)		REMOTE (In support, note 2)		REMOTE (In support, note 2)	
28	TRANSMITTER	HOUSING MATERIAL			Aluminium with powder coating on polyester base (5)		Aluminium with powder coating on polyester base (5)		Aluminium with powder coating on polyester base (5)		Aluminium with powder coating on polyester base (5)		Aluminium with powder coating on polyester base (5)		Aluminium with powder coating on polyester base (5)		Aluminium with powder coating on polyester base (5)		Aluminium with powder coating on polyester base (5)	
29	ACCESORIES	LOCAL DISPLAY			YES (Note 4)		YES (Note 4)		YES (Note 4)		YES (Note 4)		YES (Note 4)		YES (Note 4)		YES (Note 4)		YES (Note 4)	
30	ACCESORIES	STILLING WELL			Not required		Not required		Not required		Not required		Not required		Not required		Not required		Not required	
31	ACCESORIES	RETAINNING CLIP			Not required		Not required		Not required		Not required		Not required		Not required		Not required		Not required	
32	ACCESORIES	MOUNTING BRACKET			YES		YES		YES		YES		YES		YES		YES		YES	
33	ACCESORIES	PROTECTION MEMBRANE (SEAL)			YES		YES		YES		YES		YES		YES		YES		YES	
34	PIPING AND INSTRUMENTATION DIAGRAM				PUB-WSP-JDD-062		PUB-WSP-JDD-063		PUB-WSP-JDD-063		PUB-WSP-JDD-064		PUB-WSP-JDD-064		PUB-WSP-JDD-065		PUB-WSP-JDD-065		PUB-WSP-JDD-066	
35																				
36	APPLICABLE NOTES				1,2,3,4,5		1,2,3,4,5		1,2,3,4,5		1,2,3,4,5		1,2,3,4,5		1,2,3,4,5		1,2,3,4,5		1,2,3,4,5	
37	NOTES	**NOTES**.-																		
38	NOTES	(1) Supplier provide transmitter with display away from the Sensor, with connection cable (Remote version).																		
39	NOTES	(2) See PUB-WSP-ISA-001 (process connection diagram)																		
40	NOTES	(3) This powder coating is suitable for maritime environment																		
41	NOTES	(4) These level transmitters will have a remote process indicator																		
42	NOTES	(5) Mounting accesories for connecting probe to the tank must be supplied																		
43	NOTES	The supplier has to complete the datasheets according to Instruments use and process condition (fluid, pressure, temperature and flow).																		
44	NOTES																			

Ultrasonic level transmitter data sheet

1	MANUFACTURER											
2	MODEL Nº											
3	POSITION Nº		REVISION Nº		9	00	10	00	11	00	12	00
4	SERVICE				DAF 2		DAF 3		DAF 4		DAF 6	
5	LINE SIZE AND SPECIFICATION				NA		NA		NA		NA	
6	DATA / PROCESSING	FLUID			CLW (Clarified water)		CLW (Clarified water)		CLW (Clarified water)		CLW (Clarified water)	
7	DATA / PROCESSING	PRESSURE (barg)	MIN	MAX	0	0	0	0	0	0	0	0
8	DATA / PROCESSING	HUMIDITY (%)	MIN	MAX	80	99	80	99	80	99	80	99
9	DATA / PROCESSING	DESIGN TEMPERATURE (ºC)	MIN	MAX	3	26	3	26	3	26	3	26
10	DATA / PROCESSING	AMBIENT TEMPERATURE (ºC)	MIN	MAX	3	26	3	26	3	26	3	26
11	SENSOR	TAG NUMBER			LE10303		LE10304		LE10305		LE10306	
12	SENSOR	ELEMENT TYPE OF MEASURE			ULTRASONIC		ULTRASONIC		ULTRASONIC		ULTRASONIC	
13	SENSOR	SENSOR MATERIAL	SEAL MATERIAL		PVDF	EPDM	PVDF	EPDM	PVDF	EPDM	PVDF	EPDM
14	SENSOR	HOUSING MATERIAL			Aluminium		Aluminium		Aluminium		Aluminium	
15	SENSOR	ENVIROMENTAL PROTECTION			IP67 as minimum		IP67 as minimum		IP67 as minimum		IP67 as minimum	
16	SENSOR	AUTOMATIC TEMPERATURE COMPENSATION			YES (integrated temperature sensor)		YES (integrated temperature sensor)		YES (integrated temperature sensor)		YES (integrated temperature sensor)	
17	TRANSMITTER	TAG NUMBER			LIT10303		LIT10304		LIT10305		LIT10306	
18	TRANSMITTER	CALIBRATION RANGE (m)			0 - 5		0 - 5		0 - 5		0 - 5	
19	TRANSMITTER	ACCURACY % FE			±0,25% or better of range for ranges more than 2400 mm ±6 mm or better for ranges less than 2400 mm		±0,25% or better of range for ranges more than 2400 mm ±6 mm or better for ranges less than 2400 mm		±0,25% or better of range for ranges more than 2400 mm ±6 mm or better for ranges less than 2400 mm		±0,25% or better of range for ranges more than 2400 mm ±6 mm or better for ranges less than 2400 mm	
20	TRANSMITTER	SIGNAL OUTPUT			PROFIBUS PA (Note 1)		PROFIBUS PA (Note 1)		PROFIBUS PA (Note 1)		PROFIBUS PA (Note 1)	
21	TRANSMITTER	OPERATING FREQUENCY			70 kHz		70 kHz		70 kHz		70 kHz	
22	TRANSMITTER	POWER SUPPLY (V and nª CONDUCTOR)			24Vcc (2 wires) / shielded		24Vcc (2 wires) / shielded		24Vcc (2 wires) / shielded		24Vcc (2 wires) / shielded	
23	TRANSMITTER	CABLE ENTRY			M20x1,5		M20x1,5		M20x1,5		M20x1,5	
24	TRANSMITTER	CABLE LENGTH TO TRANSMITTER			Vendor specified (Note 2)		Vendor specified (Note 2)		Vendor specified (Note 2)		Vendor specified (Note 2)	
25	TRANSMITTER	ENVIROMENTAL PROTECTION			IP65		IP65		IP65		IP65	
26	TRANSMITTER	DANGEROUS AREAS PROTECTION			NA		NA		NA		NA	
27	TRANSMITTER	MOUNTING			Remote on standard support (Note 3)		Remote on standard support (Note 3)		Remote on standard support (Note 3)		Remote on standard support (Note 3)	
28	ACCESORIES	LOCAL DISPLAY WITH PROGRAMMING KEYBOARD			REMOTE (Note 4)		REMOTE (Note 4)		REMOTE (Note 4)		REMOTE (Note 4)	
29	ACCESORIES	STILLING WELL			NO		NO		NO		NO	
30	ACCESORIES	RETAINNING CLIP			NO		NO		NO		NO	
31	ACCESORIES	FILTER OF CABLE COMPENSATION			YES		YES		YES		YES	
32	ACCESORIES	MOUNTING SUPPORT			YES		YES		YES		YES	
33	ACCESORIES											
34	PIPING AND INSTRUMENTATION DIAGRAM				PUB-WSP-JDD-003		PUB-WSP-JDD-003		PUB-WSP-JDD-003		PUB-WSP-JDD-003	
35	APPLICABLE NOTES				1,2,3,4		1,2,3,4		1,2,3,4		1,2,3,4	

1	MANUFACTURER											
2	MODEL Nº											
3	POSITION Nº		REVISION Nº		13	00	14	00	15	00	16	00
4	SERVICE				DAF 5		DAF SLUDGE CHANNEL		CLARIFIED WATER TANK 1		CLARIFIED WATER TANK 2	
5	LINE SIZE AND SPECIFICATION				NA		NA		NA		NA	
6	DATA / PROCESSING	FLUID			CLW (Clarified water)		FLS (Floated sludge)		CLW (Clarified water)		CLW (Clarified water)	
7	DATA / PROCESSING	PRESSURE (barg)	MIN	MAX	0	0	0	0	0	0	0	0
8	DATA / PROCESSING	HUMIDITY (%)	MIN	MAX	80	99	80	99	80	99	80	99
9	DATA / PROCESSING	DESIGN TEMPERATURE (ºC)	MIN	MAX	3	26	3	26	3	26	3	26
10	DATA / PROCESSING	AMBIENT TEMPERATURE (ºC)	MIN	MAX	3	26	3	26	3	26	3	26
11	SENSOR	TAG NUMBER			LE10307		LE10308		LE10401		LE10402	
12	SENSOR	ELEMENT TYPE OF MEASURE			ULTRASONIC		ULTRASONIC		ULTRASONIC		ULTRASONIC	
13	SENSOR	SENSOR MATERIAL	SEAL MATERIAL		PVDF	EPDM	PVDF	EPDM	PVDF	EPDM	PVDF	EPDM
14	SENSOR	HOUSING MATERIAL			Aluminium		Aluminium		Aluminium		Aluminium	
15	SENSOR	ENVIROMENTAL PROTECTION			IP67 as minimum		IP67 as minimum		IP67 as minimum		IP67 as minimum	
16	SENSOR	AUTOMATIC TEMPERATURE COMPENSATION			YES (integrated temperature sensor)		YES (integrated temperature sensor)		YES (integrated temperature sensor)		YES (integrated temperature sensor)	
17	TRANSMITTER	TAG NUMBER			LIT10307		LIT10308		LIT10401		LIT10402	
18	TRANSMITTER	CALIBRATION RANGE (m)			0 - 5		0 - 5		0 - 10,5		0 - 10,5	
19	TRANSMITTER	ACCURACY % FE			±0,25% or better of range for ranges more than 2400 mm ±6 mm or better for ranges less than 2400 mm		±0,25% or better of range for ranges more than 2400 mm ±6 mm or better for ranges less than 2400 mm		±0,25% or better of range for ranges more than 2400 mm ±6 mm or better for ranges less than 2400 mm		±0,25% or better of range for ranges more than 2400 mm ±6 mm or better for ranges less than 2400 mm	
20	TRANSMITTER	SIGNAL OUTPUT			PROFIBUS PA (Note 1)		PROFIBUS PA (Note 1)		PROFIBUS PA (Note 1)		PROFIBUS PA (Note 1)	
21	TRANSMITTER	OPERATING FREQUENCY			70 kHz		70 kHz		70 kHz		70 kHz	
22	TRANSMITTER	POWER SUPPLY (V and nª CONDUCTOR)			24Vcc (2 wires) / shielded		24Vcc (2 wires) / shielded		24Vcc (2 wires) / shielded		24Vcc (2 wires) / shielded	
23	TRANSMITTER	CABLE ENTRY			M20x1,5		M20x1,5		M20x1,5		M20x1,5	
24	TRANSMITTER	CABLE LENGTH TO TRANSMITTER			Vendor specified (Note 2)		Vendor specified (Note 2)		Vendor specified (Note 2)		Vendor specified (Note 2)	
25	TRANSMITTER	ENVIROMENTAL PROTECTION			IP65		IP65		IP65		IP65	
26	TRANSMITTER	DANGEROUS AREAS PROTECTION			NA		NA		NA		NA	
27	TRANSMITTER	MOUNTING			Remote on standard support (Note 3)		Remote on standard support (Note 3)		Remote on standard support (Note 3)		Remote on standard support (Note 3)	
28	ACCESORIES	LOCAL DISPLAY WITH PROGRAMMING KEYBOARD			REMOTE (Note 4)		REMOTE (Note 4)		REMOTE (Note 4)		REMOTE (Note 4)	
29	ACCESORIES	STILLING WELL			NO		NO		NO		NO	
30	ACCESORIES	RETAINNING CLIP			NO		NO		NO		NO	
31	ACCESORIES	FILTER OF CABLE COMPENSATION			YES		YES		YES		YES	
32	ACCESORIES	MOUNTING SUPPORT			YES		YES		YES		YES	
33	ACCESORIES											
34	PIPING AND INSTRUMENTATION DIAGRAM				PUB-WSP-JDD-003		PUB-WSP-JDD-003		PUB-WSP-JDD-004		PUB-WSP-JDD-004	
35	APPLICABLE NOTES				1,2,3,4		1,2,3,4		1,2,3,4		1,2,3,4	

36	NOTES	**NOTES**.-	UNIT
37	NOTES	(1) Minimum two SPDT contacts provided for alarms	PRESSURE: Barg
38	NOTES	(2) Supplier provide transmitter with display away from the Sensor, with connection cable (Remote version).	TEMPERATURE: ºC
39	NOTES	(3) See PUB-WSP-ISA-001 (process connection diagram)	LEVEL : meters (mm)
40	NOTES	(4) Supplier provide transmitter with display away from the Sensor, with connection cable.	
41	NOTES	The supplier has to complete the datasheets according to Instruments use and process condition (fluid, pressure, temperature and flow).	
42	NOTES		
43	NOTES		

FLOAT LEVEL SWITCHES DATA SHEET

1	MANUFACTURER																		
2	MODEL Nº																		
3	ITEM Nº	REVISION Nº	25	00	26	00	27	00	28	00	29	00	30	00	31	00	32	00	
4	TAG		LSL13302		LSLL13302		LSH13303		LSL13303		LSLL13303		LSH13304		LSL13304		LSLL13304		
5	SERVICE		BASIC CIP TANK 1		BASIC CIP TANK 1		ACID CIP TANK 2		ACID CIP TANK 2		ACID CIP TANK 2		BASIC CIP TANK 1		BASIC CIP TANK 1		BASIC CIP TANK 1		
6	TANK		TK-13302		TK-13302		TK-13303		TK-13303		TK-13303		TK-13304		TK-13304		TK-13304		
7	DATA PROCESSING	FLUID	CWC (Clean Water Chemistry)		CWC (Clean Water Chemistry)		CWC (Clean Water Chemistry)		CWC (Clean Water Chemistry)		CWC (Clean Water Chemistry)		CWC (Clean Water Chemistry)		CWC (Clean Water Chemistry)		CWC (Clean Water Chemistry)		
8		STATE	Liquid		Liquid		Liquid		Liquid		Liquid		Liquid		Liquid		Liquid		
9		HUMIDITY (%) : MINIMUM MAXIMUM	80	99	80	99	80	99	80	99	80	99	80	99	80	99	80	99	
10		PRESSURE (bara): NORMAL	1		1		1		1		1		1		1		1		
11		TEMPERATURE (ºC): NORMAL	26	32	26	32	26	32	26	32	26	32	26	32	26	32	26	32	
12		AMBIENT TEMPERATURE (ºC)	5	50	5	50	5	50	5	50	5	50	5	50	5	50	5	50	
13	INSTRUMENT	MODEL	Float		Float		Float		Float		Float		Float		Float		Float		
14		MOUNTING	Top		Top		Top		Top		Top		Top		Top		Top		
15		CONNECTION TYPE AND SIZE IN TANK	Suspended by a SS wire		Suspended by a SS wire		Suspended by a SS wire		Suspended by a SS wire		Suspended by a SS wire		Suspended by a SS wire		Suspended by a SS wire		Suspended by a SS wire		
16		SWITCH/FLOAT DIMENSIONS (mm)	By supplier		By supplier		By supplier		By supplier		By supplier		By supplier		By supplier		By supplier		
17		SWITCH/FLOAT MATERIAL	Stainless Steal		Stainless Steal		Stainless Steal		Stainless Steal		Stainless Steal		Stainless Steal		Stainless Steal		Stainless Steal		
18		WEIGHT WITHOUT CABLE (gr)	By supplier		By supplier		By supplier		By supplier		By supplier		By supplier		By supplier		By supplier		
19		ELECTRICAL CONNECTION	1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		
20	SWITCH	TYPE	Relay		Relay		Relay		Relay		Relay		Relay		Relay		Relay		
21		POWER SUPPLY	24 Vdc (loop powered)		24 Vdc (loop powered)		24 Vdc (loop powered)		24 Vdc (loop powered)		24 Vdc (loop powered)		24 Vdc (loop powered)		24 Vdc (loop powered)		24 Vdc (loop powered)		
22		CIRCUIT PROTECT.	1DPTD	IP65	1DPTD	IP65	1DPTD	IP65	1DPTD	IP65	1DPTD	IP65	1DPTD	IP65	1DPTD	IP65	1DPTD	IP65	
23		HAZARDOUS AREA PROTECTION	NOT APPLY		NOT APPLY		NOT APPLY		NOT APPLY		NOT APPLY		NOT APPLY		NOT APPLY		NOT APPLY		
24		OUTPUT SIGNAL	24 Vdc		24 Vdc		24 Vdc		24 Vdc		24 Vdc		24 Vdc		24 Vdc		24 Vdc		
25	PIPING AND INSTRUMENTATION DIAGRAM		PUB-WSP-JDD-033		PUB-WSP-JDD-033		PUB-WSP-JDD-033		PUB-WSP-JDD-033		PUB-WSP-JDD-033		PUB-WSP-JDD-033		PUB-WSP-JDD-033		PUB-WSP-JDD-033		
26	APPLICABLE NOTES																		

27	NOTES	**NOTES**.-	UNIT
28		The supplier has to complete the datasheets according to Instruments use and process condition (fluid, pressure, temperature and flow).	PRESSURE: Bara
29			TEMPERATURE: ºC
30			
31			

Level gauge and magnetic switch data sheet

1		MANUFACTURER																	
2		MODEL Nº																	
3		ITEM Nº	REVISION Nº	1	01	2	01	3	01	4	01	5	01	6	01	7	01	8	01
4		TAG		LI16201		LI16202		LI16301		LI16302		LI16501		LI16502		LI16601		LI16602	
5		SERVICE		SOH STORAGE TANK 1		SOH STORAGE TANK 2		FEC STORAGE TANK 1		FEC STORAGE TANK 2		SAH STORAGE TANK 1		SAH STORAGE TANK 2		SMH STORAGE TANK 1		SMH STORAGE TANK 2	
6		LINE SIZE AND SPECIFICATION		TK-16201		TK-16202		TK-16301		TK-16302		TK-16501		TK-16502		TK-16601		TK-16602	
7	DATA	FLUID		SOH (Sodium Hypochlorite)		SOH (Sodium Hypochlorite)		FEC (Ferric Chloride)		FEC (Ferric Chloride)		SAH (Sulphuric Acid)		SAH (Sulphuric Acid)		SMH (Sodium Hydroxide)		SMH (Sodium Hydroxide)	
8		STATE		Liquid		Liquid		Liquid		Liquid		Liquid		Liquid		Liquid		Liquid	
9		HUMIDITY (%) : MINIMUM	MAXIMUM	80	99	80	99	80	99	80	99	80	99	80	99	80	99	80	99
10		PRESSURE (bara): NORMAL		1		1		1		1		1		1		1		1	
11		TEMPERATURE (ºC): NORMAL		26	32	26	32	26	32	26	32	26	32	26	32	26	32	26	32
12		AMBIENT TEMPERATURE (ºC)		5	50	5	50	5	50	5	50	5	50	5	50	5	50	5	50
13	INSTRUMENT	TAG NUMBER		LI16201		LI16202		LI16301		LI16302		LI16501		LI16502		LI16601		LI16602	
14		MATERIAL		PVC		PVC		PVC		PVC		PVC		PVC		PVC		PVC	
15		WETTED PARTS MATERIAL		PVC		PVC		PVC		PVC		cPVC		cPVC		PVC		PVC	
16		CONECTIONS FLANGES	SIZE	BS 4504	DN25	BS 4504	DN25	BS 4504	DN25	BS 4504	DN25	BS 4504	DN25	BS 4504	DN25	BS 4504	DN25	BS 4504	DN25
17		PROCESS CONECTIONS		DN32		DN32		DN32		DN32		DN32		DN32		DN32		DN32	
18		DISTANCE BETWEEN CONECTIONS																	
19		DESIGN NOMINAL PRESSURE		PN10		PN10		PN10		PN10		PN10		PN10		PN10		PN10	
20		SCALE LENGTH		0 - 80000 l		0 - 80000 l		0 - 60000 l		0 - 60000 l		0 - 45000 l		0 - 45000 l		0 - 60000 l		0 - 60000 l	
21		DRAIN AND VENT VALVES		YES		YES		YES		YES		YES		YES		YES		YES	
22		SEAL																	
23	FLOAT	DIAMETER		Ø 78 mm		Ø 78 mm		Ø 78 mm		Ø 78 mm		Ø 78 mm		Ø 78 mm		Ø 78 mm		Ø 78 mm	
24		DIMENSION (mm)		long130 mm		long130 mm		long130 mm		long130 mm		long130 mm		long130 mm		long130 mm		long130 mm	
25		MATERIAL		PEHD		PEHD		PEHD		PEHD		PEHD		PEHD		PEHD		PEHD	
26		WETTED PARTS MATERIAL		PEHD		PEHD		PEHD		PEHD		PEHD		PEHD		PEHD		PEHD	
27	SWITCH	TYPE		Magnetic		Magnetic		Magnetic		Magnetic		Magnetic		Magnetic		Magnetic		Magnetic	
28		POWER SUPPLY		24 Vdc (loop powered)		24 Vdc (loop powered)		24 Vdc (loop powered)		24 Vdc (loop powered)		24 Vdc (loop powered)		24 Vdc (loop powered)		24 Vdc (loop powered)		24 Vdc (loop powered)	
29		CONTACT TYPE	PROTECT.	1DPTD	IP65	1DPTD	IP65	1DPTD	IP65	1DPTD	IP65	1DPTD	IP65	1DPTD	IP65	1DPTD	IP65	1DPTD	IP65
30		HAZARDOUS AREA PROTECTION		NOT APPLY		NOT APPLY		NOT APPLY		NOT APPLY		NOT APPLY		NOT APPLY		NOT APPLY		NOT APPLY	
31		HIGH SWITCH		LSH16204		LSH16203		LSH16301		LSH16302		LSH16501		LSH16502		LSH16601		LSH16602	
32		LOW SWITCH		LSL16201		LSL16202		LSL16301		LSL16302		LSL16501		LSL16502		LSL16601		LSL16602	
33		OUTPUT SIGNAL		24 Vdc		24 Vdc		24 Vdc		24 Vdc		24 Vdc		24 Vdc		24 Vdc		24 Vdc	
34	ACCES	MOUTING ACCESORIES		YES		YES		YES		YES		YES		YES		YES		YES	
35		MATERIAL MOUTING ACCESORIES		PVC		PVC		PVC		PVC		PVC		PVC		PVC		PVC	
36		PIPING AND INSTRUMENTATION DIAGRAM		PUB-WSP-JDD-062		PUB-WSP-JDD-062		PUB-WSP-JDD-063		PUB-WSP-JDD-063		PUB-WSP-JDD-065		PUB-WSP-JDD-065		PUB-WSP-JDD-066		PUB-WSP-JDD-066	
37		APPLICABLE NOTES																	
38	NOTES	**NOTES**.-														UNIT			
39		The supplier has to complete the datasheets according to Instruments use and process condition (fluid, pressure, temperature and flow).														PRESSURE: Bara			
40																TEMPERATURE: ºC			
41																			
42																			

Vibrating level switch data sheet

1		MANUFACTURER										
2		MODEL Nº										
3		POSITION Nº	REV Nº	33	00	34	00	35	00	36	00	
4		TAG NUMBER		LS12501		LS12502		LS12601		LS12602		
5		SERVICE		UF RACK 17 VENT		UF RACK 17 VENT		UF RACK 18 VENT		UF RACK 18 VENT		
6		LINE SIZE AND SPECIFICATION		DN50/1P4		DN50/1P4		DN50/1P4		DN50/1P4		
7	DATA PROCESS	FLUID		DRW (Drain water)		DRW (Drain water)		DRW (Drain water)		DRW (Drain water)		
8		DESIGN TEMPERATURE (ºC) MIN	MAX	26	32	26	32	26	32	26	32	
9		AMBIENT TEMPERATURE (ºC) MIN	MAX	5	32	5	32	5	32	5	32	
10		PRESSURE: OPERATION	DESIGN	0	0	0	0	0	0	0	0	
11		FLUID DENSITY		997,31		997,31		997,31		997,31		
12		HUMIDITY (%) MIN	MAX	80	99	80	99	80	99	80	99	
13	BODY	SENSOR MATERIAL		1.4435		1.4435		1.4435		1.4435		
14		MOUNTING		PROCESS PIPE		PROCESS PIPE		PROCESS PIPE		PROCESS PIPE		
15		CONNECTION TYPE AND SIZE		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		
16		MEASUREMENT PRINCIPLE		VIBRATING		VIBRATING		VIBRATING		VIBRATING		
17		SENSOR LENGTH (mm)		50,5		50,5		50,5		50,5		
18		WETTED PARTS		1.4435		1.4435		1.4435		1.4435		
19	SWITCHES	TYPE		2 wire		2 wire		2 wire		2 wire		
20		POWER SUPPLY:		24 Vdc		24 Vdc		24 Vdc		24 Vdc		
21		DIFFERENTIAL: FIXED	ADJUSTABLE	NA	YES	NA	YES	NA	YES	NA	YES	
22		ADJUSTMENT: INTERNAL	EXTERNAL	YES	NA	YES	NA	YES	NA	YES	NA	
23		CONTACT CLOSED WHEN:		ADJUSTABLE		ADJUSTABLE		ADJUSTABLE		ADJUSTABLE		
24		MAX. MEASURED ERROR		±1 mm		±1 mm		±1 mm		±1 mm		
25		REPEATABILITY		0,1 mm		0,1 mm		0,1 mm		0,1 mm		
26		HYSTERISIS		2 mm aprox.		2 mm aprox.		2 mm aprox.		2 mm aprox.		
27		SWITCHING TIME		0,5-60 s (Configurable)		0,5-60 s (Configurable)		0,5-60 s (Configurable)		0,5-60 s (Configurable)		
28		HAZARDOUS AREA PROTECTION		Not apply		Not apply		Not apply		Not apply		
29		AMBIENT PROTECTION		IP-66		IP-66		IP-66		IP-66		
30		BOX MATERIAL		PBT-FR		PBT-FR		PBT-FR		PBT-FR		
31		ELECTRICAL CONNECTION		M20x1,5		M20x1,5		M20x1,5		M20x1,5		
32		SWITCHING MAX. VOLTAGE	CURRENT	125 VDC	6 A	125 VDC	6 A	125 VDC	6 A	125 VDC	6 A	
33		CONNECTION TYPE		1 X DPDT		1 X DPDT		1 X DPDT		1 X DPDT		
34		OUTPUT SIGNAL		PROFIBUS PA		PROFIBUS PA		PROFIBUS PA		PROFIBUS PA		
35		OUTPUT SIGNAL POWER FAILURE		YES		YES		YES		YES		
36				-		-		-		-		
37	ACCESSORIES	MOUNTING ACCESORIES		Not apply		Not apply		Not apply		Not apply		
38		MATERIAL MOUNTING ACCESORIES		Not apply		Not apply		Not apply		Not apply		
39		CONNECTION WITH DRAIN PLUG		Not apply		Not apply		Not apply		Not apply		
40		ELECTRONIC INSERTS		YES		YES		YES		YES		
41		PIPING AND INSTRUMENT DIAGRAM Nº		PUB-WSP-JDD-025		PUB-WSP-JDD-025		PUB-WSP-JDD-026		PUB-WSP-JDD-026		

42	NOTES	(1) THIS INSTRUMENT IS ISOLATED FROM THE PROCESS WITH A BALL ISOLATION VALVE.
43		
44		
45		
46		
47		The supplier has to complete the datasheets according to Instruments use and process condition (fluid, pressure, temperature and flow).
48		
49		
50		
51		
52		
53		
54		
55		
56		

UNITS
PRESSURE: Bar (g)
TEMPERATURE: ºC
DENSITY: Kg/m^3
LENGTH: mm

Pressure gauge data sheet

MANUFACTURER:					MODEL:								
ENCLOSURE	DESIGN: BS EN 837			INTERNAL ELEMENTS	ELEMENT: BOURDON			ACCURACY: 1%					
	DIAL DIAMETER: 160 mm				CONNECTION: 1/2" NPT			OVERPRESSURE: +30 % f.s.					
	DIAL: WHITE (ALUMINIUM), BLACK LETTERING				MOVEMENT: STAINLESS STEEL			MOUNT: LINE (LOWER MOUNT)					
	POINTER: BLACK (ALUMINIUM)				MATERIAL CODE			FILLING FLUID: Glycerin 99,7%					
	WINDOW: LAMINATED SAFETY GLASS				A1=BRONZE	A2=BRASS							
	ENCLOSURE MAT.:SS 316				B=MONEL	E=SS 316L							
	ENCLOSURE PROTECTION: IP-65				C=AISI-316L	D=							

ITEM No.	REV. No.	TAGGING	SERVICE	MAX. TEMP. °C	PRESSURE			CONNECTION ELEMENT MATERIAL	ACCESORIES SEE NOTE Nº	P&ID No.	MODEL
					OPERATION	MAX	RANGE				
24	01	PI10509	DAF 3 PNEUMATIC PANEL	32	10	15	0/16	E	1,2,3	PUB-WSP-JDD-005	
25	01	PI10510	DAF 4 PNEUMATIC PANEL	32	10	15	0/16	E	1,2,3	PUB-WSP-JDD-005	
26	01	PI10511	DAF 5 PNEUMATIC PANEL	32	10	15	0/16	E	1,2,3	PUB-WSP-JDD-005	
27	01	PI10512	DAF 6 PNEUMATIC PANEL	32	10	15	0/16	E	1,2,3	PUB-WSP-JDD-005	
28	01	PI10601	UF DISC FILTERS INLET	32	2,5	3,75	0/5	E	1,2,3	PUB-WSP-JDD-006	
29	01	PI10602	UF DISC FILTERS OUTLET	32	2,5	3,75	0/5	E	1,2,3	PUB-WSP-JDD-006	
30	01	PI10701	BRINE BACKWASH PUMP 1	32	5,6	8,4	0/10	E	1,2,3	PUB-WSP-JDD-007	
31	01	PI10702	BRINE BACKWASH PUMP 2	32	5,6	8,4	0/10	E	1,2,3	PUB-WSP-JDD-007	
32	01	PI10703	BRINE BACKWASH PUMP 3	32	5,6	8,4	0/10	E	1,2,3	PUB-WSP-JDD-007	
33	01	PI13301	UF CIP PUMP 1	32	1,8	2,7	0/4	E	1,2,3,4,5	PUB-WSP-JDD-033	
34	01	PI13302	UF CIP PUMP 2	32	1,8	2,7	0/4	E	1,2,3,4,5	PUB-WSP-JDD-033	
35	01	PI13303	UF CIP PUMP 3	32	1,8	2,7	0/4	E	1,2,3,4,5	PUB-WSP-JDD-033	
36	01	PI13401	RO FEED PUMP 1	32	3,3	5	0/6	E	1,2,3,4	PUB-WSP-JDD-034	
37	01	PI13402	RO FEED PUMP 2	32	3,3	5	0/6	E	1,2,3,4	PUB-WSP-JDD-034	
38	01	PI13403	RO FEED PUMP 3	32	3,3	5	0/6	E	1,2,3,4	PUB-WSP-JDD-034	
39	01	PI13404	RO FEED PUMP 4	32	3,3	5	0/6	E	1,2,3,4	PUB-WSP-JDD-034	
40	01	PI13405	RO FEED PUMP 5	32	3,3	5	0/6	E	1,2,3,4	PUB-WSP-JDD-034	
41	01	PI13406	UF BACKWASH & CEB PUMP 1	32	4	6	0/8	E	1,2,3,4	PUB-WSP-JDD-034	
42	01	PI13407	UF BACKWASH & CEB PUMP 2	32	4	6	0/8	E	1,2,3,4	PUB-WSP-JDD-034	
43	01	PI13408	UF BACKWASH & CEB PUMP 3	32	4	6	0/8	E	1,2,3,4	PUB-WSP-JDD-034	
44	01	PI13409	UF BACKWASH & CEB PUMP 4	32	4	6	0/8	E	1,2,3,4	PUB-WSP-JDD-034	
45	01	PI13410	UF BACKWASH & CEB PUMP 5	32	4	6	0/8	E	1,2,3,4	PUB-WSP-JDD-034	
46	00	PI13501	RO DISC FILTERS INLET	32	3,5	5,25	0/6	E	1,2,3	PUB-WSP-JDD-035	

NOTES.-

1.- DIAPHRAGM AND WET PARTS (IN CONTACT WHIT PROCESS FLUID) WILL BE STAINLESS STEEL 316L. IN AMMONIA APPLICATIONS, DIA
SHALL BE IN STAINLESS STEEL. IN CHLORINE APPLICATIONS, DIAPHRAGM SHALL BE IN SILVER OR TANTALUM. IN SULPHUR DIOXIDE
IN TANTALUM.

2.- THIS INSTRUMENT IS ISOLATED FROM THE PROCESS WITH A ISOLATION VALVE.

3.- PRESSURE GAUGE SHALL PROVIDED WITH THREE VALVE MANIFOLD FOR ISOLATION AND DRAINAGE

4.- PRESSURE GAUGE WITH SWITCH CONTACTS

THE SUPPLIER HAS TO COMPLETE THE DATASHEET ACCORDING TO INSTRUMENTS USE AND PROCESS CONDITION (FLUID, PRESSURE, TEMPERATURE AND FLOW)

UNITS	
PRESSURE:	Bara
TEMPERATURE:	ºC

Pressure transmitter data sheet

1	MANUFACTURER																		
2	MODEL Nº																		
3	ITEM Nº		REVISION Nº	9	01	10	01	11	01	12	01	13	01	14	01	15	01	16	01
4	TAG			PT10505		PT10506		PT10507		PT10508		PT10509		PT10510		PT10511		PT10512	
5	SERVICE			DAF 5 PRESSURIZATION PUMP		DAF 6 PRESSURIZATION PUMP		DAF 1 PRESSURIZATION LINE 1		DAF 1 PRESSURIZATION LINE 2		DAF 2 PRESSURIZATION LINE 1		DAF 2 PRESSURIZATION LINE 2		DAF 3 PRESSURIZATION LINE 1		DAF 3 PRESSURIZATION LINE 2	
6	LINE SIZE AND SPECIFICATION			DN300/1P4		DN300/1P4		DN200/1P4		DN200/1P4		DN200/1P4		DN200/1P4		DN200/1P4		DN200/1P4	
7	DATA PROCESSING	FLUID		CLW (Clarified water)		CLW (Clarified water)		CLW (Clarified water)		CLW (Clarified water)		CLW (Clarified water)		CLW (Clarified water)		CLW (Clarified water)		CLW (Clarified water)	
8	DATA PROCESSING	PRESSURE (bara): NORMAL	MAXIMUM	6,5	10	6,5	10	6,5	10	6,5	10	6,5	10	6,5	10	6,5	10	6,5	10
9	DATA PROCESSING	HUMIDITY (%) : MINIMUM	MAXIMUM	80	99	80	99	80	99	80	99	80	99	80	99	80	99	80	99
10	DATA PROCESSING	TEMPERATURE (ºC): NORMAL	MAXIMUM	26	32	26	32	26	32	26	32	26	32	26	32	26	32	26	32
11	DATA PROCESSING	AMBIENT TEMPERATURE (ºC)		5	50	5	50	5	50	5	50	5	50	5	50	5	50	5	50
12	SENSOR & TRANSMITTER	ELEMENT TYPE OF MEASURE		Piezoresistive (direct)		Piezoresistive (direct)		Piezoresistive (direct)		Piezoresistive (direct)		Piezoresistive (direct)		Piezoresistive (direct)		Piezoresistive (direct)		Piezoresistive (direct)	
13	SENSOR & TRANSMITTER	MEASURE ELEMENT MATERIALS	Seal	Super Duplex	PVDF	Super Duplex	PVDF	Super Duplex	PVDF	Super Duplex	PVDF	Super Duplex	PVDF	Super Duplex	PVDF	Super Duplex	PVDF	Super Duplex	PVDF
14	SENSOR & TRANSMITTER	BODY MATERIAL AND CONNECTION		Stainless Steel		Stainless Steel		Stainless Steel		Stainless Steel		Stainless Steel		Stainless Steel		Stainless Steel		Stainless Steel	
15	SENSOR & TRANSMITTER	PROCESS CONNECTION (SIZE AND TYPE)		ubbing 1/2" NPT wall thickness 1,5 m		ubbing 1/2" NPT wall thickness 1,5 m		ubbing 1/2" NPT wall thickness 1,5 m		ubbing 1/2" NPT wall thickness 1,5 m		ubbing 1/2" NPT wall thickness 1,5 m		ubbing 1/2" NPT wall thickness 1,5 m		ubbing 1/2" NPT wall thickness 1,5 m		ubbing 1/2" NPT wall thickness 1,5 m	
16	SENSOR & TRANSMITTER	CALIBRATION RANGE		0-10 bar		0-10 bar		0-10 bar		0-10 bar		0-10 bar		0-10 bar		0-10 bar		0-10 bar	
17	SENSOR & TRANSMITTER	ACCURACY % FS		±0,15% of span		±0,15% of span		±0,15% of span		±0,15% of span		±0,15% of span		±0,15% of span		±0,15% of span		±0,15% of span	
18	SENSOR & TRANSMITTER	OVERPRESSURE		200%		200%		200%		200%		200%		200%		200%		200%	
19	SENSOR & TRANSMITTER	AMBIENT TEMPERATURE DEVIATION		±0,05% of span per ºC (note 3)		±0,05% of span per ºC (note 3)		±0,05% of span per ºC (note 3)		±0,05% of span per ºC (note 3)		±0,05% of span per ºC (note 3)		±0,05% of span per ºC (note 3)		±0,05% of span per ºC (note 3)		±0,05% of span per ºC (note 3)	
20	SENSOR & TRANSMITTER	COMMUNICATION PROTOCOL		Profibus PA		Profibus PA		Profibus PA		Profibus PA		Profibus PA		Profibus PA		Profibus PA		Profibus PA	
21	SENSOR & TRANSMITTER	POWER SUPPLY (V & nª CONDUCTOR)		24Vdc (2 wire)		24Vdc (2 wire)		24Vdc (2 wire)		24Vdc (2 wire)		24Vdc (2 wire)		24Vdc (2 wire)		24Vdc (2 wire)		24Vdc (2 wire)	
22	SENSOR & TRANSMITTER	CASING MATERIAL	Salinity Environment	Stainless steel		Stainless steel		Stainless steel		Stainless steel		Stainless steel		Stainless steel		Stainless steel		Stainless steel	
23	SENSOR & TRANSMITTER	CABLE ENTRY		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT	
24	SENSOR & TRANSMITTER	ENCLOSURE PROTECTION		IP65 or higher		IP65 or higher		IP65 or higher		IP65 or higher		IP65 or higher		IP65 or higher		IP65 or higher		IP65 or higher	
25	SENSOR & TRANSMITTER	HAZARDOUS AREA PROTECTION		NA		NA		NA		NA		NA		NA		NA		NA	
26	SENSOR & TRANSMITTER	MOUNTING		In support (Note 4)		In support (Note 4)		In support (Note 4)		In support (Note 4)		In support (Note 4)		In support (Note 4)		In support (Note 4)		In support (Note 4)	
27	ACCESORIES	LOCAL DISPLAY		NO		NO		NO		NO		NO		NO		NO		NO	
28	ACCESORIES	PULSATION DAMPENER		YES		YES		YES		YES		YES		YES		YES		YES	
29	ACCESORIES	DIAPHRAGM SEPARATOR		If apply		If apply		If apply		If apply		If apply		If apply		If apply		If apply	
30	ACCESORIES	MANIFOLD		YES (two valves)		YES (two valves)		YES (two valves)		YES (two valves)		YES (two valves)		YES (two valves)		YES (two valves)		YES (two valves)	
31	ACCESORIES	MOUNTING BRACKET		YES		YES		YES		YES		YES		YES		YES		YES	
32	PIPING AND INSTRUMENTATION DIAGRAM			PUB-WSP-JDD-005		PUB-WSP-JDD-005		PUB-WSP-JDD-005		PUB-WSP-JDD-005		PUB-WSP-JDD-005		PUB-WSP-JDD-005		PUB-WSP-JDD-005		PUB-WSP-JDD-005	
33	APPLICABLE NOTES			3, 4		3,4		3,4		3,4		3,4		3,4		3,4		3,4	

34	NOTES	**NOTES**.- (1) TRANSMITTER WITH SEPARATE DISPLAY OF SENSOR, WITH CONNECTION CABLE	UNIT
35	NOTES	(2) TRANSMITTER WITH INTEGRATED INDICATOR DISPLAY.	PRESSURE: Bara
36	NOTES	(3) AFTER APPLICATION FO10 MINUTES OF PRESSURE AT 130% OF MAXIMUM PRESSURE, THE CHANGE IN ZERO AND SPAN SHALL NOT EXCEED ±0,1% OF SPAN.	TEMPERATURE: ºC
37	NOTES	(4) SEE PUB-WSP-ISA-001 (PROCESS CONNECTION DIAGRAM)	
38		THE SUPPLIER HAS TO COMPLETE THE DATASHEET ACCORDING TO INSTRUMENTS USE AND PROCESS CONDITION (FLUID, PRESSURE, TEMPERATURE AND FLOW)	

Pressure switch data sheet

1	MANUFACTURER																			
2	MODEL Nº																			
3	ITEM Nº		REVISION Nº	17	00	18	00	19	00	20	00	21	00	22	00	23	00	24	00
4	SERVICE			DAF PRESSURIZATION PUMP 4		DAF PRESSURIZATION PUMP 5		DAF PRESSURIZATION PUMP 6		DAF 1 PNEUMATIC PANEL		DAF 2 PNEUMATIC PANEL		DAF 3 PNEUMATIC PANEL		DAF 4 PNEUMATIC PANEL		DAF 5 PNEUMATIC PANEL	
5																				
6	LINE SIZE AND SPECIFICATION			DN300/1P4		DN300/1P4		DN300/1P4		1 1/4"/1C2		1 1/4"/1C2		1 1/4"/1C2		1 1/4"/1C2		1 1/4"/1C2	
7	DATA	PROCESS	FLUID	CLW (Clarified water)		CLW (Clarified water)		CLW (Clarified water)		SEA (Service air)		SEA (Service air)		SEA (Service air)		SEA (Service air)		SEA (Service air)	
8			HUMIDITY (%): MINIMUM	MAXIMUM	80	99	80	99	80	99	80	99	80	99	80	99	80	99	80	99
9			OPERATION PRESSURE	MAXIMUM (bara)	6,5	10	6,5	10	6,5	10	10	16	10	16	10	16	10	16	10	16
10			OPERATION TEMP.	MAXIMUM TEMP. ºC	26	32	26	32	26	32	26	32	26	32	26	32	26	32	26	32
11			MIN AMBIENT TEMP.	MAXIMUM TEMP. ºC	5	50	5	50	5	50	5	50	5	50	5	50	5	50	5	50
12	ENCLOSURE AND ELEMENT		TAG NUMBER		PSH10504		PSH10505		PSH10506		PIS10501		PIS10502		PIS10503		PIS10504		PIS10505	
13			MEASURE RANGE **??**		6,5	10	6,5	10	6,5	10	10	16	10	16	10	16	10	16	10	16
14			OVERPRESSURE PROTECTION		50%		50%		50%		50%		50%		50%		50%		50%	
15			REPEATABILITY		±1% or better		±1% or better		±1% or better		±1% or better		±1% or better		±1% or better		±1% or better		±1% or better	
16			MEASURE ELEMENT	MATERIAL	Piezoresistive	AISI 316	Piezoresistive	AISI 316	Piezoresistive	AISI 316	Piezoresistive	AISI 316	Piezoresistive	AISI 316	Piezoresistive	AISI 316	Piezoresistive	AISI 316	Piezoresistive	AISI 316
17			PROCESS CONECTION		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT	
18			WETTED PARTS MATERIAL		SS 316		SS 316		SS 316		SS 316		SS 316		SS 316		SS 316		SS 316	
19			SEPARATING DIAPHRAGM		Metallic		Metallic		Metallic		Metallic		Metallic		Metallic		Metallic		Metallic	
20			ENCLOSURE		Cast bronze or alluminium		Cast bronze or alluminium		Cast bronze or alluminium		Cast bronze or alluminium		Cast bronze or alluminium		Cast bronze or alluminium		Cast bronze or alluminium		Cast bronze or alluminium	
21			AMBIENT PROTECTION		IP 65		IP 65		IP 65		IP 65		IP 65		IP 65		IP 65		IP 65	
22			HAZARDOUS AREA PROTECTION		NA		NA		NA		NA		NA		NA		NA		NA	
23			MOUNTING		With pressure gauge (Note 2)		With pressure gauge (Note 2)		With pressure gauge (Note 2)		Tubbing 1/2" (Note 2)		Tubbing 1/2" (Note 2)		Tubbing 1/2" (Note 2)		Tubbing 1/2" (Note 2)		Tubbing 1/2" (Note 2)	
24			WIRING INPUTS		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT	
25			TERMINALS: INTERNAL	IN EXTERNAL BOX	NA	YES	NA	YES	NA	YES	NA	YES	NA	YES	NA	YES	NA	YES	NA	YES
26	SWITCHES		TYPE		SOLID STATE		SOLID STATE		SOLID STATE		SOLID STATE		SOLID STATE		SOLID STATE		SOLID STATE		SOLID STATE	
27			QUANTITY	CIRCUITRY	2	PNP	2	PNP	2	PNP	2	PNP	2	PNP	2	PNP	2	PNP	2	PNP
28			RATING		0,5A	24Vdc	0,5A	24Vdc	0,5A	24Vdc	0,5A	24Vdc	0,5A	24Vdc	0,5A	24Vdc	0,5A	24Vdc	0,5A	24Vdc
29			DIFERENTIAL : FIXED	ADJUSTABLE	NA	YES	NA	YES	NA	YES	NA	YES	NA	YES	NA	YES	NA	YES	NA	YES
30			ADJUSTMENT : INTERNAL	EXTERNAL	NA	YES	NA	YES	NA	YES	NA	YES	NA	YES	NA	YES	NA	YES	NA	YES
31			ACTION POINT		9 Bara		9 Bara		9 Bara		1 2 Bara		1 2 Bara		1 2 Bara		1 2 Bara		1 2 Bara	
32			CONTACT OPENS WHEN PRESSURE INCREASES		NA		NA		NA		NA		NA		NA		NA		NA	
33			CONTACT CLOSES WHEN PRESSURE INCREASES		YES		YES		YES		YES		YES		YES		YES		YES	
34	ACCESORIES		PULSATION DAMPENER		YES		YES		YES		YES		YES		YES		YES		YES	
35			DIAPHRAGM SEAL		NA		NA		NA		NA		NA		NA		NA		NA	
36			LOCAL INDICATOR		YES		YES		YES		YES		YES		YES		YES		YES	
37			APPLICABLES NOTES		2		2		2		1,2		1,2		1,2		1,2		1,2	
38	PIPING AND INSTR. DIAGRAM. Number				PUB-WSP-JDD-005		PUB-WSP-JDD-005		PUB-WSP-JDD-005		PUB-WSP-JDD-005		PUB-WSP-JDD-005		PUB-WSP-JDD-005		PUB-WSP-JDD-005		PUB-WSP-JDD-005	
39																				
40	APPLICABLE NOTES																			

41	NOTES	**NOTES**.-
42		(1) THIS INSTRUMENT IS ISOLATED FROM THE PROCESS WITH A BALL ISOLATION VALVE.
43		(2) SEE PUB-WSP-ISA-001 (PROCESS CONNECTION DIAGRAM)
44		THE SUPPLIER HAS TO COMPLETE THE DATASHEET ACCORDING TO INSTRUMENTS USE AND PROCESS CONDITION (FLUID, PRESSURE, TEMPERATURE AND FLOW)
45		
46		
47		

UNITS
FLOW: m3/h
PRESSURE: Bara
TEMPERATURE: ºC
LENGTH: m
DENSITY : kg/m^3

Differential pressure transmitter data sheet

1	MANUFACTURER																		
2	MODEL Nº																		
3	ITEM Nº	REVISION Nº	1	01	2	01	3	01	4	01	5	01	6	01	7	01	8	01
4	TAG		PDIT10601		PDIT10602		PDIT10603		PDIT10604		PDIT13501		PDIT13502		PDIT13503		PDIT13504	
5	SERVICE		UF DISC FILTERS		UF DISC FILTERS		UF DISC FILTERS		UF DISC FILTERS		RO DISC FILTERS		RO DISC FILTERS		RO DISC FILTERS		RO DISC FILTERS	
6	LINE SIZE AND SPECIFICATION		DN600-900/1P4		DN900/1P4		DN600-900/1P4		DN900/1P4		DN600-900/1P4		DN900/1P4		DN600-900/1P4		DN900/1P4	
7	DATA PROCESSING	FLUID	CLW (Clarified water)		CLW (Clarified water)		CLW (Clarified water)		CLW (Clarified water)		UFW (Ultrafiltrated water)		UFW (Ultrafiltrated water)		UFW (Ultrafiltrated water)		UFW (Ultrafiltrated water)	
8		HUMIDITY (%) : MINIMUM MAXIMUM	80	99	80	99	80	99	80	99	80	99	80	99	80	99	80	99
9		PRESSURE (bara): NORMAL MAXIMUM	3,6	10	3,6	10	3,6	10	3,6	10	3,5	10	3,5	10	3,5	10	3,5	10
10		TEMPERATURE (ºC): NORMA MAXIMUM	26	32	26	32	26	32	26	32	26	32	26	32	26	32	26	32
11		AMBIENT TEMPERATURE (ºC)	5	50	5	50	5	50	5	50	5	50	5	50	5	50	5	50
12	SENSOR & TRANSMITTER	ELEMENT TYPE OF MEASURE	Piezoresistive (direct)		Piezoresistive (direct)		Piezoresistive (direct)		Piezoresistive (direct)		Piezoresistive (direct)		Piezoresistive (direct)		Piezoresistive (direct)		Piezoresistive (direct)	
13		MEASURE ELEMENT MATERIALS Seal	Super Duplex	PVDF	Super Duplex	PVDF	Super Duplex	PVDF	Super Duplex	PVDF	Super Duplex	PVDF	Super Duplex	PVDF	Super Duplex	PVDF	Super Duplex	PVDF
14		BODY MATERIAL AND CONNECTION	Stainless Steel		Stainless Steel		Stainless Steel		Stainless Steel		Stainless Steel		Stainless Steel		Stainless Steel		Stainless Steel	
15		PROCESS CONNECTION (SIZE AND TYPE)	ubbing 1/2" NPT wall thickness 1,5 m		ubbing 1/2" NPT wall thickness 1,5 m		ubbing 1/2" NPT wall thickness 1,5 m		ubbing 1/2" NPT wall thickness 1,5 m		ubbing 1/2" NPT wall thickness 1,5 m		ubbing 1/2" NPT wall thickness 1,5 m		ubbing 1/2" NPT wall thickness 1,5 m		ubbing 1/2" NPT wall thickness 1,5 m	
16		CALIBRATION RANGE	0-1 bar		0-1 bar		0-1 bar		0-1 bar		0-1 bar		0-1 bar		0-1 bar		0-1 bar	
17		ACCURACY % FS	±0,15% of span		±0,15% of span		±0,15% of span		±0,15% of span		±0,15% of span		±0,15% of span		±0,15% of span		±0,15% of span	
18		OVERPRESSURE	200%		200%		200%		200%		200%		200%		200%		200%	
19		AMBIENT TEMPERATURE DEVIATION	±0,05% of span per ºC (note 3)		±0,05% of span per ºC (note 3)		±0,05% of span per ºC (note 3)		±0,05% of span per ºC (note 3)		±0,05% of span per ºC (note 3)		±0,05% of span per ºC (note 3)		±0,05% of span per ºC (note 3)		±0,05% of span per ºC (note 3)	
20		COMMUNICATION PROTOCOL	Profibus PA		Profibus PA		Profibus PA		Profibus PA		Profibus PA		Profibus PA		Profibus PA		Profibus PA	
21		POWER SUPPLY (V & nª CONDUCTOR)	24Vdc (2 wire)		24Vdc (2 wire)		24Vdc (2 wire)		24Vdc (2 wire)		24Vdc (2 wire)		24Vdc (2 wire)		24Vdc (2 wire)		24Vdc (2 wire)	
22		CASING MATERIAL Salinity Environment	Stainless steel		Stainless steel		Stainless steel		Stainless steel		Stainless steel		Stainless steel		Stainless steel		Stainless steel	
23		CABLE ENTRY	1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT	
24		ENCLOSURE PROTECTION	IP65 or higher		IP65 or higher		IP65 or higher		IP65 or higher		IP65 or higher		IP65 or higher		IP65 or higher		IP65 or higher	
25		HAZARDOUS AREA PROTECTION	NA		NA		NA		NA		NA		NA		NA		NA	
26		MOUNTING	In support (Note 4)		In support (Note 4)		In support (Note 4)		In support (Note 4)		2" pipe mount		2" pipe mount		2" pipe mount		2" pipe mount	
27	ACCESORIES	LOCAL DISPLAY	DIGITAL/INTEGRATED (Note 2)		DIGITAL/INTEGRATED (Note 2)		DIGITAL/INTEGRATED (Note 2)		DIGITAL/INTEGRATED		NO		NO		NO		NO	
28		PULSATION DAMPENER	YES		YES		YES		YES		YES		YES		YES		YES	
29		DIAPHRAGM SEPARATOR	If apply		If apply		If apply		If apply		If apply		If apply		If apply		If apply	
30		MANIFOLD	YES (three valves)		YES (three valves)		YES (three valves)		YES (three valves)		YES (three valves)		YES (three valves)		YES (three valves)		YES (three valves)	
31		MOUNTING BRACKET	YES		YES		YES		YES		YES		YES		YES		YES	
32	PIPING AND INSTRUMENTATION DIAGRAM		PUB-WSP-JDD-006		PUB-WSP-JDD-006		PUB-WSP-JDD-006		PUB-WSP-JDD-006		PUB-WSP-JDD-035		PUB-WSP-JDD-035		PUB-WSP-JDD-035		PUB-WSP-JDD-035	
33	APPLICABLE NOTES		2, 3, 4		2, 3, 4		2, 3, 4		2,3,4		2,3,4		2,3,4		2,3,4		2,3,4	

34	NOTES	**NOTES**.- (1) TRANSMITTER WITH SEPARATE DISPLAY OF SENSOR, WITH CONNECTION CABLE	UNIT
35		(2) TRANSMITTER WITH INTEGRATED INDICATOR DISPLAY.	PRESSURE: Bara
36		(3) AFTER APPLICATION FO10 MINUTES OF PRESSURE AT 130% OF MAXIMUM PRESSURE, THE CHANGE IN ZERO AND SPAN SHALL NOT EXCEED ±0,1% OF SPAN.	TEMPERATURE: ºC
37		(4) SEE PUB-WSP-ISA-001 (PROCESS CONNECTION DIAGRAM)	
38		THE SUPPLIER HAS TO COMPLETE THE DATASHEET ACCORDING TO INSTRUMENTS USE AND PROCESS CONDITION (FLUID, PRESSURE, TEMPERATURE AND FLOW)	

Temperature Transmitter data sheet

1	MANUFACTURER										
2	MODEL										
3	ITEM Nº	REVISION	1	01	2	01	3	01	4	01	
4	TAGS		TIT13301		TIT13302		TIT13303		TIT13304		
5	SERVICE		UF CIP TANK 1 (TK-13301)		UF CIP TANK 2 (TK-13302)		UF CIP TANK 3 (TK-13303)		UF CIP TANK 4 (TK-13304)		
6	LINE SIZE AND SPECIFICATION		NA		NA		NA		NA		
7	PROCESS	FLUID	CWC (Clean Water Chemistry)		CWC (Clean Water Chemistry)		CWC (Clean Water Chemistry)		CWC (Clean Water Chemistry)		
8											
9		TANK ID	TK-13301		TK-13302		TK-13303		TK-13304		
10		STATE	LIQUID		LIQUID		LIQUID		LIQUID		
11		HUMIDITY (%): MIN/MAX	80	99	80	99	80	99	80	99	
12		TEMPERATURE (ºC): MiNIMUM / MAXIMUM	26	32	26	32	26	32	26	32	
13		PRESSURE (bara) OPERATION / MAXIMUM	1	1	1	1	1	1	1	1	
14		OPERATION TEMPERATURE (ºC)									
15		AMBIENT TEMPERATURE MIN/MAX	5	50	5	50	5	50	5	50	
16		IN SAMPLING LINE	NA		NA		NA		NA		
17	PROBE	MODEL	RTD (1x4 wire type)		RTD (1x4 wire type)		RTD (1x4 wire type)		RTD (1x4 wire type)		
18		TYPE	Pt100		Pt100		Pt100		Pt100		
19		EXTENSION (mm)									
20		DIAMETER (mm)									
21		TOLERANCE									
22		MOUNTING	THERMOWELL, connection to head M24x1,5		THERMOWELL, connection to head M24x1,5		THERMOWELL, connection to head M24x1,5		THERMOWELL, connection to head M24x1,5		
23		MATERIAL	Stainless steel		Stainless steel		Stainless steel		Stainless steel		
24		SENSOR MEASURING RANGE °C	0	100	0	100	0	100	0	100	
25	TRANSMITTER	TYPE									
26		POWER SUPPLY	24VDC - loop-powered		24VDC - loop-powered		24VDC - loop-powered		24VDC - loop-powered		
27		ACCURACY	± 0,15% of span or better		± 0,15% of span or better		± 0,15% of span or better		± 0,15% of span or better		
28		DRIFT	≤ 0.1 ºC		≤ 0.1 ºC		≤ 0.1 ºC		≤ 0.1 ºC		
29		MOUNTING	on wall tank (note 1)		on wall tank (note 1)		on wall tank (note 1)		on wall tank (note 1)		
30		OUTPUT SIGNAL	Profibus PA		Profibus PA		Profibus PA		Profibus PA		
31		LOCAL INDICATOR	YES		YES		YES		YES		
32		CALIBRATION RANGE	0 - 65		0 - 65		0 - 65		0 - 65		
33		MULTIFUNCTION INPUT	Not apply		Not apply		Not apply		Not apply		
34	HEAD	IP PROTECTION	IP65		IP65		IP65		IP65		
35		MATERIAL	Aluminium with Epoxy		Aluminium with Epoxy		Aluminium with Epoxy		Aluminium with Epoxy		
36		TYPE									
37		ELECTRICAL CONNECTION	M20 x 1,5		M20 x 1,5		M20 x 1,5		M20 x 1,5		
38	WELL	MODEL									
39		CONNECTION TO PROBE	M24 x 1,5		M24 x 1,5		M24 x 1,5		M24 x 1,5		
40		MATERIAL	Stainless steel		Stainless steel		Stainless steel		Stainless steel		
41		CONNECTION TO PROCESS TYPE / DN	FLANGED (Note 1)		FLANGED (Note 1)		FLANGED (Note 1)		FLANGED (Note 1)		
42		CONNECTION TO PROCESS PN	PN40		PN40		PN40		PN40		
43		IMMERSION LENGTH (U) mm									
44		OVERALL LENGTH (H + U) mm									
45	PIPING AND INSTR. DIAGRAM. Number		PUB-WSP-JDD-033		PUB-WSP-JDD-033		PUB-WSP-JDD-033		PUB-WSP-JDD-033		
46	APPLICABLE NOTES		1,2		1,2		1,2		1,2		
47											

48	NOTES	(1) See PUB-WSP-ISA-001 (process connection diagram)
49		(2) Shall comply with BS 1041 and BS EN 60751
50		The supplier has to complete the datasheets according to Instruments use and process condition (fluid, pressure, temperature and flow).
51		
52		
53		
54		

UNITS
PRESSURE: Bara
TEMPERATURE: ºC
FLOW: m3/h
DENSITY: Kg / m^3
VISCOSITY: cP
CONDUCTIVITY: µS / cm

ANNEX III: INSTRUMENT SPECIFICATION

CONSTRUCTION OF 3rd DESALINATION PLANT AT TUAS (SINGAPORE)

Flowmeter Technical Specification

Doc. Nº: PUB-WSP- IIP-001
Revision: 01 Date: 16/04/19

Done by	Checked	Approved
JFH	EAG	RFD

CHANGE LOG

REV.	DATE	SECTION / PARAGRAPH AFFECTED	REASONS FOR CHANGE

Index

1 OBJECTIVE

The objective of this Technical Specification is to define the minimum requirements for developing the detailed engineering, manufacture, supply of material, testing, packing, delivery, assembly and commissioning of the instruments for the construction of the 3rd Desalination plant at Tuas III (Singapore).

Supplier shall apply Good Practice, acting in good faith to perform obligations in accordance with the requirements of the Law and international Good Practice in the electricity and desalination industries commonly used in prudent engineering and operation to design, engineer, construct, test, operate and maintain equipment lawfully, safely and economically as applicable to desalination facilities of the size, service, and type as the Plant.

The proposed site is located in Singapore.

2 DEFINITIONS

This specification will be using the followings terms and definition:

- ONWER: The term refers to company that owns the SWRO plant.
- PURCHASER: The term refers to responsible for the construction of the SWRO plant.
- ENGINEERS: The term refers to company that provide engineering services.
- BIDDER: The term refers to the company that submit an offer in accordance with this specification.
- SUPLLIER: The term refers to a bidder whose proposal is accepted.

3 REFERENCE DOCUMENTS

- PUB-WSP-JDD-000 PIPING AND INSTRUMENTATION DIAGRAMS
- PUB-WSP-ILP-001 INSTRUMENT LIST
- PUB-WSP-IHI-001 ELECTROMAGNETIC FLOWMETER DATASHEET
- PUB-WSP-IHI-002 VORTEX FLOWMETER DATASHEET
- PUB-WSP-IHI-003 THERMAL MASS FLOWMETER DATASHEET
- PUB-WSP-IHI-023 ROTAMETER DATASHEET
- PUB-WSP-IHI-026 FLOW SWITCH DATASHEET
- PUB-WSP-DND-001 CODING PROCEDURE
- PUB-WSP-DND-002 P&ID CODING PROCEDURE
- Annex 01_P16 SECURITY AND KINS REQUIREMENTS
- Annex 02_G1.4 PAINTING AND PROTECTIVE COATINGS
- Annex 03_P11 DURABILITY AND MATERIAL OF CONSTRUCTION

4 GENERAL REQUIREMENTS

4.1 Measurement units

In general term the SI unit system shall be used for all technical documents, calculations and data sheets.

The use of another unit system shall be subject to the Purchaser's prior authorization.

4.2 Language

All the documents to be generated by the Contractor during the course of project shall be in English, including those referring to design, manufacture, inspections, quality control, operation & maintenance, etc., as well as the final dossier As-Built.

Any change of language in the documents to be distributed must be authorized by the Purchaser.

The equipment markings, panels and plaques shall be in English.

- Identification plates

4.3 Security and KINS requirements

Instruments shall be comply with "Annex 01 Security and KINS requirements" of this Specification relates to the security and blast services.

4.4 Identification plates

Instruments shall have a manufacturer supplied engraved/stamped metal tag bearing the instrument tag number and calibration data.

4.5 Codes & Standards

Equipment and its parts must be in accordance with some of the following or equivalent latest national and international standards for manufacture, testing and performance.

British Standards

- BS 1646. Symbolic representation for process measurement, control functions and instrumentation.
- BS 1553. Specification for graphical symbols for general engineering.
- BS EN 60073. Basic and safety principles for man-machine interface, marking and identification. Coding principles for indication devices and actuators.
- BS EN 60529. Specification for degrees of protection provided by enclosures
- BS EN 60079-10: Classification of Hazardous Areas.
- BS EN 60079-14: Electrical installations in hazardous areas.

- BS EN 60079-17: Inspection and maintenance of electrical installations in hazardous areas.
- BS 1042: Measurement of fluid flow in closed conduits.
- BS 1322: Specification for aminoplastic moulding materials.
- BS 3406: Determination of Particle Size Distribution
- BS 5424: Specification for Control gear for voltages up to and including 1000 Vac and 1200 Vdc.
- BS 5558: Controllers with analogue signals for use in industrial process control systems.
- BS EN 1092: Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Steel flanges.

American National Standards Institute / Instrumentation, Systems and Automation Society Standards.

- ANSI/ISA 5.1 Instrumentation symbols and identification.
- ANSI/ISA 5.3 Graphic Symbols for Distributed Control/Shared.
- ANSI/ISA 5.4 Instrument loop diagrams.
- ANSI/ISA 5.5 Graphic Symbols for Process Displays.
- ANSI/ISA 7.0.01 Quality Standard for Instrument Air.
- ANSI/ISA 26 Dynamic response testing of process control instrumentation.
- ANSI/ISA 50.1 Compatibility of analogue signals for electronic industrial process instruments.
- ANSI/ISA 50.02 Fieldbus Standard for Use in Industrial Control Systems.
- ANSI/ISA 51.1 Process instrumentation terminology.

Other Standards

IEC (International Electrotechnical Comission) Guidelines for the Documentation of Computer Software for Real Time and Interactive Systems.

- IEC 61131-3 Programmable Controllers - Part 3: Programming Languages.
- IEC 61158 Fieldbus for use in industrial control systems (technically equivalent to ANSI/ISA S50.02) United Kingdom Health & Safety Executive (HSE) Guidelines for Programmable Electronic Systems in safety related applications).

OIML (ORGANISATION INTERNATIONALE DE MÉTROLOGIE LÉGALE)

- R49-1. Water meters for cold potable water and hot water: Type P Accuracy Class 1. Accuracy Class 1 with +/- 0.2% accuracy. OIML R49 Type P specifies continuous self-checking of the sensor and transmitter to ensure a higher accuracy and long term performance.

The applicable standards and design codes shall be the indicated in the datasheets or in this specification. The Supplier shall let the Purchaser know any discrepancy existing between the specified requirements and his experience. If there is any difference of opinion as per the requirements, the Purchaser’s interpretation shall prevail over any other.

4.6 Noise Level (if apply)

The Sound Pressure Level (SPL) of the equipment offered shall not surpass 85 dB (A) at 1m from the reference surface and under environmental conditions appropriate to the test requirements of ISO 37456.

Unless otherwise specified, if the SPL exceed this value the Supplier shall to provide the appropriate noise enclosure and take the necessary measures to comply with this point.

4.7 General conditions of the site

4.7.1 Indicative climatic conditions

The climatic conditions provided in table should be taken into consideration in the design of the Plant.

Temperatures		
Maximum ambient temperature in the shade, to be taken as air inlet temperature for air-conditioning and ventilation	40	°C
Minimum ambient temperature	20	°C
Average annual ambient air temperature	30	°C
Maximum metal temperature in the sun	85	°C
Barometric Pressure		
Maximum barometric pressure	1030	mbar
Minimum barometric pressure	970	mbar
Humidity		
Maximum ambient relative humidity	100	%
Average annual ambient relative humidity	90-95	%
Minimum ambient relative humidity	50	%
Annual Rainfall		
Maximum rainfall during 15 minutes	12	mm
Total rainfall during 2012 and 2013	124	mm
Wind		
Maximum wind velocity	>140	km/h
Design wind velocity	120	km/h
Dust concentration		
Dust concentration in the air under normal conditions	1.0–2.0	mg/m^3
Dust concentration in the air approx. under dust storm conditions	100	mg/m^3
Seismic Activity	Not apply	

4.7.2 Seawater conditions

Feed water for the 3rd Desalination Plant at Tuas (TDP3) will be open intake seawater from the Straits of Johor.

Sea water analysis is typically as follows:

Parameter	Unit	Historical Seawater Data			Design Range	Addopted Design ions
		Mean	95%ile	Maximum		
Ca^{2+}	mg/l	357.00	429.00	768.00	<=500	500.00
Mg^{2+}	mg/l	1,131.00	1,388.00	1,580.00	<=1,400	1,400.00
Na^{+}	mg/l	9,254.00	10,875.00	11,600.00	<=11,500	10,410.85
K^{+}	mg/l	348.00	411.00	436.00	<=420	420.00
Sr^{2+}	mg/l	5.90	7.20	7.30	<=7.3	7.30
Ba^{2+}	mg/l	0.07	0.10	0.10	<=0.1	0.10
NH_4^{+}	mg/l	0.06	0.11	0.82	<=0.2	0.20
Fe	mg/l	0.15	0.40	0.77	<=0.5	0.50
HCO_3^{-}	mg/l	-	-	-	<=150	150.00
SO_4^{2-}	mg/l	2,518.00	2,853.00	3,020.00	<=3,000	2,853.00
Cl^{-}	mg/l	16,760.00	19,020.00	20,800.00	<=20,000	19,158.75
Br^{-}	mg/l	59.00	68.00	72.00	<=70	70.00
NO_3^{-}	mg/l	0.03	0.10	0.78	<=0.15	0.66
F^{-}	mg/l	0.80	1.10	2.00	<=1.5	1.50
SiO_2	mg/l	0.63	1.00	1.30	<=1.2	1.20
B^{3-}	mg/l	3.80	4.70	6.10	<=5.0	5.00
TDS	**mg/l**	**30,833**	**34,500**	**45,100**	**<=35,000**	**35,000**

Intake Sea Water Quality (Chlorophyll-a, TSS and oil and grease):

Parameter	Unit	Historical Seawater Data			Design Range
		Mean	95%ile	Maximum	
Chlorophyll-a	µg/l	1.2	9.3	60	<=60
TSS	mg/l	18	34	127	<=60
Oil and grease	mg/l	0.4	1.7	10	<=10
TOC	mg/l	1.6	2.7	4.5	<=5

The plant design to be based on the following seawater design characteristics.

PARAMETER	Raw Seawater Conditions

TDS mg/l	**35000**
Conductivity mS/cm	**54.6**
Temperature	**26ºC – 32ºC**

5 SCOPE OF SUPPLY

This specification covers the technical requirements to supply instrumentation. It extended to all auxiliaries and accessories (of the above instruments) which are necessary to proper operation of plant.

The scope of supply is indicated in the associated "Datasheets ". The supplier must fill in the information requested in data sheets according to the process conditions and application of the instrument.

5.1 Equipment and services provided by supplier

The Supplier shall be responsible for the manufacture and supply all instruments, devices and equipment defined in the data sheets. If the requirements stated in the data sheets differ from those included in this specification shall prevail those indicated data sheet.

The Supplier will also be responsible for sending all documents, drawings typical installation instructions and technical data specified in chapter 6. Including reports required by design codes and standards and quality certificates. The delivery of the documents shall be those indicated in section 6.2.4.

The Supplier will be responsible for cleaning, packaging and instructions storage and unpacking of each of the instruments and equipment scope of this specification.

The Supplier shall be accepted responsibility to supply compatible components of an instrument or equipment, even that any or all components of the equipment have been supplied by third part or different Suppliers.

If the Supplier wishes to subcontract any part of the work covered by this specification, will be your responsibility to ensure that their subcontractors are fully aware of the relevant requirements of this specification and must be notify Purchaser.

Nothing said in this specification relieve Supplier of the responsibility to perform the analysis, testing, inspection and other activities that Supplier may be considered necessary to ensure that the design, materials and workmanship are satisfactory for common usage or good practice.

5.2 Other services provided by supplier

The Supplier shall include in the supply, quotation and estimate duration for following services:

- Transport work according to established procedures.
- Technical assistance to assembly and install the instruments and equipment.

6 DOCUMENTATION TO PROVIDE

6.1 With the offer

The Bidder shall send the technical offer according to the structure and order of this specification, including a detailed description of the equipment offered. The exceptions will be detailed in the order and form of this specification, referring to the numbers of its most important sections.

The Bidder shall include technical offer those drawings, diagrams, technical reports, etc. that consider adequate to understand the offered equipment. Respects to drawings, the minimum to be included are:

- Dimensional sketch of each instrument or group of identical instruments, with assembling data and wiring terminals of all equipment included in the offer.
- Data sheets for each group of instruments including operational data functional characteristics.
- Spare parts list, with prices including, recommended by supplier for six years of operation and special tools required for assembly and disassembly.

Each bidder may prepare the offer according to its own format and experience; however, it is mandatory that the offer includes clearly and separately the following chapters:

I. Acceptance and exceptions to the technical aspects.
   This section shall begin with a clause of knowledge and acceptance of all technical aspects of offer request by Purchaser that will include the following statement: "This offer is subject to all specification terms except exceptions to specification listed below.
   ”Below are listed the exceptions justifying conveniently and with reference to the headings and paragraphs corresponding to offer request. The exceptions not covered by this section shall not be considered binding.
II. Comments and clarifications to the specification.
III. The notes or comments that not involve deviations of the terms of the specification will be listed "Comments and Clarifications to Specification".
IV. Complete description of supply scope of equipment and materials and associated services.
V. Technical data, drawings, diagrams, charts, procedures and methods.
VI. Program times.
VII. Quality Certificates.
VIII. Possible technical variations that can propose the Bidder.

6.2 With the contract

6.2.1 Document for approval

The Supplier shall submit for approval by Purchaser or its representative, manufacturing procedures and tests required by applicable codes and standards besides the documents listed below:

- Dimensional drawings with general details, space requirements, total weight, mounting information and location of accessories and other data necessary for the design of all equipment supplied.
- Purchaser data sheets for each instrument.
- Documentation and registration of tests.
- Production schedule.
- Inspection Points Program (IPP)
- Testing procedures (acceptance, hydrostatic and calibration)

The performance of any work and/ or manufacturer of equipment before Purchaser acceptance are responsibility of the Supplier.

6.2.2 Document for information

The Supplier will send the following documents for information: Manuals, commissioning, operation and maintenance of each type of equipment or instrument, contain at least the following required information:

- Installation manual and initial startup.
- Operating instructions.
- Material list and components with identity number.
- Recommended spare parts and instructions to order replaceable parts.
- Recommended inspection points periods.
- Troubleshooting guide.
- Supplier quality certificates.

6.2.3 Final document

Once ended the supply, the Supplier delivers manufacturing dossier, containing the following documents:

- Official copy of the quality system certification of the Supplier.
- Inspection Points Program Inspection completed (IPP). This document must be signed and stamped by Supplier and Purchaser.
- Approval procedures copy.
- Certified calibration of all instruments.
- EC declaration of conformity with the applicable directives and in particular with the Pressure Equipment Directives (PED) (97/23 / EC) and Electromagnetic Compatibility (EMC) (89/336 / EEC).
- Copies of quality certificates, reports, test reports, testing protocols, etc.
- Reports documented significant deviations that have occurred.
- Final certified Supplier Quality.
- Delivery Purchaser copy sent by Supplier.

6.2.4 Delivery times

The Supplier shall send the document to review by Purchaser. Delivery times will be starting from purchase order.

Document	Deadline
Document project time schedule	Launch meeting
Inspection point program (IPP)	By supplier
Program design, manufacturing, testing and delivery dates.	By supplier
Completed data sheet	By supplier
Dimensional drawings, connection diagrams	By supplier
Installation, operation, commissioning and maintenance manuals	By supplier
Manufacturing Dossier	By supplier

7 GENERAL CRITERIA DESIGN FOR INSTRUMENTS

The supplier must validate the diameter of flow element (measuring tube according to process conditions, the fluid speed must be between 1-3.5 m/s as general rule.

Instruments and equipment shall keep their characteristics under environmental conditions specified in chapters 4.7 and during their useful life.

All instruments and equipment must be calibrated and adjusted at factory. Calibration or hydrostatic testing shall be conducted using air or demineralized water, where applicable, the instruments and equipment will dry and drain when the test finalized.

Instruments shall be IP 65 (equivalent NEMA) as minimum, where an instrumentation device is located below flood level it shall be IP 68 (equivalent NEMA).

In general, the normal measure of the process variable remains between 50% and 75% of full scale. The instruments must resist 150% over measure.

The transmitters will be supplied with a calibrated output, accuracy not less than SPAN ±.1%. Zero and span could be adjusted easily.

In general, the electrical connection conduit and process connection tubbing will be 1/2" NPT.

The switches provided with adjustable hysteresis. The differential operation will be studied and the switch function is not disturbed. The switching point shall adjust easily without disassembly. To prevent accidental handing shall be protective cover or similar. The repeatability of the switching point of the switches will be best of + 1% of full control range.

Contacts will be dry-contact, the "snap-action" type with switched DPDT (double-pole, double throw) contacts. No mercury vial switches are used.

Voltage	Contac type	Circuit breaker capability
125 V cc	Snap	10 A not inductive 0.5 A inductive
125- 230 V ca	Snap	10 A inductive
< 24 V cc	Snap (Gold Contacts)	1 A not inductive 0.5 inductive

7.1 Datasheet

The supplier has to complete the datasheets according to Instruments use and process condition (fluid, pressure, temperature and flow). The instrument parts in contact with the

fluid and internal mechanisms must be suitable materials for fluid and service. In case of parts in contact with chemical products, manufacturer shall be recommended the proper material in data sheets.

The supplier is the only responsible for the design and construction of all construction details of the field instruments to be provided to ensure reliable operation, safe and appropriate to the application in accordance with the regulations and standards, good practices and their own experience.

7.2 Measurement units

Measurement units to be used for general purpose instrumentation will be as follows, unless indicated in data sheets:

- Flow: m3/h or l/h
- Pressure: Bar, mbar or m.c.w. (a): absolute, (g): relative.
- Level: m (meters).
- Temperature: º C. (centigrade degrades).
- Conductivity: µS/cm (microsiemens per centimeter) or mS/cm (milisiemens per centimeter).
- pH: absolute measure: 0 – 14 points.
- Redox: mV (millivolts).
- Turbidity: NTU.
- Free Chlorine: mg/l (ppm).
- Other chemical: mg/l (ppm).

7.3 Identification

The instruments identification shall be according to PUB-WSP-DND-002 P&ID coding procedure. The tag of the equipment will be defined by the Engineering, according to documents mentioned above. These identification numbers will be engraved on plates of metal (stainless steel) and permanently attached to equipment.

Instruments are delivered with following identification engraved in a metal plate, mechanically fixed to them, where they shall appear at least the following data recorded in an indelible way:

- Tag (code)
- Manufacturer
- Model
- Serial number
- Maximum and minimum calibration

A second stainless steel plate engraved with the tag of the instrument and set to the instrument by stainless steel wire will be included with it. The plaque will be adequate for at least 16 characters of at least 5 mm in height, also indelibly recorded (preferably by stamping).

8 PARTICULAR CRITERIA DESIGN FOR INSTRUMENTS

Next the particular requirements of construction and design for the different instruments are specified according to measurement principle type.

If the characteristics listed below differ from those indicated in the respective data sheets, prevail those indicated in the data sheets.

8.1 Variable area flowmeters (rotameters)

Variable area flowmeters shall be installed in locations free from vibration and with sufficient clearance for the removal of the float. If used in conjunction with a flow regulating valve, the valve and meter shall be close together, with the valve downstream of the meter. Pipework shall be supported, having regard to the weight of the meter.

Rotameters shall have a float moving vertically in a tapered tube, the position of the float being proportional to the flow. The meter tube shall be calibrated for the specific fluid in mass or flow units. The calibration conditions shall be engraved on the tube. Linearity shall be ±3% of full scale or better and repeatability shall be ±1% of full scale or better across a 10:1 flow range. Rotameters shall be factory calibrated and the supplier shall be provided certificates.

Metering tubes shall be removable for range change or cleaning without dismantling the meter or removing it from the line. Metering tubes shall have ends of equal cross-sectional area and if O ring seals are used, tube retainer springs shall be outside the fluid stream. End fittings shall be rotatable to any angle.

Be flanged connection or threaded on both sides with equal diameter to the inserted conduit reductions may be used if necessary.

Rotameters will have an accuracy of 2% of SPAN and the minimum scale divisions will be appropriate for the specified range. The range of flow indicators will be such that the maximum normal operation process value shall be within two thirds of full instrument scale. The maximum measure value must be at 90% of the range wherever possible.

If fitted with switches, the terminal enclosures shall have a degree of protection of IP65 except for locations prone to flooding the enclosure shall be protected to IP68 with a minimum submergence of 10 meters for 8 hours.

8.2 Electromagnetic flowmeters

<u>Construction</u>

Flowmeters shall operate on the electromagnetic induction principle and shall consist of a measuring sensor and measuring transmitter complying with BS EN ISO 6817.

Transmitter could be installed remotely or on pipe. The transmitters shall be intelligent, configuration, auto-diagnostics and allowing remote reading from any point signal loop. The logic board could be replaceable without removing the instrument.

Flowmeter shall be capable of guaranteeing their operation according to specified parameters when mounting on pipes, in a vertical or horizontal position.

The body of the measuring element shall be encapsulated coil type. The measurement tube shall be designed to avoid any risk of blockage. The materials used for the body and connections shall be compatible with the fluid's properties and process conditions, which are usually the same material as the pipe. The internal coating shall be resistant to any possible corrosive action from the fluid, usually made of Teflon or (NBR) Nitrile butadiene rubber. If a higher quality material is required due to the fluid's conditions, the coating may be made of AISI 316 Stainless steel or super duplex.

Measuring sensors shall have a full bore stainless steel metering tube and non-conductive, abrasion-resistant lining to suit the fluid being metered. For potable water applications, the lining material shall be of an approved material. For other applications the lining material shall be suitable for the fluid being measured.

The flanges shall be compatible with those specified for the associated pipework. The size, material and rating of flanges shall meet the specifications in the data sheet.

Measuring sensors shall have factory-sealed power and signal cables, and where applicable, earth cables. The cable lengths shall be sufficient to permit termination external to the chamber, directly to the measuring transmitter. Measuring sensors installed within a chamber shall have a degree of protection IP 68 and shall be suitable for indefinite submersion under a head of water equal to the chamber depth or 3 metres whichever is the greater.

Measuring sensors shall be installed on a steel cradle or concrete plinth with upstream and downstream straight pipe lengths not less than those recommended by the manufacturer. When fitted in lined non-metallic or internally-coated pipework, measuring sensors shall have an earthing electrode or corrosion-resistant earthing rings.

Measuring sensors shall be bonded by tinned copper braid links at each end to the adjacent pipework to ensure a good connection between the body and the metered liquid. Earthing rings shall be provided where required.

Measuring sensors installed in a cathodic protected pipeline shall have isolation and bonding in accordance with the recommendations of the manufacturer.

The flowmeter shall be suitable for use in the prevailing process conditions including but not limited to vacuum conditions where these exist.

The measuring transmitter supply voltage shall be 230 Vac 50Hz unless otherwise specified. The measuring transmitter shall provide a precise current input to the field winding of the measuring sensor and shall convert the resultant signal from the electrodes to analogue and pulse outputs in accordance with BS 5863.

The signal processing facilities of the converter shall ensure that the output signals are unaffected by interfering voltages, stratified flow, changes in fluid electrical conductivity within the limit stated, non- homogeneity of the fluid and the presence of ferrous particles. The instrument zero shall be set at the manufacturer's premises and thereafter this zero shall be maintained automatically without interruption of flow or output signals. The zero and output signals shall be unaffected by partly-fouled electrodes.

The following measuring transmitter features shall be provided as a minimum; additional requirements may be stated elsewhere in the Specification:

1) Pulsed dc field excitation.

2) Scalable pulse output for integration counter drive.

3) Capability of bi-directional measurement with differing forward and reverse ranges and with local and remote indication of flow reversal.

4) Contact operation at a programmable measured value.

5) Integral display of flow and integrated quantity.

6) Galvanic isolation between each output circuit and between the electrode circuit and output circuit.

7) Output circuit isolation from earth within the instrument but suitable for earthing at any point in the external circuit.

8) Key entry for basic parameters.

9) Commissioning and re-scaling to require no special programming.

10) Empty pipe detection using physical electrode.

11) Adjustable low flow cut-off.

12) Self-diagnosis.

13) Continuously adjustable velocity and flow range settings.

14) Terminals accommodated in a compartment separate from electronic components.

Performance

The following performance shall be available as a minimum; superior standards shall be met where stated elsewhere in the Specification or where so required by the metering and/or control requirements.

Overall flow system accuracy for local and remote display (including pulse counter):

True flow as % of full scale setting	Maximum error
30 to 100%	±0.25 % of measured value
10 to 30%	±0.5 % of measured value
5 to 10%	±0.5 % of measured value
Repeatability	Better than ±0.2% of true value

Measuring transmitters shall be interchangeable with those of any other electromagnetic flowmeter of the same design. Calibration checking shall require no auxiliary test meter or simulator.

Plant-mounted measuring transmitter enclosures shall have a degree of protection of not less than IP 65. Measuring transmitters shall not be located in flowmeter chambers or areas subject to flooding.

Electromagnetic flowmeters shall be supplied with a factory calibration certificate for a least a 5-point calibration. For flowmeters over 250mm in diameter this calibration certificate shall be certified traceable to one of the following measurement standards: NAMAS, NATA and NIST.

The following methods shall be used for factory calibration:

1) BS EN 24185:1993, ISO 4185-1980: Measurement of fluid flow in closed conduits and weighing method;

2) BS EN ISO 8316:1997: Method of liquid flow in closed conduits. Method of collection of the liquid in volumetric tank.

3) BS EN 29104:1993, ISO 9104:1991: Measurement of fluid flow in closed conduits. Methods of evaluating the performance of electromagnetic flowmeters for liquids.

Shielded electrodes shall be used. The material shall be suitable for the process conditions, usually AISI 316 stainless steel. For corrosive fluids, higher quality materials shall be used (for example Hastelloy). Standard electrodes shall be used, including a grounding electrode, and they shall be replaceable without requiring to be removed from the pipe's measurement tube.

If fluid speed is higher than 2-3 m/s in measuring tube, a diaphragm shall be used with the electrodes as protection. The transmitter shall be capable of measuring the flow in both directions.

8.3 Thermal flow switches

The thermal flow switch sensing head shall screw into a boss on the process fluid pipeline. The cooling effect of the flowing process fluid shall enable the instrument to determine the velocity of flow and hence operate the flow switch.

The switch-point shall be adjustable over the specified range and shall operate for either a high or low alarm condition. The operation delay time shall be less than 20 seconds and the switching hysteresis shall be less than 10% of the selected range, the wetted materials shall be suitable for the process fluid which may be liquid or gas.

All components of the flow switch shall have enclosures to IP65 or better. The flow switch shall have indicators for power and switch status which shall be visible with all covers closed.

8.4 Vortex meters

Vortex meters shall comprise a transmitter unit and an in-line sensor factory installed into a spool piece. The transmitter may be attached to the sensor in the factory to form a one piece unit. Units with a separate power supply/signal demodulator shall also be acceptable. The probe-transmitter combination shall be selected and calibrated to suit the particular gas to be measured. The vortex flowmeter shall provide a output signal proportional to the volumetric flow and a pulse output for totalization. The transmitter shall provide local indication and calibration facilities.

Vortex meter sensors and spool pieces shall be constructed of stainless steel and suitable for the application and environment and shall be hermetically sealed to prevent the ingress of liquids and gases. The enclosure shall be IP65 or better.

Vortex meters shall be installed such that upstream and downstream straight pipe lengths are not less than those recommended by the manufacturer.

Vortex meters shall be suitable for intrinsically safe installations where specified.

At Reynolds numbers over 20,000, the vortex meter shall have accuracy equal to or better than ±0.75% of reading for liquids and ±1.0% of reading for gases and the repeatability shall be ±0.2% of rate or better. For Reynolds numbers between 4,000 and 20,000 the above accuracy and repeatability limits shall apply as percentages of full scale deflection.

8.5 Thermal flow/mass flow meters

Thermal mass flow meters shall comprise a transmitter unit and a sensor probe for insertion into the process line. The probe-transmitter combination shall be selected and calibrated to suit the particular fluid to be measured. The contractor shall ensure that the mass flow meter shall not be affected by the expected moisture content of the process stream. The mass flowmeter shall provide output signal proportional to the mass flow, and a pulsed output to give totalized flow. The transmitter shall provide local indication and calibration facilities.

Thermal flow meter probes shall be constructed of stainless steel and suitable for the application and environment and shall be hermetically sealed to prevent the ingress of liquids and gases. Probe assemblies shall be complete with facilities including gate valves and packing glands to permit their removal from a running plant, at full line pressure without allowing any escape of liquid. i.e. a “hot tap” type fitting. The transmitter unit shall have an enclosure to IP65 or better.

Thermal mass flow meters shall be suitable for intrinsically safe installations where specified. The mass flow meter shall have an overall accuracy equal to or better than ±3% of mass flow reading.

9 INSPECTION POINTS PROGRAM AND ACCEPTANCE TEST

9.1 Inspection points program

The Supplier shall submit for approval to Purchaser, the Inspection Points Program that supplier shall de perform each and every one of followings stages: collection, manufacturing, testing, calibration and preparation for shipping. The Purchaser shall select the points to watch for him or her representatives.

Inspection Points Program shall contain at least the following sections, indicating in each the following information:

a) Materials inspection: Material receiving inspection used in manufacturing, indicating those quality certificates are required.
b) Manufacturing Inspection: List of main manufacturing checkpoints.
c) Tests: List of testing and tests applicable during the manufacturing process.
d) Protection, cleaning, painting, coating, marking and shipping.

9.2 Tests

9.2.1 General

The Supplier shall perform required tests in his workshop to demonstrate the satisfaction of the Purchaser, that equipment meets the requirements of specification tests. Test reports must be submitted to Purchaser to review and approval. All tests may be subject to inspection by Purchaser or its representative.

9.2.2 Factory acceptance test (FAT)

Each instrument should be tested according to the test procedures developed by Supplier to verify instruments performance characteristics (precision, etc). Tests may be performed at reference environmental conditions and nominal conditions.

9.2.3 Hydrostatic testing leak

Instrument part that work under pressure condition, must be tested hydrostatically for a minimum of ten (10) minutes at a pressure equal to 1 1/2 times the design pressure to detect leaks. The appearance of leakage or loss in hydrostatic pressure will be cause for instrument refusal.

Demineralized water, distilled or clean air is used to perform the test. The water should have a content of less than 10 ppm of chlorides. After hydrostatic testing, instrument drying will be done by air.

9.2.4 Calibration tests

The instruments must be calibrated to the ranges indicated in the data sheets.

The fluids used for calibration must be the same as indicated in the "hydrostatic leak testing."

The instruments must be disassembled not to proceed to drying or other reasons after calibration tests performed.

10 CLEANING AND COATING

The materials and components of all instruments supplied under this specification must be cleaned and prepared at the factory, at the time of shipment, the instruments must be clean.

Surface preparation and coatings shall be in accordance with the specification G1.6 “Painting and Protective Coatings” (See annex 2).

11 PACKING AND PREPARATION FOR SHIPPING

All instruments and equipment specified here must be packed and protected in the factory, to ensure they do not suffer any kind of damage during transport, storage and installation.

Protection, packaging and preparation for shipment shall comply with the general purchase conditions. The Supplier shall provide a transportation schedule that will include the procedures necessary for compliance.

12 QUALITY GUARANTEE

Quality guarantee will be subject to the provisions of the "Terms of purchase" and the specification P11 “Durability and Materials of Construction” (See annex 3).

The Supplier must guarantee the instruments supplied, it will be in accordance with the specifications in the documents included in the request for quotation, ensuring that your design meets the operational requirements set forth herein in its entirety.

The minimum design life shall be 15 years.

The Supplier will have quality documented system. This system will contain as a minimum requirement in order to meet the indicated in this specification, written procedures that ensure adequate control of the manufacture, installation, testing and inspection and testing. This system shall include means for control of materials, parts and components, a plan for the inspection of manufacturing operations, document control, control special processes (eg heat treatment, welding, non-destructive testing, approved welding procedures and data forms) as well as procedures for testing and final inspection. Likewise, the Supplier will require its subcontractors and suppliers applying control requirements similar quality. The Quality Assurance Manual will also be available to the Purchaser and its authorized representative upon request.

Purchaser may make inspections for quality assurance during the manufacturing facilities of the Supplier in order to ensure that the equipment is being built to specification and in accordance with the program.

Purchaser, either as part of the inspection or prior to it, review the System of Quality Assurance and Quality Control System and Supplier manuals, to ensure their validity in the supply of equipment. During the inspection, the Purchaser can audit quality assurance in order to ascertain whether they are following the Quality Assurance System of the Supplier.

The Supplier shall submit for approval to the Purchaser the provision of non-conforming materials found during inspection or final test, or any time within the warranty period. It is the responsibility of the Supplier making satisfactory to the Purchaser, a list of materials identified as not complying with this specification.

The Supplier shall make the repairs or replace defective materials or unsatisfactory in the workshop of the Supplier or on site, depending on where the defect is observed. Such work shall be borne by the Supplier.